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Forest conservation in a changing world: natural or cultural? Example from the Western Carpathians forests, Romania

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Abstract. In order to plan for the future management of some of the most biodiverse forests of Europe, it is essential that we understand under which condition they arose and the time and processes responsible for their variability. Here, I highlight the main findings from the paleoecological (pollen and charcoal), archaeological, and historical investigation comprising the last 6000 years in the Apuseni Natural Park (NW Romania), and discuss the effect of the past land use and forest management on these forests. I then ask what does it mean in term of conservation values if these forests are not natural but a human product and bring up the relevance of cultural landscape for conservation.

Keywords: pollen, documentary records, land use change, forest management, cultural landscape, conservation, Apuseni Natural Park, Romania.

INTRODUCTION

Paleoecological and paleoenvironmental records provide information on ecosystem dynamics such as the time and condition of their development, the range of environmental variability and human impact they have been throughout and can therefore assist the restoration of damaged or degraded ecosystems (Willis and Birks, 2006; Jackson and Hobbs, 2009). Although, ecological systems are not static in time and space, the management of many European landscapes, and of forests in particular, is focused on practices that see the ecological systems as 'stable' to any change be it from human activity or climate. Conservation policy also sets as primary aim of nature reserves to conserve the natural landscapes. This contrasts with paleoecological research, which often reveals deep human imprints on many ecological systems (Willis and Birks, 2006; Jackson and Hobbs, 2009). After the introduction of the cultural landscapes in the World Heritage Convection in 1992, because these landscapes are created by man and nature and reflect the development of human society and their subsidence over time, there has been a number of national and international initiatives such as Pan-European Biological and Landscape Diversity Strategy, World Heritage Convention of UNESCO, European Landscapes Convention, Italian National Council for rural development, underway to conserve these cultural landscapes (Agnoletti, 2007). The cultural origin is mostly applied to open landscapes to illustrate the rural development and preservation of cultural heritage. On the contrary, forested landscapes tend to be viewed as natural even if the paleoecological studies indicate that forests, which have been cleared or intensively managed, can be compositionally different to what would occur there under natural climatic conditions (Peterken, 1996, 1999; Bradshaw, 2004). However, in the mountain areas of Eastern Europe, large parts of the forests are still considered undisturbed or old-growth forests. In this region, there has been relatively little work to examine condition under which these forests arose and the range of environmental variability and human impact they have experienced.

In the following, I highlight the main findings from published (Feurdean and Willis, 2008a, b; Feurdean et al., 2009) paleoecological (pollen and charcoal), archaeological and historical investigation comprising the last 6000 years, in the Apuseni Natural Park, NW Romania (Fig. 1), a reserve thought to preserve large track of the old-growth forests and their high diversity and show the effect of past land-use changes and forest management on these forests composition. I then ask what does it mean in term of conservation values if these forests are not pristine but rather a human product?

ENVIRONMENTAL CHANGES VERSUS HUMAN IMPACT IN DRIVING FOREST DYNAMICS DURING THE LAST 6000 YEARS IN THE ANP

Results from the paleoecological investigation indicate that forest composition have been dynamic over the last 6000 years with continual development of new species assemblages, whilst old one dissolved.

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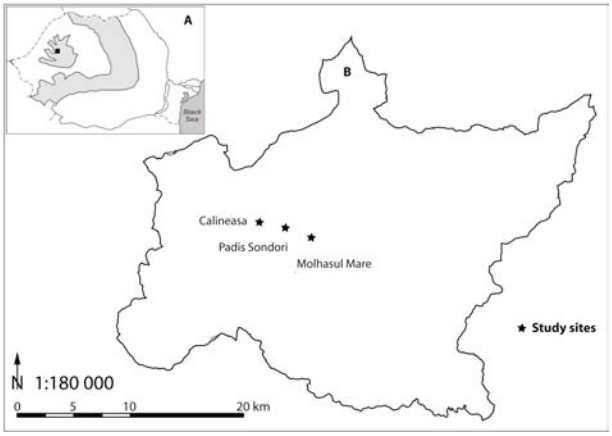

Fig. 1. *Map showing (A) the location of the Apuseni Natural Park and (B) the sites within park boundaries used for paleoecological investigations.*

Changes in vegetation and their driving factors can largely be summarized as follows. Before 3500 yr BP changes in climate and natural fire regime were the main triggering factors for the species composition with humans having only subtle influence (Figs. 2, 3).

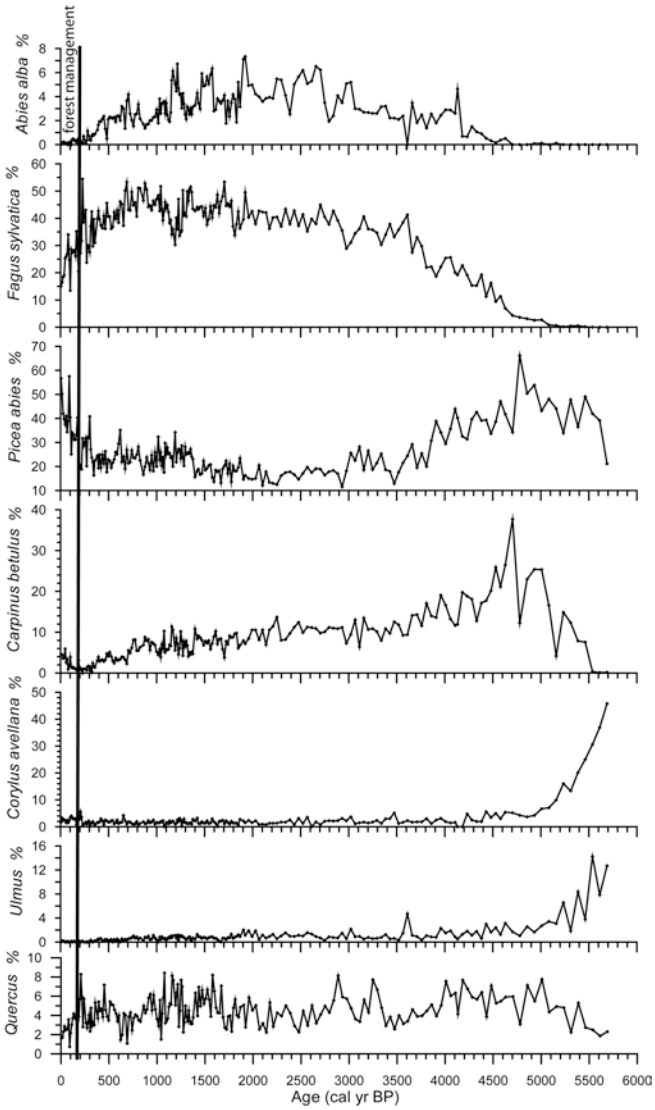

Fig. 2. *Trends in the pollen percentages of the selected forest species in the Apuseni Natural Park throughout the last 6000 years.*

These forests were initially (ca. 6000 yr BP) dominated by *Corylus avellana* - *Picea abies* with abundant presence of *Ulmus, Quercus, Tilia, Fraxinus excelsior, Alnus, Betula, Pinus,* and from about 4800 yr BP by *Fagus sylvatica, Picea abies, Carpinus betulus,* and *Abies alba* with a notable reduction in *Ulmus, Tilia, Fraxinus excelsior* (Bodnariuc et al., 2002; Jalut et al., 2003; Feurdean and Willis, 2008a, b; Feurdean et al*.,* 2009). Although still delicate, human impact became more visible between 3500-2200 yr BP. The intensity of human impact has, however, intensified from about 2200 yr BP onwards when small-scale forest clearances, burnings, seasonal forest and meadow livestock grazing became increasingly common. Mining activity became more widespread and there is also a correspondent increase in forest clearance to supply wood for smelting (Feurdean et al*.,* 2009). Forests became depleted in tree species such as *Fagus sylvatica*, *Abies alba, Ulmus, Tilia, Fraxinus excelsior*, and enriched in *Picea abies, Betula, Alnus,* and *Pinus* (Figs. 2, 3).

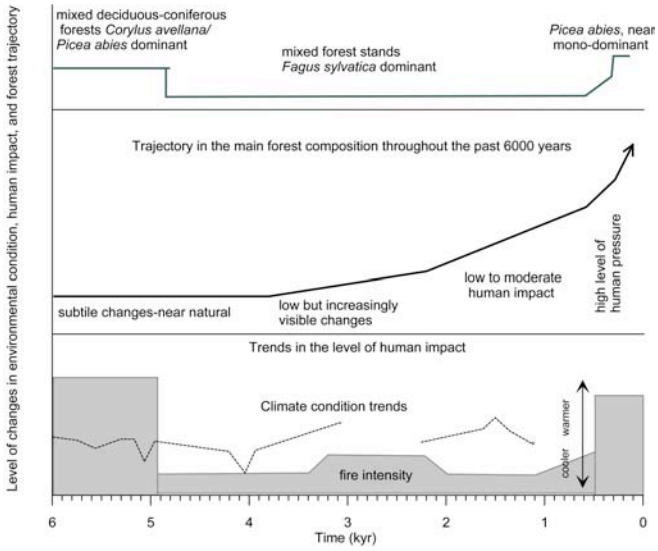

Fig. 3. *Schematic representation of changes in temperature based on oxygen isotope record (after Onac et al., 2002; dashed line), alongside with fire intensity, human impact, and trajectory in the main forest composition (after Feurdean and Willis, 2008a, b; Feurdean et al., 2009). Paleoecological study show that human impact over the last 150 years have severely altered the forest composition by switching the forest type from Fagus sylvatica to near mono-dominant Picea abies forests.*

However, despite this human legacy the forests have kept the relative abundance of the dominant species *Fagus sylvatica*. At ca. 1850 AD, mechanized timber exploitation and forest management practice (timber harvesting and reforestation) have been introduced (Csuscuja, 1998). Rural depopulation in the mountain areas in the last decades left industrial timber exploitation the dominant economic activity. The ecological impact of this late human impact (ca. 1850 AD) is the increase in the distribution areas for *Picea abies* and the decline of other species, primarily of *Fagus sylvatica* (Fig. 2).

So when and how did the present forests arise? The paleoecological perspective shows that *Fagus sylvatica* forests, the dominant species until few centuries ago, have been formed ca. 5000 yr BP likely do to cooler and moister climate condition. Its relative abundance has been rather constant until ca. 500 years ago, with only low to moderate fluctuations. Contrary, although *Picea abies* was an abundant tree species before the significant human impact, formation of the current *Picea abies* dominant forests took

place over the last two centuries apparently as a result of plantation following clearance and fast natural regeneration. Results thus indicate that superimposed to environmental variability, human impact became increasingly responsible for the changes in the forest composition (Fig. 3). However, at low level of anthropogenic impact as that prior to 1500-1850 AD forest has recovered, although with a slightly modified forest composition. On the contrary, deeper anthropogenic impact over the last 200 years has resulted in passing the threshold and in a switch of the forest composition from a species rich forest to an almost mono-dominant *Picea abies* forests (Figs. 2-4).

Fig. 4. *Landscape in the central-western part of Apuseni Natural Park illustrating the consequence of forest management on the forest composition and structure (Photo: M. Petrovici).*

ECOLOGICAL RESTORATION AND CONSERVATION: NATURAL OR CULTURAL?

Evidence from this paleoecological record shows that the forests in the study area are compositionally different than that of pre-human impact, i.e., *Picea abies*, not *Fagus sylvatica* dominated. Although many of the forests in the central-western part of the APN are not old growth and contain rather small remaining original-natural fragments, all tree species are native to the region and most of the forests are ecologically well connected. This finding thus indicates that probably few if any European forests contain large tracks of old growth natural forests. The current forests of ANP have significant legacy of former land use systems and forest management practice, and suggest that some consideration of the cultural legacy should be included in the management and conservation of these forested landscapes. Considering the long-term dimension we determined types of former land use, which can help preservation of closer to natural landscapes (*Fagus sylvatica* forest prior to 1550 AD), i.e., small-scale forest clearance, burning, livestock summer grazing. This scale of human activity also appeared to produce a mosaic of landscape features contributing to the increase in landscape diversity. Contrary, land use types such as large-scale industrial forest exploitation and forest management have altered the forest ecosystems composition and function i.e. have switched the dominance from deciduous taxa, *Fagus sylvatica* to the conifers *Picea abies*. Reinforcement of the traditional farming practice such as summer livestock grazing can reduce the conservation costs of maintaining the reserve and its people, as opposite to only focus on forests. These reference conditions will also result in the conservation of historical, spiritual and educational values of these landscapes. Ecosystem services, i.e., unmarked values of the forests such as recreational activities, biodiversity, refugia, climate regulation, medicine, and food products, not solely or importantly for its timber purpose increase the capita of a forest and contribute to human welfare (Constanza et al., 1997; Reif et al., 2008; Sutherland et al., 2009).

While these are suggestions for conservation approach based on paleo-perspective, an integrated approach by using multi-proxy investigations (paleo-data, observation, modeling) will most probably better prepare to handle the future impact of climate change and humans on the ecosystems. Such efforts are increasingly committed and it is expected that this will increase the prediction accuracy on how to master the ecological systems and their diversity.

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