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Long-term Fire History and Remote Sensing Based Fuel Assessment: Key Elements for Landscape Management in the Swiss National Park

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Abstract

Swiss Federal law protects all natural processes occurring within the borders of the Swiss National Park (SNP). Natural wildland fires are counted among them and should not be extinct. Strict nature conservation represents the top goal of the SNP (IUCN category I) and does not allow any mitigation measures being undertaken unless the park is put at risk in its very existence. However, for societal reasons all fires are put out at present regardless whether they are of natural or human origin. Ninety years of strict nature protection have triggered fuels to build up in the boreal type forests of the SNP reaching the point where natural fire cycles could come into play again.

With field-based fuel investigations and high-resolution Remote Sensing (i.e. LIDAR and Imaging Spectroscopy) we get a very good picture of the present forest and fuel structures, allowing us to predict potential fire behavior. On the other hand pollen and charcoal analysis show us that fire has been an important and regular disturbance factor in the SNP area, shaping vegetation succession long before men became a dominant factor in this remote landscape. All these elements are input to the fire management policy of the Swiss National Park.

Introduction and Motivation

The leasing contracts between the Swiss National Park and the land owning communities specify that the SNP is liable for damages emerging from within its borders. Therefore, all fires are extinct at present regardless whether they are of natural or human origin. After ninety years of strict nature protection – meaning no management measures whatsoever – the question arises whether or not fuels are building up in the boreal type forests of the SNP reaching the point where natural fire cycles could come into play again and what to do from a managerial point of view?

The goal of this long-term study is to develop fire management strategies that integrate ecological and societal demands alike and thus have a chance to be accepted by the local population and authorities.

Material and Methods

Fire history and vegetation conditions are part of the puzzle required for the elaboration of a Wildland Fire Management Plan (FMP) that meets the requirements of a nature conservation area such as the Swiss National Park. However, it is not the goal of this paper to give a detailed description of how a complete FMP is developed, yet to give details on a future FMP for the Swiss National Park.

<u>Study Area (Swiss National Park)</u>

The Swiss National Park is situated in the Southeast of Switzerland in the midst of the Engadine Valley, one of the top tourist destinations of the Canton of Grison. Rugged topography, Dolomite limestone and little precipitation (900 mm per year) create harsh environmental conditions. Forests cover one third of the Swiss National Park. Before the foundation of the SNP in 1914 these forests were heavily logged and livestock grazing was going on (Parolini 1999).

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Fuel Assessment

Specific SNP fuel models were established in former investigations (ALLGÖWER et al. 1998) and introduced to GIS-based fire propagation modeling.

In 2002 a high resolution remote sensing campaign took place where the Ofenpass area was investigated with a LIDAR sensor (Falcon II by Toposys, Ravensburg, Germany) as well as two Imaging Spectroscopy sensors (DAIS and ROSIS by DLR, Germany. Both flight and ground truth campaigns are described in detail by MORSDORF et al. (2004) and KOETZ et al. (2004)

Long-term Fire History

Little is known on the long-term fire history of the Swiss National Park. Unfortunately natural archives such as mires are very rare in that area. Nevertheless it was possible to core one mire south of Il Fuorn (central Ofenpass) and to perform pollen, plant macrofossils, microscopic and macroscopic charcoal analysis. A detailed description of our Holocene fire history investigations can be found in STÄHLI et al. (subm.).

Results

Fuel Models and Fuel Build-up

Former studies produced three fuel models (A, B, and C) for the Swiss National Park (ALLGÖWER et al. 1998). Species names follow the nomenclature of the *Flora Helvetica* by LAUBER and WAGNER (1996).

Model A is an assemblage of mixed conifers, namely *Larix decidua, Pinus sylvestris* L., *Pinus mugo* ssp. *uncinata, Picea abies,* and *Pinus cembra.* This vegetation set-up is typical for N, NW and NE oriented slopes. The understorey is formed by *Erica carnea* L., *Rhododendron* L. *hirsutum* L., and *Rhododendron ferrugineum* L. as well as various *Gramineae* and *Cyperaceae* associations. Fuel loads are low to medium. Fire behavior is expected to be of low to medium intensity. However, some stands could easily develop intense fire behavior as they are rich in vertical fuels consisting of lichens and low reaching branches.

Model B consists of Mountain Pine *Pinus mugo* ssp. *uncinata* mainly and is typical for the S, SW and SE facing slopes. The understorey is formed of dense *Erica carnea* L. 'carpets' that would maintain a low intensity surface fire. Depending on the amount of fine dead fuels and the distribution of vertical fuels fire behavior is expected to vary from medium to severe. In general surface fires are expected to develop into crown fires easily wherever vertical fuels, especially low reaching branches allow for torching.

In Model C the 'dwarfed Mountain Pine' (German Legföhre) *Pinus mugo* ssp. *mugo* is the dominant tree species. Fuel loads are high and fire behavior is expected to be severe. This *Pinus* variation forms a brush like, very dense vegetation cover that grows to an average height of 2 to 3, seldom 5 meters; it is typical for avalanche shoots and other disturbance areas. The understorey often contains dense *Erica carnea* L. 'carpets' but may also consist of gravel which then reduces fire potential considerably.

The LIDAR investigation provided very good data on the vertical and horizontal distribution of the fuels as single tree geometry can be derived, in particular tree height, crown base height, crown diameter and from that fractional cover. The main output of the DAIS campaign are Leaf Area Index LAI (m^2/m^2), crown water content (g/m^2), water equivalent water thickness (g/cm^2), and live fuel moisture content (%). All results are described in detail in MORSDORF et al. 2004 and KOETZ et al. 2004.

Long-term Fire History

Our pollen and charcoal analysis show that fire has been an important and regular disturbance factor in the SNP area, shaping vegetation succession long before men became a dominant factor in this remote landscape. The Il Fuorn core allows us to study approximately 8000 years of landscape and vegetation history. Thereafter we can distinguish two phases: a) 6000 BC to 0 and b) 0 and 2002 AC. Contradictory to all expectations the first phase is characterized by a rather high fire frequency – one event per approximately every 250 to 300 years, whereas fire cycles become almost twice as long during the second phase. During the investigated time period *Pinus mugo* ssp. *uncinata* has always been the dominant tree species and seemed to nicely intertwine with *Picea abies* which was present in higher concentrations than today. Herbs and *Graminacea* pollen do not vary significantly between the two phases; *Cerealia* pollen cannot be found at any time at the coring site of Il Fuorn. This indicates that the Ofenpass was settled only late and for logging purposes mainly. This may also explain why fire cycles increased despite human presence. Logging and livestock activities kept fuel loads low and hence decreased fire ignition probability.

Discussion and Outlook

Fire and Mountain Pine stands seem to go along fine – they even appear to promote each other! This comes as no surprise really as it is a well-known fact that many pine species and fire have a close relationship and depend on each other. Hence, given the fact that fuels are building up in the Swiss National Park it is maybe only a question of time until a natural fire regime will establish itself again. Future fire management that fully respects the park's goals and legislation needs to respect ecological and societal requirements alike and will have to balance them carefully. If the SNP succeeds to handle this challenge successfully, he will become a pioneer in dealing appropriately with (natural) fires in the Alps in the future. Based on the described results, previous analysis of the present fire situation (LANGHART et al. 1998) as well as fire risk analysis (BÄRTSCH 1998) wildland fire management strategies are now being developed that seek to meet the requirements of the SNP and the surrounding areas. With that we hope to set the path for the successful and well-received 're-introduction' of a natural and moderate fire regime to the landscapes of the Swiss National Park.

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