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On: 30 November 2012, At: 03:47

Publisher: Taylor & Francis

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International Journal of Biodiversity Science, Ecosystem Services & Management

Publication details, including instructions for authors and subscription information:
<http://www.tandfonline.com/loi/tbsm21>

Changes in land use and landscape dynamics in mountains of northern Europe: challenges for science, management and conservation

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Version of record first published: 30 Nov 2012.

To cite this article: Gunhild Setten & Gunnar Austrheim (2012): Changes in land use and landscape dynamics in mountains of northern Europe: challenges for science, management and conservation, *International Journal of Biodiversity Science, Ecosystem Services & Management*, 8:4, 287-291

To link to this article: <http://dx.doi.org/10.1080/21513732.2012.738094>

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EDITORIAL

Changes in land use and landscape dynamics in mountains of northern Europe: challenges for science, management and conservation

People have influenced mountain landscapes in northern Europe for several thousand years. Land use has produced habitats and biodiversity as well as cultural heritage and our sense of place and identity. Changes in land use now place us at a critical point in determining future management strategies.

This brief statement formed the basis for an international conference under the heading of *People and nature in mountains: changing land use and landscape dynamics* held in Trondheim, Norway, on 21–23 September 2011. The conference marked the end of a 3-year-long research project revolving around the inherent and fundamental dynamic character of landscapes (project title: How to manage DYNAMIC LANDscapes; DYLAN became the project acronym). DYLAN was designed to produce knowledge for evidence-based management and conservation of natural and cultural heritage in upland Landscape Conservation Areas (IUCN category V; protected areas) in Norway.¹ The empirical basis for DYLAN has mainly been limited to Norway, with the exception of a comparative study of protected areas in Great Britain and Norway. The research carried out through DYLAN does, however, reflect larger trends, issues and challenges concerning management and conservation of mountain landscapes, very much set within the Western world more generally. Two interlinked challenges in particular are of concern in this editorial, as well as the articles contained within this special issue; first, the need for integrated knowledge about these landscapes and, second, the need for a long-term perspective on the dynamic character of these landscapes.

Folded into the project, and consequently the introductory statement above, was a concern for how archaeology, cultural history and long-term and contemporary ecology can cross-fertilise each other in order to better understand landscape dynamics in mountain environments.² The purpose of the conference was consequently to present a broad set of knowledge about these environments in order to enable a critical discussion of the need for integrated knowledge which must underpin sustainable management and conservation across the cultural and natural heritage and biodiversity spectrum.

A crucial premise for DYLAN as a whole, as well as the conference, was an acknowledgement of the key role of humans for mountain landscape dynamics, both short term and long term; it is a fact that ‘The changing nature of

mountains is the product of historical interactions between environmental and human-related factors’ (Thompson, Nagy, et al. 2005, p. 43). Different farming systems, a key form of land use, have to a great extent shaped mountain environments and understanding and analysing the role and complexities of changing land uses related to agriculture have guided the project in fundamental ways. A main ambition has been to study such complexities from a variety of disciplinary and methodological perspectives. Running through these different perspectives has been a concern for a long-term land use narrative and its importance for guiding future use, management and conservation efforts. Additionally, understanding long-term changes force us to acknowledge that at present, the changes appear to be more rapid than ever before. In fact, land use is often at present considered to be the *main* driver of changes in mountain ecosystems (e.g. Körner and Osawa 2005; Thompson, Price, et al. 2005), although climate changes are beginning to make themselves increasingly felt, especially in arctic and alpine ecosystems (e.g. Schroter et al. 2005; Kausrud et al. 2008; Post et al. 2009).

With reference to the articles published in this special issue, we will shortly discuss in more detail why integrated knowledge and a long-term perspective is necessary in order to inform a better understanding of mountain landscape dynamics. First, we want on a more general level to briefly outline some key characteristics of mountain landscapes, particularly in the Scandinavian part of northern Europe, and related current scientific and political challenges we are faced with due to great shifts in land use.

Mountain land use and landscape dynamics: a brief outline of long-term use

Although mountain landscapes are harsh and often envisaged as remote wilderness, human use of natural resources has strong traditions in these landscapes (e.g. Birks et al. 1988; MacDonald et al. 2000; Thompson, Price, et al. 2005; Moen 2006; Dodgshon and Olsson 2007; Emanuelsson 2009). Reindeer hunting has probably affected upland ecosystems since the beginning of the Holocene. Grazing indicating plants in pollen diagrams, bones and archaeological findings suggest grazing in upland areas as early as the Late Neolithic, but data on

the densities and regional distribution of prehistoric livestock farming are insufficient, and the relative importance of hunting versus farming was likely to be relative to the environment in question (e.g. Hjelle et al. 2006). Early upland livestock farming is believed to be connected to a nomadic system (mountain transhumance), and, in the Norwegian case, seasonal farms (e.g. mountain summer farms) are so far only dated back to the early Roman Iron Age or the Bronze Age in a few cases (Kvamme 1988). Pollen diagrams demonstrate that livestock farming strongly increased through the Roman and Migration periods (Hjelle et al. 2006). Iron-making, which depended on vast amounts of fuel wood, was also important in several upland landscapes in the same period, and most likely increased the area of open grasslands while forest and fuel-wood resources may have been in short supply. Land use history (type and intensity) of upland landscapes further varied due to both cultural and natural factors such as climate, diseases and social organisation of communities (Welinder et al. 1998; Almås 2004), and from pollen analysis we find depressions due to major catastrophes (e.g. the Black Death) as well as gradual increase in land use intensity from the seventeenth century onwards (Hjelle et al. 2006).

In Norway, the intensity in upland land use probably peaked in the mid-nineteenth century. This is indicated by the high number of mountain summer farms (Reinton 1955). Lack of fuel wood limited the processing of dairy products in some areas. However, the effects of summer farming on landscape structure likely varied among regions and over time due to changes in land use type and intensity, especially over the last 150 years or so. In addition, summer farms were mainly found in southern Norway. Livestock farming had limited importance in most inland areas in the north (at least until the eighteenth century) where reindeer was the main large herbivore. Domestication of reindeer has prehistoric roots, especially in the northern part of Scandinavia and developed in the sixteenth and seventeenth centuries as Saami reindeer nomadism (Dahle et al. 1998; Moen 2006).

Today's Scandinavian subalpine landscape is in a process of forest succession (Emanuelsson 1987; Hofgaard 1997; Linkowski and Lennartsson 2005), but tree density and treeline expansion are very much dependent on the grazing regime (Hofgaard 1997; Speed et al. 2010). With the exception of free ranging sheep, wild browsers/grazers like reindeer and to some extent moose and red deer are the dominating herbivores (Austrheim et al. 2011). The few summer farms only use fodder and fuel wood to a limited extent. However, semi-domestic reindeer still have a strong impact on upland ecosystems in northern Scandinavia (Moen 2006; Bråthen et al. 2007; Ravolainen et al. 2010).

Importantly, new land uses often occur as direct results of the dynamism described. Today, tourism and nature protection stand out as two very important uses, both marking a public interest and responsibility for these environments.

Long-term challenges for science, planning and management

This briefly outlined 'state of affairs' is consequently a result of intimately related social–ecological factors and must be seen in relation to wider processes of restructuring and decline in small and medium-scale agriculture, so characteristic of the upland farming sector across Europe today (e.g. Olsson et al. 2011). The social and economic conditions for upholding traditional land uses have, crudely put, become unfavourable; hence, large parts of the rural populations experience increasing marginalisation driven by a global and liberalist market economy. At the same time, 'mountain areas are particularly valuable areas for biodiversity conservation' (MacDonald et al. 2000, p. 48) much due to these different long-term, low-intensity land uses. The fact that mountain landscapes are characterised by a particular vulnerability due to physical marginality and remoteness and the abandonment of small and extensive farming systems (MacDonald et al. 2000, p. 48) leaves us with this now well-known dilemma that much of the natural (biodiversity) and cultural heritage inherent in these landscapes are depending on land use, e.g. summer farming or transhumance, in order to be sustained. For example, in Norway the majority of red-listed alpine vascular plants are evaluated as threatened due to changes in land use and are associated with semi-natural habitats (Austrheim et al. 2010). Similarly, agriculture is repeatedly stressed as important for upholding cultural heritage values (Daugstad et al. 2006). However, land use is also a complex driver of landscape dynamics, and changes in land uses (or disturbance regimes *sensu* Hobbs and Huenneke 1992) are also threats to sustainable management.

The current situation relating to mountain landscapes is not only a concern for the management and conservation sectors. Because land use is a complex driver, land use is often difficult to measure or quantify and draw upon more experimentally oriented studies. Such studies are the more highly ranked studies in the scientific literature. At the same time, landscapes, because of their complexity, make experimental studies less applicable. In summary, this leaves us with uncertainties as to how land use actually affects these landscapes and the management strategies necessary for a sustainable development of these mountain areas.

The articles

The articles published in this special issue on *Changes in land use and landscape dynamics in mountains of northern Europe* offer different insights into the above outlined complex questions and challenges. All articles are the result of the Trondheim meeting, yet emanating not only from the DYLAN project as such. We wanted this special issue to reflect also wider debates relevant for land use and landscape dynamics. We thus take off from the basic question of temporality, represented by the notion of 'long term', set within the context of ecology and conservation biology.

Cultural landscapes are inherently layered, yet it can be argued that management tends to have a stronger focus on the more recent cultural practices which are part of our (generations) own life histories. However, landscapes/ecosystems as we perceive them today are the result of age-old uses, as outlined above. Thus, understanding the long-term perspective is also a basis for sustainable management of dynamic landscapes and ecosystems with an often shifting impact on different natural and cultural processes driving these changes. In the first article of this issue, *Ecological palaeoecology and conservation biology: controversies, challenges, and compromises*, John Birks argues that in order to understand long-term dynamics as a tool for both predicting and managing biodiversity there is a need for a stronger integration between palaeoecology and conservation biology. As a means to facilitate this interaction, he presents nine questions of critical importance to conservation biology that could be answered by palaeoecology. Many of these questions are later touched upon by case studies in this issue.

In the second article, *Ecosystem services and landscape management: three challenges and one plea*, Setten, Stenseke and Moen critically discuss the nature of landscapes and landscape dynamics within an ecosystem services framework. The ecosystem services framework has been designed to raise awareness of services provided by ecosystems to humans, also in mountain environments. Inherent in the framework is an argument that such service-providing ecosystems must be protected. This article reflects the fact that mountains, as only one example of environments representing important natural and cultural resources, are caught up in a rather recent type of land use, namely that of management, protection and conservation. In this conceptual article, the authors argue that the widespread rise of the ecosystem services framework does not guarantee sustainable management, let alone sound use and protection of resources. Taking landscape dynamism and management as points of departure, it is argued that the ecosystem services framework is neither readily applicable in framing nor analysing landscape management.

The four articles which now follow are direct results of the DYLAN project. Hence, we now move explicitly into the practical world of integrated knowledge and a long-term perspective.

Landscape conservation, at least in a Norwegian perspective, has mainly focused on natural heritage; biodiversity at different scales from populations to ecosystems, and from a nature conservation point of view land use activities and their marks in landscapes could be perceived as ecological factors shaping semi-natural habitats. Cultural heritage is often an important part of the conservation objectives independent of their functional importance for natural heritage or biodiversity. Objects pre-dating 1537 and Saami objects older than 100 years are automatically protected by law in Norway, while younger objects or wider landscapes are all left for endless disputes relating to conservation values where age appears to be the only guideline. Furthermore, land use *practices* could also

be perceived as cultural heritage, which opens up questions relating to whether we also need conservation of specific land use techniques? If yes, how can that be achieved?

In an international perspective, the Norwegian concern for encroachment and the subsequent reduction of open semi-natural upland habitats is contrasted with the view of maintaining and restoring natural habitats which have been tree felled, burned and heavily grazed. This is the case for many conservation areas in the United Kingdom, where strong grazing pressure by sheep and deer, burning and anthropogenic nutrient deposition have been identified as key drivers of habitat degradation (Thompson, Nagy, et al. 2005). Woodland encroachment is thus not an issue in the United Kingdom, where land use factors still favour the suppression of woodland regeneration and even of dwarf shrub vegetation in some areas. In their article, *Natural and cultural heritage in mountain landscapes: towards and integrated valuation*, Speed et al. present findings from a comparative study of four Norwegian and three British upland sites (the Lake District, the Cairngorms and Snowdonia). The research team have examined cultural and natural heritage areas and objects in relation to land use history and conservation philosophy and suggested a model for integrated valuation of natural and cultural heritage along a gradient of land use intensity.

As stated by Speed et al., the upland landscape defined as a more large-scale areal unit, including both natural and cultural objects, differs both between countries like the United Kingdom and Norway, as well as to a large extent within countries. An important aim for the DYLAN project has been to examine these differences in land use and landscape dynamics more in detail within Norway. Four upland study sites were selected in different regions and a coarse chronology of the upland landscape in the Holocene (c. 10,000 BP up to present) was presented based on palaeoecological, archaeological, historical and ecological data in protected areas representing different natural and cultural environments. In their study, Hjelle et al. have integrated studies in ecology, palaeoecology and archaeology in the valley Erdalen in western Norway, where agricultural land use was dated back to the Bronze Age. They examine how more or less continuous land use processes have impacted this valley situated in an inner fjord to underpin knowledge-based management and conservation of this ancient cultural landscape. In their article, *Ecology and long-term land use, palaeoecology and archaeology - the usefulness of interdisciplinary studies for knowledge based conservation and management of cultural landscapes*, they argue for continued land use to maintain semi-natural habitats and for the visibility of archaeological sites.

In the article, *Historical legacy of the old-growth pine forest in Dividalen, northern Scandes*, Sjøgren and Kirchhefer tell a very different story. In Dividalen, northern Norway, Saami reindeer pastoralism has affected the landscape before agriculture and forestry entered the valley in the mid-nineteenth century. Trees represent important heritage at this site, both in cultural terms as they are modified by humans and in natural terms as the pine trees together

with dead wood are also important for a high number of red-listed fungi, lichens and invertebrates. Maintenance of old pine trees is thus central for both natural and cultural heritage conservation in Dividalen.

In the third case study from the DYLAN project, Solem et al. examined the effect of long-term land use on landscape dynamics in the upland landscape conservation area of Budalen, central Norway. In Budalen mountains, summer farming has been the main land use during the latest century, and the vegetation today is dominated by open birch forest with grasslands and patches of mire. Archaeological and historical investigations combined with palaeoecological and ecological studies are presented in the article *Long term land use and landscape dynamics in Budalen, central Norway*. The findings show that the opening of the forest corresponded with iron production at lower altitudes as early as BC 180–AD 25, while haymaking and livestock grazing mainly started to affect the birch meadow forest in fifteenth to sixteenth centuries. Thus, today's wooded birch meadows probably dominated the valley also before humans used the land.

Land use processes are undoubtedly also important drivers for vegetation changes in Norway. In the final article, *Impacts of land use on the vegetation in three rural landscapes of Norway*, Bryn and Hemsing present findings from a study where they have compared actual and historical vegetation maps with potential natural vegetation models to quantify the present land area with a vegetation type that differs from the estimated natural state. They conclude that 56–66% of the total area in three rural Norwegian municipalities (with a large proportion of upland areas) appears to have been modified by land use. Moreover, land use changes during the latest 35–40 years have caused a turnover in vegetation types by 25%. Forest succession in former open semi-natural habitats accounts for a large proportion of this change.

Concluding remarks

The divide between science and management is generally described as increasing. This is worrying for an evidence-based management regime that aims at employing an adaptive procedure; a continuous process improvement to the management (Holling 1978). The DYLAN project was based on management challenges identified by the Office of the Auditor General of Norway (2006), highlighting that changes in land use and landscape dynamics were threatening natural (biodiversity) and cultural heritage in protected areas in Norway, of which many could be found in the mountains. We hope that this special issue not only provides knowledge useful for understanding the dynamics of these cultural landscapes, but also more directly challenge stakeholders as well as policymakers, planners and managers working in mountain landscapes to provide concrete answers to the question: Which are the main natural and cultural heritages representing different land use and landscape states in the past that we would like to maintain in the future?

Acknowledgements

We are grateful to John H.J. Birks, Alison Hester, John Atle Kålås and Des B.A. Thompson for providing valuable comments for planning this special issue and to all the reviewers who contributed to increase the quality of the articles. We are also grateful to the managing editor Alexander van Oudenhoven for keeping us on our toes during the publishing process.

Notes

1. DYLAN was financed by the Research Council of Norway's programme on Norwegian environmental research towards 2015 (MILJØ2015), project number 190044/S30, <https://www.vm.ntnu.no/dylan/>.
2. Also related fields such as human geography and environmental history were represented in the project.

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