History of anthropogenic disturbances in the pine forest belt of the Swiss Rhone valley (Valais)

Author(s):
Gimmi, Urs

Publication Date:
2006

Permanent Link:

https://doi.org/10.3929/ethz-a-005358604 →

Diss. ETH No. 16764

History of anthropogenic disturbances in the pine forest belt of the Swiss Rhone valley (Valais)

A dissertation submitted to the
SWISS FEDERAL INSTITUTE OF TECHNOLOGY
For the degree of
DOCTOR OF SCIENCES

presented by
Urs Gimmi

Dipl. Geograph, Universität Bern
Born 18th September 1972
Citizen of Bürglen TG

Accepted on the recommendation of
Prof. Dr. Klaus C. Ewald, examiner
Prof. Dr. Anton Schuler, co-examiner
Prof. Dr. Christian Pfister, co-examiner
PD Dr. Matthias Bürgi, co-examiner

Table of contents

Supplementary Material is added on CD-ROM

Includes interview guideline, transcribed interviews, livestock statistics

Summary

Most landscapes and ecosystems are affected by human activities. Therefore anthropogenic activities are widely recognized as important components of most landscapes and ecosystems. This is also the case for forest ecosystems. In forest ecology research human activities are understood as ecosystem disturbances in the same way as natural disturbances such as storms and forest fire. The understanding of human impacts on ecosystems and landscapes is therefore essential for the appropriate interpretation of the current state of these systems and forms the baseline for more informed prediction about their future development. Historical ecology research integrates the anthropogenic dimension into ecological research by linking history and ecology.

In the last decades, significant shifts in tree species composition from Scots pine (*Pinus sylvestris* L.) to pubescent oak (*Quercus pubescens* Willd.) and other deciduous trees have been observed in the pine forest belt of the Swiss Rhone valley (Valais). Complex interactions between climate change and land use change as well as insects, fungal decay and phytopathogenes were suspected to contribute to these effects. This thesis examines the contribution of anthropogenic disturbances to changes in Scots pine ecosystem in the Swiss Rhone valley with a specific focus on past traditional non-timber forest uses (e.g. wood pasture and forest litter collecting). The thesis addresses the following research aims: i) identification of the important non-timber forest uses in the Scots pine forests of the Valais during the 19th and 20th century (chapter I), ii) quantification of past forest-uses in terms of intensity as well as spatial and temporal extent (chapter II) and iii) assessment of the impact of these forest uses on Scots pine forest ecosystems (chapter III). Furthermore, the implications of this study for forest management and global change research are discussed.

In the first study (chapter I), a comprehensive picture about past traditional forest uses in the Swiss Rhone valley is elaborated by combining information from forest management plans with oral history interviews. Wood pasture (goats and sheep) and forest litter collecting are identified as the most important traditional non-timber forest uses in the pine forest belt of the Valais. Other practises are of local socio-cultural relevance but of minor ecological importance. The spatial and temporal extent of traditional non-timber

forest uses is determined by the regulation of the forest authorities, the accessibility of the forests, the access to substitute products, the economic situation of the local people and changes in the demand. The results of this first qualitative study establish the basis for the subsequent quantitative studies aiming at the quantification of traditional non-timber forest uses (chapter II) and the assessment of the impact of these practises on the recently observed changes in tree species composition in the Valais (chapter III).

The second study (chapter II) shows that wood pasture and forest litter collecting were practised on a significant proportion of the forested landscape in the Valais up to the second half of the 20th century. Until the implementation of forest management plans in the 1930s, almost half of the forests in the study area was affected by wood pasture and/or forest litter collecting. The regulations in the management plans led to an essential reduction of this area but also to an increased pressure on the remaining areas. The results suggest that the notion of a slow but steady disappearance of traditional non-timber forest uses and the associated effects on forest ecosystems is oversimplified. Quantitative reconstructions of biomass output resulting from these practises confirm the importance of traditional non-timber forest uses for ecosystem development in this region.

In chapter III, tree species composition on about 9'500 ha of forest land in the upper Valais is compared for two time steps (1930 and 1994) and analysed in the context of anthropogenic disturbance regimes. Significant decrease of Scots pine (-11.1%) and increase of deciduous trees (+10.8%) is found for forests in lower altitudes (below 1200 m asl). In higher elevations a shift from spruce (*Picea abies*) (-8.1%) to larch (*Larix deciduas*) (+8.3%) occurred. The changes in tree species composition are related to different anthropogenic disturbance regimes. The increase of deciduous trees is more pronounced in stands formerly not used for grazing and/or litter collecting whereas the decrease in Scots pine is not significantly correlated with former anthropogenic practises. This correlation is interpreted as a result of wood pasture and litter collecting hindering the regeneration of deciduous trees until the abandonment of these practises a few decades ago. The increase of larch to the disadvantage of spruce can be explained through specific silvicultural management schemes which aimed at the promotion of larch recruitment.

The findings from this study from the Swiss Rhone valley are of high importance for other inner-alpine regions of the European Alps, where similar ecosystem processes are running. Detailed information on historical forest uses is important for forest managers to understand the temporal dynamics of ecosystem changes and to develop appropriate management tools. Furthermore, global change research may integrate the findings of this study in the context of recovering forest nutrient pools and in the discussion about forest and forest soils in their function as potential carbon sink.

Zusammenfassung

Die meisten Landschaften und Ökosysteme sind von menschlichen Einflüssen geprägt. Deshalb gelten menschliche Aktivitäten als wichtige Einflussgrössen für landschaftsrelevante und ökosystemare Prozesse. Dies ist auch bei Waldökosystemen der Fall. In der waldökologischen Forschung werden menschliche Aktivitäten als anthropogene „Störungen" (disturbances) verstanden, analog zu natürlichen Störungen wie Windwürfe und Waldbrände. Daher ist das Verständnis von menschlichen Einflüssen sowohl für eine angemessene Beurteilung von aktuellen Zuständen von Waldökosystemen, als auch für die Prognose von zukünftigen Entwicklungen von zentraler Bedeutung. Die Historische Ökologie versucht durch die Verbindung von Geschichte und Ökologie, die menschliche Dimension in die ökologische Forschung einzubringen.

In den letzten Jahrzehnten wurden im Walliser Föhrenwaldgürtel signifikante Veränderungen in der Baumartenzusammensetzung von der Waldföhre (*Pinus sylvestris* L.) hin zur Flaumeiche (*Quercus pubescens* Willd.) und anderen Laubbaumarten festgestellt. Als Gründe für dieses Phänomen werden komplexe Interaktionen zwischen Klima- und Landnutzungsänderungen, sowie Insekten, Pilzen und Pytopathogenen verantwortlich gemacht. Die vorliegende Dissertation untersucht den Einfluss von Veränderungen in der menschlichen Waldnutzung auf die oben beschriebenen Vegetationsprozesse. Ein spezielles Augenmerk wird dabei auf die so genannten „Nebennutzungen" wie die Waldweide und die Streunutzung gelegt. Die Arbeit verfolgt folgende Forschungsfragen: i) Welche Waldnutzungen waren im Walliser Föhrenwaldgürtel im 19. und 20. Jahrhundert von Bedeutung? ii) Können diese Nutzungen bezüglich ihrer räumliche und zeitliche Verbreitung sowie hinsichtlich ihrer Intensität quantifiziert werden? und iii) Welchen Einfluss haben diese Nutzungen auf die Waldföhrenökosysteme? Aus den Resultaten werden schliesslich mögliche Folgerungen für die zukünftige Waldbewirtschaftung und weiterer Forschungsbedarf im Kontext der „Global Change"-Forschung abgeleitet.

In der ersten Studie (chapter I) wurde durch die Analyse von Waldwirtschaftsplänen und Interviews mit Zeitzeugen ein umfassendes Bild der früheren Waldnutzungen im Wallis

gezeichnet. Dabei stellten sich die Waldweide (mit Ziegen und Schafen) sowie die Streunutzung als wichtigste Formen traditioneller Waldnutzungen heraus. Andere Nutzungsweisen sind zwar von lokaler kulturhistorischer Bedeutung jedoch nicht von ökologischer Relevanz. Die raum-zeitliche Ausprägung dieser Nutzungen wurde durch Regulierungen der Forstbehörden, die Erreichbarkeit der Wälder, dem Zugang zu Ersatzprodukten, die lokalen wirtschaftlichen Verhältnisse sowie Veränderungen in der Nachfrage gesteuert. Die Resultate dieser qualitativen Studie bildet die Grundlage für die folgenden quantitativen Untersuchungen, welche auf die Quantifizierung der traditionellen Waldnutzungen (chapter II) und den Einfluss dieser Nutzungen auf die Baumartenzusammensetzung (chapter III) im Walliser Föhrenwaldgürtel zielen.

Die zweite Studie (chapter II) zeigt, dass die Waldweide und das Sammeln von Waldstreu im Wallis bis in die zweite Hälfte des 20.Jahrhunderts hinein weit verbreitet waren. Bis zur Einführung der definitiven Waldwirtschaftplänen in den 1930er Jahren, waren fast die Hälfte aller Wälder von diesen Nutzungen betroffen. Die Wirtschaftspläne führten zwar zu einer erheblichen Verkleinerung der Nutzungsflächen, dadurch erhöhte sich jedoch der Nutzungsdruck auf die verbleibenden Wälder. Das Bild von einem kontinuierlichen Verschwinden der traditionellen Waldnutzungen und deren Auswirkungen auf die Waldökosysteme muss daher relativiert werden. Die quantitative Rekonstruktion der durch Waldweide und Streunutzung resultierenden Entnahme von Biomasse, bestätigt die ökologische Relevanz dieser Nutzungen in der Region.

Im dritten Kapitel (chapter III) wird die Baumartenzusammensetzung auf etwa 9500 ha für zwei Zeitschnitte (1930 und 1994) verglichen und in Zusammenhang mit unterschiedlichen Nutzungsregimes gebracht. In tieferen Lagen (unter 1200 m.ü.M) zeigt sich ein deutlicher Rückgang der Waldföhre (-11.1%) und eine entsprechende Zunahme von Laubbäumen (+10.8%). Über 1200 m ist ein Wechsel von der Fichte (*Picea abies*) (-8.1%) hin zur Lärche (*Larix decidua*) festzustellen. Die Zunahme der Laubbaumfraktion in den tiefer gelegenen Wäldern ist deutlich ausgeprägter in Beständen, welche nicht von Waldweide und Streunutzung betroffen waren. Die Föhre hingegen nimmt in allen Beständen in ähnlichem Ausmass ab. Beweidung und Streunutzung könnten bis zu ihrer Aufgabe die Verjüngung von Laubbäumen verhindert haben. Der Wechsel von Fichte zu Lärche ist hingegen auf gezielte waldbauliche Massnahmen zur Förderung der

Lärchenverjüngung zurückzuführen.

Die Resultate dieser Studie sind von grosser Bedeutung für andere europäische inneralpine Regionen, wo ähnliche Ökosystemprozesse im Gange sind. Detaillierte Informationen zu historischen Waldnutzungen sind von konkreter Bedeutung für die Waldwirtschaft. Sie helfen dem Forstdienst die zeitliche Dynamik von Veränderungsprozessen besser einzuschätzen und liefern die Grundlage für die Entwicklung angemessener waldwirtschaftlicher Massnahmen. Die Resultate dieser Studie können schliesslich im Bereich der „Global Change"-Forschung Anwendung finden. Sie liefert interessante Hinweise im Kontext von sich vergrössernden Nährstoffspeichern in Waldökosystemen oder in der Diskussion um Wälder und ihre Bedeutung als potentielle Kohlenstoffsenken.

General Introduction

Human impact on forest ecosystems

Since the beginning of human existence, landscapes and ecosystems were increasingly affected and transformed by human activities. Therefore it is widely recognized that anthropogenic activities are components of most landscapes and ecosystems (e.g. Birks et al. 1988, Turner 1990, Goudie 2006). This is also the case for forest ecosystems (e.g. Rackham 1980, Kirby and Watkins 1996). In forest ecology research human activities are understood as a type of ecosystem disturbances in analogy to natural disturbances such as storms and forest fire (e.g. Foster et al. 1998, Foster et al. 2003). The understanding of human impacts on ecosystems and landscapes is therefore essential for the appropriate interpretation of the current state of these systems and forms the baseline for more informed prediction about their future development (Christensen 1989, MacDonnell and Pickett 1993, Bürgi and Russell 2001). Consequently, it is important to integrate the anthropogenic dimension into ecological research by linking history and ecology (Russell 1997) which is the case in several international long-term research programs such as the UNESCO MAB-Program (http://www.unesco.org/mab/), LTER (http://lternet.edu/), and PAGES (http://www.pages.unibe.ch/) particularly in the activities of HITE ("Human Impact on Terrestrial Ecosystems") (http://www.liv.ac.uk/geography/hite).

The Scots pine forest belt and pubescent oak forests in the Valais

In the upper Swiss Rhone valley (Canton of Valais) an essential portion of the forested area is covered with Scots pines (*Pinus sylvestris* L.) and pubescent oak (*Qeurcus pubescens* Willd.). In a recent vegetation map (Werlen 1994) approximately 10% of the total forested area is declared as dominated by Scots pine whereas pubescent oak dominated stands cover about 2% (Figure 1). Both tree species are predominately located in the central main valley and to a lesser extent in the southern side valleys. Scots pine stands occur from the valley bottom (around 450 masl) up to 1500 masl, whereas pubescent oak is restricted to lower elevations below 1000 masl. Pine and oak forests fulfil different important functions. They protect human settlement and infrastructure against natural hazards such as avalanches, landslides and falling rocks (Pfister and Eggenberger 1988) and constitute a recreation area for the local people and tourists.

Additionally, pine forests represent a typical element of the landscape in the region harbouring one of the Swiss biodiversity hotspots (Wohlgemuth 1998).

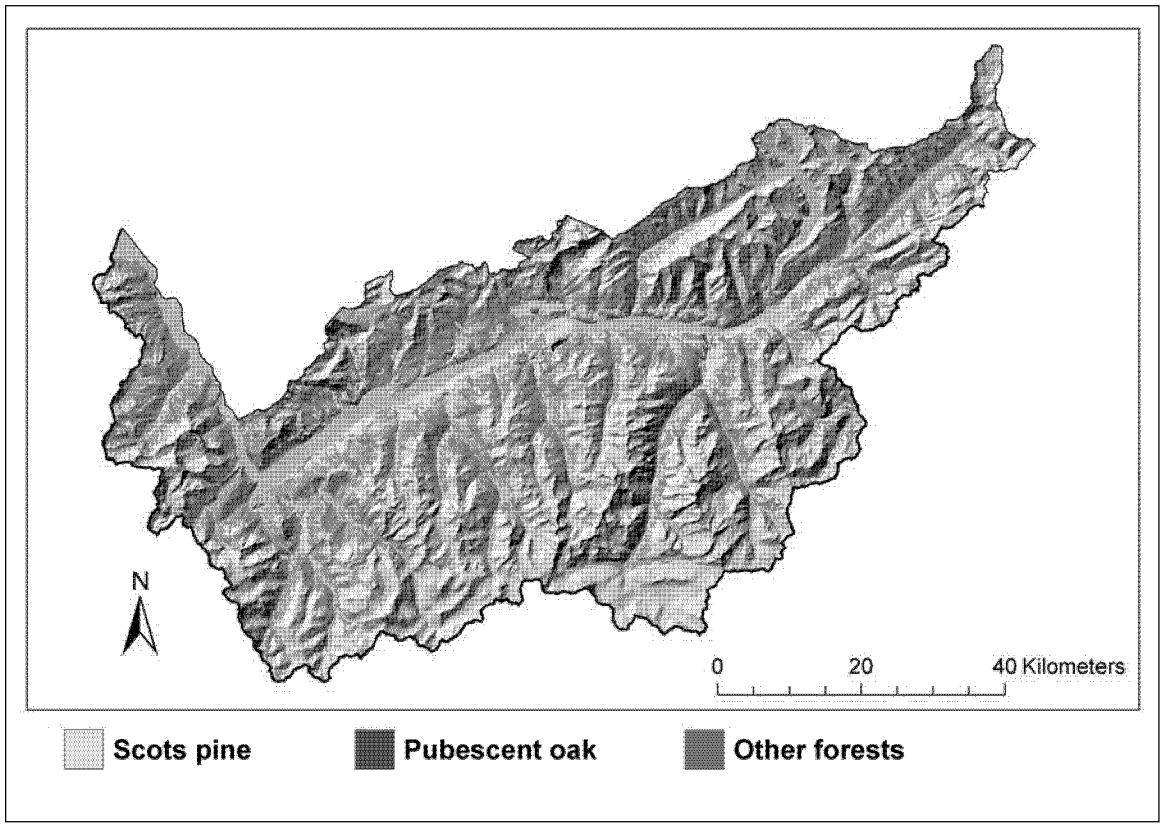


Figure 1: Distribution of pine and oak dominated forests in the Valais (data from Werlen 1994).

The distribution are of Scots pine covers the Euro-Sibirian range, whereas pubescent oak is a typical sub-Mediterrean deciduous tree species (Meusel et al. 1965). Their distribution overlaps in mountainous regions characterised by sub-continental, sub-Mediterrean climate such as the Valais (Burnand 1976). Early plant sociologist regarded Scots pine forests as being the main native forest associations at xeric, low-elevation sites in the Valais (e.g. Braun-Blanquet 1917, Christ 1920, Schmid 1936, Schmid 1961 a&b). Although some studies have also mentioned oak forest associations, they usually ascribed them minor importance because most native oak forests have been replaced by vineyards (Braun-Blanquet 1961, Schmid 1961b). For the forests in the region of Visp, Christ (1920) reported that there was hardly any trace of pubescent oak which clearly contrasts to recent vegetation observations in the same region (e.g. Lock et al. 2003). Burnand

(1976) for the first time investigated the ecological limits the ecological limits of pubescent oak, including the impact of changing forest use on the occurrence of pubescent oak and Scots pine in the Valais.

The WSL Pine project

Since the beginning of the 20th century high mortality rates of Scots pines have been observed (Wille 1922). In the 1970s a strong relationship between mortality rates of Scots pine and fluorine emissions from the local aluminium industry could be detected (Flühler et al. 1981, Ferlin et al. 1982). The installation of filter systems resulted in a clear reduction of the fluorine emission and consequently the related damages on Scots pines largely disappeared.

Since the beginning of the 1990s Scots pines are again affected by increased mortality. Additionally, significant shifts from the sub-boreal Scots pine to the sub-Mediterrean pubescent oak and other deciduous trees are observed (Rigling and Cherubini 1999; Rigling et al. 2000, Lock et al. 2003). Similar phenomena are reported for inner alpine regions in neighbouring countries (e.g. Minerbi 1992; Cech and Tomiczeck 1996, Schwaninger 1999, Motta and Edouard 2005).

In this context the Swiss Federal Research Institute for Forest, Snow and Landscape (WSL) launched a interdisciplinary project "Die Waldföhrenwälder im Wallis – ein Landschaftselement im Umbruch" (Pine project) which aimed at evaluating the complex background of pine decline. The following hypotheses were formulated (Rigling 2002)

1) Scots pine decline is caused by climatic factors related to climate warming (endogenous disturbance):
    a) directly by increasing drought
    b) indirectly by increasing abundance of insects, phytopathogenes and mistletoes in consequence of increasing temperature
2) Scots pine decline is caused by non-climatic factors:
    a) native and non-native phytopathogenes (exogenous disturbance)
    b) altered competitive interactions due to land-use change (anthropogenic disturbance)
    c) natural succession (endogenous disturbance)

This thesis focuses on the role of anthropogenic disturbances (hypothesis 2b) with an emphasis on traditional non-timber forest uses such as wood pasture and forest litter collecting.

Forest uses changes in the Valais

In the past, the forests of central Europe were not only sources of timber and fuel wood but also directly and indirectly supplied nutrients to sustain human population (e.g. Radkau and Schäfer 1987). Agrarian societies, which were largely based on self-sufficiency, depended heavily on traditional non-timber forest uses, such as wood pasture and forest litter collecting (Bürgi 1999, Stuber and Bürgi 2001, 2002; Bürgi and Stuber 2003). The practise of traditional non-timber forest uses was abundant in many regions of the Swiss Alps during the 19th and first half of the 20th century (Landolt 1862, Fankhauser 1887, Grossmann 1927, Waldmeier-Brockmann 1941). This is particularly reported for the Valais in a number of regional studies (Kuonen 1993, Stebler 1901; 1914; 1921). In the Valais the practise of traditional non-timber forest uses has been abandoned only some decades ago (Kempf 1982; 1985, Kempf und Scherrer 1985). Consequently, it can be assumed that traditional non-timber forest uses play an important role in the context of pine decline in the region. Different studies have shown that the practise of traditional non-timber forest uses have significant impact on forest ecosystems (Glatzel 1990; 1991, Hüttl and Schaaf 1995, Dzwonko and Gawronski 2002,).

Methodological framework: Historical Ecology

Several disciplines such as historical geography, environmental history, anthropology and archaeology investigate interactions between men and nature over time. Historical Ecology points out the historical dimension of ecosystems by integrating the human dimension into ecological studies (Bürgi 2003). In the focus are ecological consequences of historical changes in the relationship man-environment (Crumley 1994, Russell 1997). Depending on the specific research topic, historical ecology combines different methods and techniques from natural science and social science (Egan and Howell 2001). Sources used include various types of historical documents (e.g Ewald 1978, Sheail 1980, Kienast 1993, Bürgi 1999, Bürgi et al. 2000, Axelson et al. 2002), narratives (e.g. Fogerty 2001,

Hessburg and Agee 2003) and archaeological evidence (e.g. Cousins et al. 2002). But also information from different natural archives such as tree rings and lake sediments are frequently used in historical ecology research (e.g. Lotter 1998, McLachlan et al. 2000, Bendel et al. 2006). The use of different source types requires a source critical approach as commonly used in historical sciences (Forman and Russell 1983, Edmonds 2001). Furthermore it is crucial to carefully test the quality of the specific sources, if possible by comparison of different source types and statistical methods (e.g. Tinner et al. 1998, Manies and Mladenoff 2000, Mladenoff et al. 2002, Bolliger et al. 2004). In this context it is of great importance to establish the cooperation of experts from different disciplines (Pfister 1992, Crumley 1998).

Historical ecology research mostly contains a clear applied dimension. Information on past states of ecosystems and landscapes in many cases are used in the context of restoration ecology (Swetnam et al. 1999, Egan and Howell 2001, Honnay et al. 2004).

Three main applications of historical ecology research can be drawn:

1. Preservation of cultural heritage
2. Assessment of ecosystem change
3. Support for ecosystem management

The general research aims of this thesis follow the three dimensions of historical ecology.

Main objectives and structure of the thesis

The overall objective of this thesis was to reconstruct the history of anthropogene disturbances in the Scots pine forest belt of the Valais. The thesis is organised in three parts addressing the following general research aims related to the three main applications of historical ecology research mentioned above:

- Identification of the important forest uses in the pine forests of the Valais during the 19th and 20th century (chapter I)
- Quantification of past forest-uses in terms of intensity as well as spatial and temporal extent (chapter II)
- Assessment of the impact of these forest uses on pine forest ecosystems (chapter III)

Specific research questions of the thesis

Chapter I: ***Using oral history and forest management plans to reconstruct traditional non-timber forest uses in the Swiss Rhone valley (Valais) since the late 19th century***

The first paper of this thesis aims at identification of the important types of past traditional non-timber forest uses in the Scots pine forest belt of the Valais. By triangulating the evidence from both documentary sources (particularly forest management plans) and oral history two key research questions were addressed:

a) Which traditional non-timber forest uses were practised in the pine forests of the Valais since the late 19th century?
b) When did traditional non-timber forest uses disappear and which socioeconomic and political drivers led to the abandonment of certain practises?

The article highlights the different quality of the two source types and the opportunities of the combination of both types (including source critical remarks). The results are illustrated by two case studies from two municipalities in the upper Rhone valley (Salgesch and Visp/Eyholz). The paper establishes a basis for the understanding of current ecological processes.

Chapter II: ***Reconstructing anthropogenic disturbance regimes in forest ecosystems – a case study from the Swiss Rhone valley***

In forest ecology research human activities are understood as ecosystem disturbances in the same way as natural phenomena such as forest fires or windthrow (e.g. Foster et al. 1998, Foster et al. 2003). Consequently anthropogenic disturbances can be classified in terms of extent, intensity and frequency similarly to natural disturbances (Frelich 2002). This paper aims at reconstructing the spatial distribution and the intensity of non-timber forest uses in the Valais by

a) reconstructing spatiotemporal patterns of forest litter collecting and wood pasture in the pine forest belt of the upper Swiss Rhone valley and

b) estimating the biomass removal through these practises.

Furthermore, relevance of the results are discussed in the context of the currently observed changes in the pine forest belt of the Valais. This study underlines the importance of environmental history for ecological sciences as well as for forest management and conservation planning as stated by Foster et al. (2003).

Chapter III: ***Impact of anthropogenic disturbances on tree species composition in the upper Swiss Rhone valley***

Land use history is increasingly recognized as a key factor to understand present vegetation patterns (e.g. Foster 1992, Foster et al. 1998, Motzkin et al. 1999, Bürgi et al. 2000, Wulf 2004). In this paper the impacts of traditional non-timber forest uses (wood pasture and forest litter collecting) and silvicultural management on changes in tree species composition were examined. For this purpose tree species composition in 1930 was reconstructed using information from contemporary forest management plans and compared with a modern vegetation map (Werlen 1994). The following research aims are addressed:

a) To identify the patterns of changes in forest composition of the upper Swiss Rhone valley,

b) to link the main features of changes in tree species composition with land use change in the region and

c) to discuss the ecological background behind these relationships.

The presented results from the Swiss Rhone valley are of high importance for other inner-alpine valleys of the European Alps, where similar processes are running.

References

Axelson, A.-L., Östlund, L., Hellberg, E. 2002: Changes in mixed deciduous forest of boreal Sweden 1866-1999 based on interpretation of historical records. Landscape Ecology 17: 403-418.

Bendel, M., Tinner, W., Ammann, B. 2006: Forest dynamics in the Pfyn forest in recent centuries (Valais, Switzerland, Central Alps): interaction of pine (*Pinus sylvestris*) and oak (*Quercus* sp.) under changing land use and fire frequency. Holocene 16: 81-89.

Birks, H.H., Birks, H.J.B., Kaland, P.E., Moe, D. 1988: The cultural landscape – past, present and future. Cambridge University Press, Cambridge.

Bolliger, J., Schulte, L.A., Burrows, S.N., Sickley, T.A., Mladenoff, D.J. 2004: Assessing ecological restoration potentials of Wisconsin (USA) using historical landscape reconstructions. Restoration Ecology 12: 124-142.

Braun-Blanquet, J. 1917: Die Föhrenregion der Zentralalpentäler, insbesondere Graubündens, in ihrer Bedeutung für die Florengeschichte. Schweizerische Naturforschende Gesellschaft 98: 59-86.

Braun-Blanquet 1961: Die inneralpine Trockenvegetation. Von der Provence bis zur Steiermark. Fischer Verlag, Stuttgart.

Bürgi M, 1999: A case study of forest change in the Swiss lowlands. Landscape Ecology 14:567-575.

Bürgi, M., Russell, E.W.B., Motzkin, G. 2000: Effects of postsettlement human activities on forest composition in the north-eastern United States: a comparative approach. Journal of Biogeography 27: 1123-1138.

Bürgi, M. and Russell, E.W.B. 2001: Integrative methods to study landscape changes. Land Use Policy 18: 9-16.

Bürgi M, Stuber M. 2003: Agrarische Waldnutzungen in der Schweiz 1800-1950. Waldfeldbau, Waldfrüchte und Harz. Schweiz. Z. Forstwes. 154: 360-375.

Bürgi, M. 2003: Historische Ökologie im und um den Wald. Schweiz. Z. Forstwes. 154: 328-332.

Burnand, J. 1976: *Quercus pubescens*-Wälder und ihre ökologischen Grenzen im Wallis (Zentralalpen). PhD Thesis Nr. 5703. Swiss Federal Institute of Technology Zürich, Zürich.

Cech, T. and Tomiczeck, C. 1996: Zum Kiefernsterben in Niederösterreich. Forstschutz aktuell 17.

Christ, H. 1920: Die Visper-Taler Föhrenregion im Wallis. Bulletin de la Murithienne 90: 1-87.

Christensen, N.L. 1989: Landscape history and ecological change. Journal of Forest History 33: 116-125.

Cousins, S.A.O., Eriksson, A, Franzen, D. 2002: Reconstructing past land use and vegetation patterns using palaeogeographical and archaeological data – A focus on grasslands in Nynas by the Baltic Sea in south-eastern Sweden. Landscape and Urban Planning 61: 1.18.

Crumley, C.L. 1994: Historical Ecology. Cultural knowledge and changing landscapes. School of American Research Press, Santa Fee.

Crumley, C.L. 1998: Foreword. In: Advances in historical ecology. Columbia University Press, New York, IX-XIV.

Dzwonko Z and Gawronski S. 2002: Effect of litter removal on species richness and acidification of a mixed oak-pine woodland. Biological Conservation 106: 389-398.

Edmonds, M. 2001: The pleasures and pitfalls of written records. In: Egan, D., Howell, E.A. (eds.): The Historical Ecology Handbook. A Restoration's Guide to Reference Ecosystems. Washington: Island Press: 73-99.

Egan, D., Howell, E.A. (Ed.) 2001. The Historical Ecology Handbook. A Restoration's Guide to Reference Ecosystems. Washington: Island Press.

Ewald, K.C. 1978: Der Landschaftswandel. Zur Veränderung schweizerischer Kulturlandschaften im 20. Jahrhundert. Berichte Eidgenössische Anstalt für das forstliche Versuchswesen 191.

Fankhauser, F. 1887: Die Bedeutung der Ziegenwirtschaft für die schweizerischen Gebirgsgegenden in forstlicher und forstwirtschaftlicher Hinsicht. Bern.

Ferlin, P., Flühler, H., Polomski, J. 1982: Immissionsbedingte Fluorbelastung eines Föhrenstandortes im unteren Pfynwald. Schweiz. Z. Forstwes. 133: 139-157

Fogerty, J.E. 2001: Oral history: a guide to its creation and use. In: Egan, D., Howell, E.A. (eds.): The Historical Ecology Handbook. A Restoration's Guide to Reference Ecosystems. Washington: Island Press: 101-120

Forman, R.T.T. and Russell, E.W.B. 1983: Evaluation of historical data in ecology. Bulletin Ecological Society America 64: 5-7.

Foster, D.R. 1992: Land-use history (1730-1990) and vegetation dynamics in central New England, USA. Journal of Ecology 80: 753-772.

Foster D.R., Motzkin G., Slater B. 1998: Land-use history as long-term broad-scale disturbance: regional forest dynamics in central New England. Ecosystems 1: 96-119.

Foster DR, Swanson F, Aber J., Burke I., Browaw N., Tilman D., Knapp A. 2003. The importance of land-use legacies to ecology and conservation. Bioscience 53: 77-88.

Frelich, L.E. 2002: Forest dynamics and disturbance regimes. Cambridge University Press.

Glatzel G. 1990: The nitrogen status of Austrian forest ecosystems as influenced by atmospheric deposition, biomass harvesting and lateral organomass exchange. Plant and Soil 128: 67-74.

Glatzel G. 1991: The impact of historic land use and modern forestry on nutrient relations of Central Europe forest ecosystems. Fertilizer Research 27: 1-8.

Goudie, A.S. 2006: The human impact on the natural environment. Past, present and future. 6th edition. Blackwell Publishing, Oxford.

Grossmann, H. 1927: Die Waldweide in der Schweiz. Zürich.

Hessburg, P.E. and Agee, J.K. 2003: An environment narrative of Inland Northwest United States forests, 1800-2000. Forest Ecology and Management 178: 23-59.

Honnay, O., Verheyen, K., Bossuyt, B., Hermy, M. (eds.) 2004: Forest biodiversity: lessons from history for Conservation. CAB International, Wallingford.

Hüttl RF, Schaaf W. 1995: Nutrient supply of forest soils in relation to management and site history. Plant and Soil 168: 31-41.

Kempf, A. 1982: Wald und Bevölkerung im Walliser Rhonetal, am Beispiel der Gemeinde Erschmatt (Bezirk Leuk). Schweizer Volkskunde 72: 56-62.

Kempf, A. 1985: Waldveränderungen als Kulturlandschaftswandel - Walliser Rhonetal. Fallstudien zur Peristenz und Dynamik des Waldes zwischen Brig und Martigny seit 1873. Basler Beiträge zur Geographie 31. Basel.

Kempf, A. and Scherrer, H.U. 1982: Forstgeschichtliche Notizen zum Walliser Wald. Literatur – und Quellenbericht über das Rhonetal zwischen Brig und Martigny seit 1800. Bericht EAFV 243.

Kienast, F. 1993: Analysis of historic landscape patterns with Geographical Information System – a methodological outline. Landscape Ecology 8: 103-118.

Kirby, K.J. and Watkins, C. 1998: The ecological history of European forests. CAB International, Cambridge.

Kuonen, T. 1993: Histoire des forêts de la région de Sion du Moyen-Age à nos jours. . Cahiers de Vallesia 3,Sion.

Landolt, E. 1862: Bericht an den hohen schweizerischen Bundesrath über die Untersuchung der Schweizerischen Hochgebirgswaldungen, vorgenommen in den Jahren 1858, 1859 und 1860. Bern.

Lock, S., Pahlmann, S., Weber, P., Rigling, A. 2003: Nach Stalden kehren die Flaumeichen zurück. Wald und Holz 9: 29-33.

Lotter, A.F. 1998: The recent eutrophication of Baldeggersee (Switzerland) as assessed by fossil diatom assemblages. Holocene 8: 395-405.

MacDonnell, M.J. and Pickett (eds.), S.T.A. 1993: Humans as components of ecosystems – the ecology of subtle human effects and populated areas. Springer, New York.

Manies, K.L., and Mladenoff, D.J. 2000: Testing methods to produce landscape-scale presettlement vegetation maps from the U.S. public land survey records. Landscape Ecology 15: 741-754.

McLachlan, J.S., Foster, D.R., Menalled, F. 2000: Anthropogenic ties to late-successional structure and composition in four New England hemlock stands. Ecology 81: 717-733.

Meusel, H., Jäger, E.J., Weinert, E. 1965: Vergleichende Chronologie der zentraleuropäischen Flora. Text und Karten. Band 1. VEB Fischer, Jena.

Minerbi, S. 1992: Wie gesund sind unsere Wälder? 10. Bericht über den Zustand der Wälder im Südtirol. Assessorat für Forstwirtschaft der Autonomen Provinz Bozen.

Mladenoff, D.J., Dahir, S.E., Nordheim, E.V., Schulte, L.A., Guntenspergen, G.G. 2002: Narrowing historical uncertainty: Probabilistic classification of ambiguously identified tree species in historical survey data. Ecosystems 5: 539-553.

Motta, R. and Edouard, J.L. 2005: Stand structure and dynamics in a mixed and multilayered forest in the Upper Susa Valley, Piedmont, Italy. Canadian Journal of Forest Research 35: 21-36. doi: 10.1139/X04-153

Motzkin, G, Wilson, P., Foster, D.R., Allen, A. 1999: Vegetation patterns in heterogeneous landscapes: the importance of history and environment. Journal of Vegetation Science 10: 903-920.

Pfister, C. 1992: Historische Umweltforschung – eine neue, fächerverbindende Aufgabe für Natur-und Sozialwissenschaften. Allg. Gesch.forsch. Ges. Schweiz (Hg.): Geschichtsforschung in der Schweiz. Basel: 169-187.

Pfister, F. and Eggenberger, M. 1988: Zukunft für den Schweizer Schutzwald? Methoden der Massnahmenplanung dargestellt am Beispiel der Region „Visp – Westl. Raron“ VS. Eidg. Anstalt für das forstliche Versuchswesen, Birmensdorf.

Rackham, O. (1980) Ancient woodland: its history, vegetation and uses in England. Edward Arnold, London.

Radkau, J. and Schäfer, I. (1987) Holz. Ein Naturstoff in der Technikgeschichte. Rowohlt, Hamburg.

Rigling, A., Cherubini, P. 1999: Wieso sterben die Waldföhren im ‘Telwald’ bei Visp? Eine Zusammenfassung bisheriger Studien und eine dendroökologische Untersuchung. Schweiz. Z. Forstwes. 150: 113-141.

Rigling, A., Forster, B., Wermelinger, B., Cherubini, P. 2000: Grossflächige Veränderung des Landschaftsbildes im Kanton Wallis – Waldföhrenbestände im Umbruch. Wald und Holz: 8-12.

Rigling, A. 2002: Waldföhrenwälder im Wallis. Einführung und Übersicht. In: Wohlgemuth, T. and Paproth, H. (eds.) Informationstagung Walddynamik, WSL, Birmensdorf.

Russell, E.W.B. 1997: People and land through time. Linking ecology and history. Yale University Press, New Haven.

Schmid, E. 1936: Die Reliktföhrenwälder der Alpen. Beiträge zur geobotanischen Landesaufnahme der Schweiz 21.

Schmid, E. 1961a: Vegetationskarte der Schweiz. Beiträge zur geobotanischen Landesaufnahme der Schweiz 39.

Schmid, E. 1961b: Erläuterungen zur Vegetationskarte der Schweiz. Beiträge zur geobotanischen Landesaufnahme der Schweiz 39.

Schwaninger, D.I. 1999: Kiefernsterben im Oberland. Tiroler Forstdienst.

Sheail, J. 1980: Historical Ecology: the documentary evidence. Huntington, Natural Environment Research Council, Institute of Terrestrial Ecology.

Stebler, .F.G. 1901: Ob den Heidenreben. Monographien aus den Schweizeralpen. Beilage zum Jahrbuch des SAC 36, Zürich.

Stebler, F.G. 1914: Sonnige Halden am Lötschberg. Monographien aus den Schweizer Alpen. Beilage zum Jahrbuch des SAC 49, Zürich.

Stebler, F.G. 1921: Die Vispertaler Sonnenberge. Jahrbuch des SAC. 56, Zürich.

Stuber M, Bürgi M. 2001: Agrarische Waldnutzungen in der Schweiz 1800-1950. Waldweide, Waldheu, Nadel- und Laubfutter. Schweiz. Z. Forstwes. 152: 490-508.

Stuber M, and Bürgi M. 2002: Agrarische Waldnutzungen in der Schweiz 1800-1950. Nadel- und Laubstreue. In: Schweiz. Z. Forstwes. 153: 397-410.

Swetnam, T.W., Allen, C.D., Betancourt, J.L. 1999: Applied historical ecology: using the past to manage for the future. Ecological Applications 9: 1189-1206.

Tinner, W., Conedera, M., Ammann, B., Gäggeler, H.W., Gedye, S., Jones, R., Sägesser, B. 1998: Pollen and charcoal in lake sediments compared with historicallly documented forest fires in southern Switzerland since AD 1920. Holocene 8: 31-42.

Turner, B.L. (Ed.) 1990: The earth as transformed by human action. Global and regional changes in biosphere over the last 300 years. Cambridge University press, Cambridge.

Waldmeier-Brockmann, A. 1941: Sammelwirtschaft in den Schweizer Alpen. Eine Ethnographische Studie. Basel.

Werlen, C. 1994: Elaboration de la carte de végétation forestière du Valais. Schweiz. Z. Forstwes. 14: 607-617.

Wille, F. 1922: Die Rauchschadenfrage der Aluminiumfabriken mit besonderer Berücksichtigung der Aluminiumfabrik Chippis. Paul Parey, Berlin.

Wohlgemuth, T. 1998: Modelling floristic species richness on a regional scale: a case study in Switzerland. Biodiversity and Conservation 7: 159-177.

Wulf M. 2004: Plant species richness of afforestations with different former use and habitat

Chapter I

Using oral history and forest management plans to reconstruct traditional non-timber forest uses in the Swiss Rhone valley (Valais) since the late 19th century

Submitted to Environment and History

Urs Gimmi and Matthias Bürgi

Swiss Federal Research Institute WSL
Department Landscape
Section Nature Protection and Historical Ecology
Zürcherstrasse 111
CH-8903 Birmensdorf, Switzerland

ABSTRACT

Changes in forest use are considered as a potential key driver for recently observed changing forest dynamics in the pine forest belt of the upper Rhone valley (Canton of Valais, Switzerland). In this region, traditional non-timber forest uses, such as forest litter harvesting and wood pasture, were practised until the second half of the 20th century. The practise of traditional non-timber forest uses led to specific environmental conditions which favoured pine as a pioneer species. With the abandonment of these practises the pine was subjected to increased competition and largely replaced by deciduous trees. In this study the history of traditional non-timber forest uses was reconstructed combining the analysis of forest management plans and the results from oral history interviews. The forest management plans represent the view of the forest administration whereas the narratives obtained from oral history interviews allow putting the traditional non-timber forest uses into the context of people's daily life. The different characteristics of the two source types are illustrated with two regional case studies. Different socioeconomic and political drivers were identified (changes in non-farming employment, changes in demand for forest products, access to substitute products, regulations), which led to the abandonment of traditional non-timber forest uses in the Valais. The combination of forest management plans and oral history leads to a comprehensive picture of the history and significance of traditional non-timber forest uses. Our findings confirm that

information on traditional non-timber forest uses is crucial for an understanding of present day dynamics in the pine forest ecosystems of the Valais.

KEY WORDS: Valais, Switzerland, oral history, forest management plans, land-use change, wood pasture, forest litter harvesting

INTRODUCTION

In the pine forest belt of the upper Rhone valley (Valais canton, Switzerland) increased mortality and a significant shift in tree species composition from the sub-Boreal Scots pine (*Pinus sylvestris* L.) to the sub-Mediterranean downy oak (*Quercus pubescens* Willd.) has been observed over the last few decades.[1] Besides climatic warming, forest use changes were considered as a potential key driver for changing forest dynamics.[2] Investigating the competition between pine and oak, Weber[3] concluded that pine as a pioneer species was favoured by traditional non-timber forest uses, such as wood pasture and litter raking. After these practices were abandoned, pine as a light demanding species was subjected to increased intra- and interspecific competition for light. Rigling and others recently showed that pine recruitment prevailed on raw soils and assumed that traditional non-timber forest uses resulted in specific environmental conditions which were more favourable for regeneration of pine than of oak.[4] Thus, it becomes important to understand the traditional practice of non-timber forest use and the causes and chronology of change to this practice that has led to this observable difference in forest composition. As such the aim of this study is to reconstruct the history of traditional non-timber forest uses in the pine forest belt of the upper Rhone valley. By triangulating the evidence from both documentary sources and oral history (both described later) two key research questions were addressed:

a) Which traditional non-timber forest uses were practised in the pine forests of the Valais since the late 19th century?
b) When did traditional non-timber forest uses disappear and which socioeconomic and political drivers led to the abandonment of certain practises?

This study is based on the combination of written documents (i.e. forest management plans) and oral history interviews with contemporary witnesses (see section Sources and Methods). In order to highlight the different quality of the two source types the

reconstruction of past traditional non-timber forest uses is illustrated with case studies from two municipalities in the upper Rhone valley (Salgesch and Visp/Eyholz). In addition the spatio-temporal patterns of the forest use history are described for the whole pine forest belt.

Relevance of traditional non-timber forest uses in Alpine regions

The history of traditional forest uses is crucial for an understanding of processes in present-day forest ecosystems. For centuries throughout Europe, the various non-timber forest uses were essential and more important than timber harvesting for the bigger part of the peasant population.[5] Wood pasture and forest litter collecting were of basic necessity to societies with a high degree of self-sufficiency.[6] Loup mentioned this important role of forests for the traditional agricultural life in the Valais[7]. Viazzo described the traditional Alpine village as a largely closed ecosystem.[8] An example of such a traditional socioeconomic structure of a mountain community in the upper Valais is given by Netting[9]. In Switzerland, forest litter harvesting and wood pasture were among the most important agricultural uses of the forest[10]. Especially in remote Alpine regions these traditional practises were conducted much longer than in more central areas of Switzerland.[11] Elias Landolt wrote in his report of 1862 to the federal council of Switzerland, which was the basis for the Swiss Federal Forest Police Law in 1876, that in many Alpine regions wood pasture and litter harvesting were still regarded as more important than timber production.[12] In Alpine regions wood pasture was practised above all with goats and sheep.[13] Whereas the sheep together with the cattle were driven to the alpine pastures during the summer, most of the goats stayed in the villages and provided the local population with milk.[14] These goats were driven to the nearby forests. Forest litter, i.e. leaves and needles, were collected in order to bind the cattle's manure in the barn as a substitute for straw. The litter was collected with iron or wooden rakes and either transported directly into the barns or stored on piles in the forest. In the lower parts of Switzerland (the so-called "Kornland"[15]) this practise gained in importance with the introduction of indoor stable feeding in the context of agricultural modernization,[16] as the demand for litter increased. In the mountainous regions (the so-called "Hirtenland") the

litter was mainly used during the winter season. Here, as in all regions where grain production was not profitable, a permanent lack of appropriate litter was prevalent.
Wood pasture and litter collecting locally had a significant impact on forest ecosystems. Damages to leaves and needles as a result of browsing and the destruction and the removal of seeds and seedlings due to litter raking were often lamented by the foresters. Missing or diminished regeneration and soil impoverishment were seen as the most important negative consequences of these practises. Particularly the goats were the nightmare of the foresters and were often called "the razors of the woods" and subject to bans and restrictions in movement through woodlands.[17] Therefore, these traditional forest uses resulted in various conflicts between farmers and forest authorities. These conflicts became more widespread, with the introduction of modern forestry in the late 18th and the 19th century, as the forest authorities increasingly focused on timber production, which became the main forest use. At the same time and linked with this shift in interest, forest authorities declared many traditional forest uses as 'harmful minor forest uses'[18].

Oral history in environmental history

To include the perspectives of both forester and farmers information from forest management plans were combined with oral history interviews conducted with contemporary witnesses. The concept of oral history has mostly been applied in social history research. Howarth noted that in the rush by historians to use oral history to study social history, other areas have been neglected.[19] Fogerty referred to oral history as a tool that is suited for understanding and reconstructing historic ecosystems.[20] But in the field of environmental history and particularly in historical ecology the use of oral evidence is not widely used. Some efforts have been made by the American Forest History Society which provides an oral history collection of more than 250 interviews conducted with individuals involved with the management and the use of forests and their related resources[21]. Recently the annual meeting of the UK branch of the European Association for Environmental History in 2004 dealt with the role of oral history in environmental history.[22] Already in the beginning of the oral history movement, some studies of agricultural history were using this approach.[23] Especially Evans highlighted in his

pioneering publication the relevance of oral tradition in recording the remains of old rural communities in East Anglia[24]. Other articles linked oral history with climatic issues.[25] Using oral history interviews, Brummond focused on the sociocultural consequences of Chernobyl nuclear accident.[26] Egoz showed that landscape tastes of New Zealand farmers are underpinned by ideologies, world views and social values and suggested a framework for interpreting the meanings embodied in the farming landscape.[27] The strength of oral history lies in the fact that it complements written, printed and visual sources and can often clearly call into question the validity of those other sources.[28] A striking example of such a combination of different sources was conducted by Fairhead and Leach.[29] They link oral history with aerial photographs and written evidence, they showed that dense forest islands in the savanna of Guinée are a result of human cultivation and not relicts of a once more extended forest cover as they have long been regarded by scientists. Riley evaluated the value of oral history to today's discussion of nature conservation.[30] He showed how the personal experience and collective memory of farmers can complete sparse ecological data sources. Furthermore, interview techniques were widely used in order to investigate local and indigenous ecological knowledge especially for regions with a living oral tradition and a lack of written ecological sources.[31] In the context of conservation ecology, oral history is seen as a tool for incorporating local knowledge in ecosystem management strategies which leads to a better acceptance of the regulations.[32] Howarth asks for using oral history as a tool to widen the scope of historical research.[33] Thompson argued that oral history not merely results in a shift in focus, but also in the opening up of important new areas of inquiry.[34] This article should contribute to a better establishment of oral history interviews in environmental and ecological research.

STUDY AREA

Valais

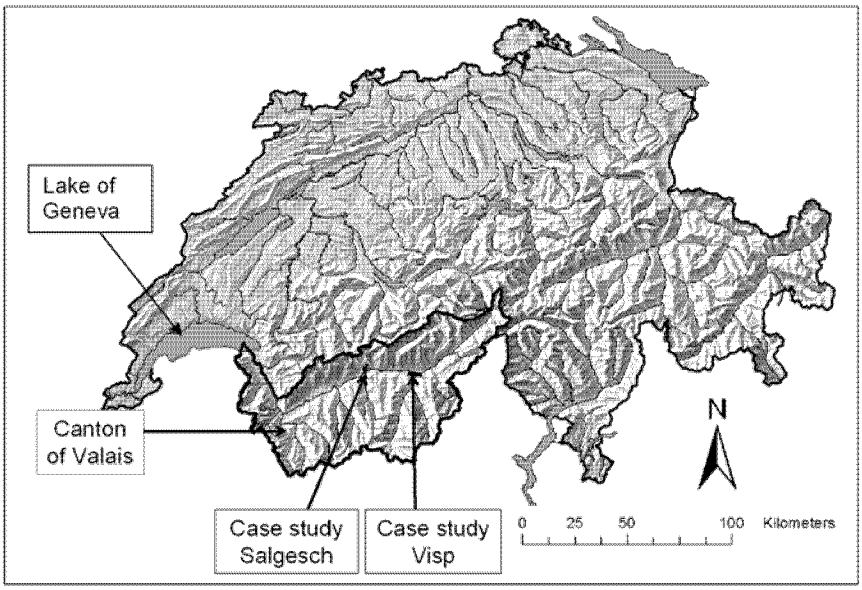
"Valais" is the French name of a Swiss canton situated in the south-western part of the country (Fig.1) bordering Haute-Savoie in France to the West and the Val d'Aosta in Italy in the south. The Valais contains the main part of the catchment area of the upper Rhone to its river-mouth into the Lake of Geneva. The mountains surrounding the valley (highest top 4618 masl) shield the inner part of the valley from the moist oceanic air

masses transported by west winds. Due to this inner-Alpine situation and the rain shadow that it creates the central Valais is a very dry region (annual precipitation at Sion = 598mm/yr^{-1}).[35]

Pine forests constitute an important forest type in the region. They cover about 11% (12'000 ha) of the total forested area of the Valais, and they are mainly located in the central part of the valley (Figure 2). Forests dominated by Scots pine occur above all in the main Rhone valley from the valley bottom (450-680 masl) up to altitudes around 1600 masl.

Case study region

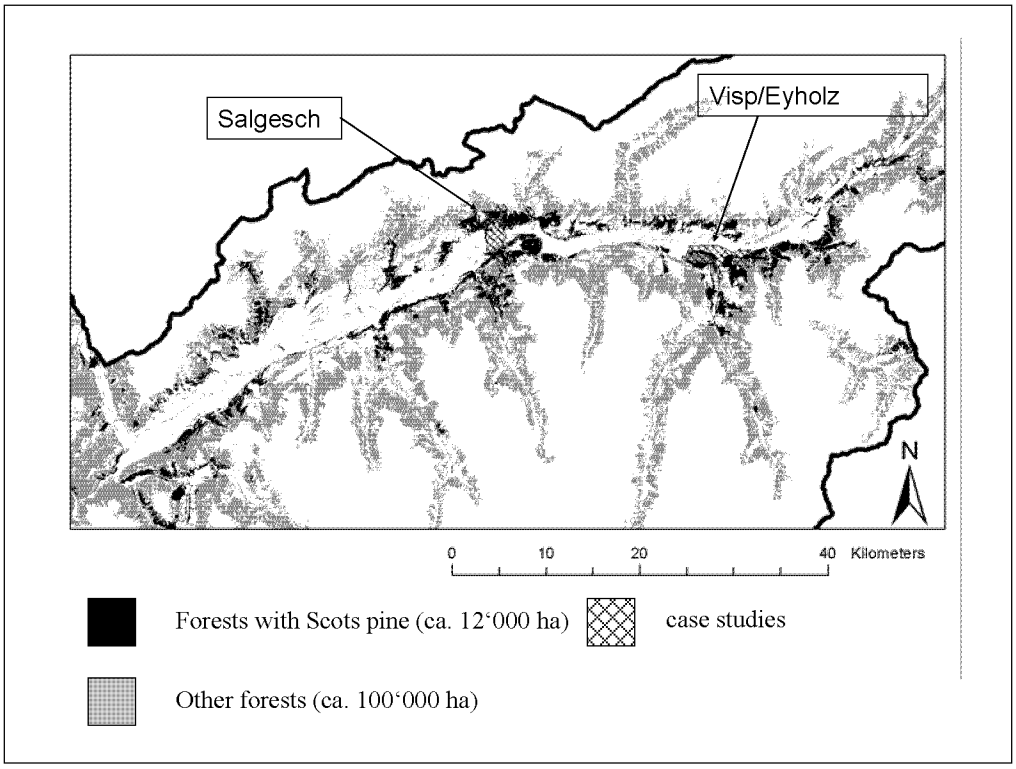
Based on excellent source availability, two regions in the upper Rhone valley were selected as case study areas. The first case study covers the municipality of Salgesch situated in the central Valais. The municipality is located at the German-French linguistic border (see Fig. 1 and 2). The Rhone divides this study area in a northern and southern section. The altitude of the municipality range between 450 and 2150 masl.



Map base: swisstopo 2004

FIGURE 1. The study area (Canton of Valais) in the south-western part of Switzerland and the location of the two case studies (Salgesch and Visp).

The second case study covers the municipalities of Visp and Eyholz located in the eastern central part of the Valais at the entrance to the valleys of Visp (Saas valley and Matter valley) (see Fig. 1 and 2). The two municipalities of Visp and Eyholz merged in 1972. The study area is restricted to the left hand side of the Rhone with altitudes between 640 and 1600 masl. With an annual precipitation sum of about 500 mm the region is the driest part of Switzerland.



Source: Werlen (1994)

FIGURE 2. Forest distribution in the Central Valais and location of the two case studies

SOURCES AND METHODS

The reconstruction of the history of traditional non-timber forest uses in the pine forest belt in the Valais is based on combining written sources (i.e., forest management plans) and oral evidence from contemporary witnesses.

Forest management plans

Forest management plans or forest surveys and reports have often been used to reconstruct changes in forest use and the related ecological effects.[36] Forest management

plans are the main planning tool in forestry.[37] The plans were written by forest engineers and refer to a specific study period. The plans should be rewritten regularly[38]. For the Valais the cantonal forestry law of 1873 asked for the implementation of forest management plans for all public forests within the next 20 years.[39] This demand was confirmed in the forest law of 1880, which was released as an adjustment of the cantonal law to the Swiss Federal Forest Police Law of 1876. Consequently, the earliest forest management plans in the Valais were established in the 1880s. The early plans from the late 19th and the first decade of the 20th century were called provisional forest management plans. These early plans include a general description of the forests, a report about the previous use, and guidelines for future management. In the last part of the plans, the different forest compartments are described in detail including data about topographic issues, soil properties, tree species, age class distribution (mostly based on visual estimation), production capacity, and timber reserve. In some cases, a small map is attached which allows one to locate the forest compartments.

In 1923 the government of the canton of Valais enacted instructions for the implementation of definite forest management plans. Among other things exact regulation of wood pasture and forest litter collecting was recommended to be added to these plans[40]. From the 1920s to the mid 1940s, the definite forest management plans were written for the forests of most municipalities in the Valais. These plans are much more comprehensive and provide more tabulated information (e.g. standing timber inventories by full callipering) than the provisional forest management plans. Most of the plans contain small-scale maps of the respective forest stands. For the second half of the 20th century, only sporadic revisions of forest management plans have been conducted. For the period from 1881 to 1990, a total number of 81 forest management plans (28 provisional, 41 definite and 12 revisions) have been examined conducting content-thematic analysis (see Fig 3). The plans were written either in German or in French.

The forest management plans have to be carefully evaluated, as they are biased to some extent by the interests of the authors and the intended readers.[41] The forest management plans represent the viewpoint of the forest authorities. Therefore they have a normative character, which means they rather represent the official line on how forest management should be (the theory) and tend to neglect the important often non-official practice of

traditional non-timber forest uses in the people's daily life. Non-timber forest uses were essential for the poor people, but forest officials often characterised wood pasture and litter collecting as minor forest uses, because their main interest was in timber production. Furthermore it should be noticed that forest management plans give account only on the management of communal forests but they do not include information about private woods. Despite these limitations forest management plans are a key source for reconstructing forest use history as they provide a wealth of information about forests and forest use and management.

Oral history interviews

In this study forest management plans were combined with information from oral history interviews. In the Valais, traditional non-timber forest uses were still practiced until the mid 20th century.[42] Therefore it is still possible to collect first hand information (expert knowledge) from contemporary witnesses, who have personally practiced litter raking and/or have intimate knowledge about wood pasture conducted some decades ago. The basic guideline of the interviews was designed for collecting this expert knowledge and did not aim at studying the variability of perceptions. The interviews allowed access to information of specific issues where the official sources remain silent. Particularly in the field of non-timber forest uses, oral history interviews provide essential additional information to the forest management plans. Most traditional non-timber forest uses were practiced by specific social groups. Usually children were herding the goats in the forests whilst litter raking was generally the job of women and children. A major strength of oral history is to give such people a voice who are underrepresented in the official records, such as forest management plans.[43]

In this project, 12 interviews were conducted. The interviewees were between 69 and 90 years old and in respect of gender equally distributed. The selection of interviewees was focussed on people who had personally carried out traditional non-timber forest uses and therefore were able to provide first-hand information. Additionally, people with a broad agricultural and/or silvicultural background were also questioned. Most interviewees we found responded to an article about the pine-forest research project published in a local newspaper. The article was accompanied with a call for contemporary witnesses with the

profile as described above. Other suitable informants were found on the occasion of a public information evening about the pine forest project and through local contacts.

To elevate the creditability of the interview, it is essential to know as much as possible about the narrator's biography.[44] Furthermore, information on the personal background is helpful to contextualize the results of the interviews. Such information helps to assess how close the interviewee was to the events he or she recounts and to ensure that the statements are first hand information.

To conduct the interviews, a semi-standardized technique was used which is a combination of specific questions and an open conversation.[45] The application of an interview guideline in all interviews enables the comparability between the different interviews. The narrative part of the conversation allows the interviewee to introduce new aspects and to emphasise the most important points in his view. If possible, the interviews were conducted in the forests, because an enhanced capacity for remembering was supposed if the interviews take place in the location of the former practices. Additionally, conducting the interviews directly in the forests, gave the interviewee the opportunity to point out traces of past forest-uses. As the statements of the narrators were interpreted as expert knowledge the interviews can consequently characterised as expert interviews.

All interviews were tape-recorded and transcribed later on. Because of the manageable number of interviews we performed a content and thematic analysis without any coding techniques.[46]

Combination of forest management plans and oral history interviews

The value of the information gained from oral history interviews was enhanced by combining them with the evidences from other sources. This combination enables one to assess past forest uses from different perspectives and therefore leads to a more comprehensive picture. The two sources complement and often clearly call into question one another. In this study the reconstruction of traditional non-timber forest uses is based on information taken from forest management plans for the late 19th and the beginning of the 20th century (Fig. 3). The range of reliable memory recall of the interviewees goes back to the second quarter of the 20th century. That was also the time when the definite forest management plans were implemented. Therefore, the two source-types can be

compared and their quality can be evaluated for this overlapping period. In the second half of the 20th century, only a few forest management plans were established. Consequently, oral history interviews are the primary source of information for this last period. This period is of particular interest because traditional non-timber forest uses were abandoned in many regions during this time.

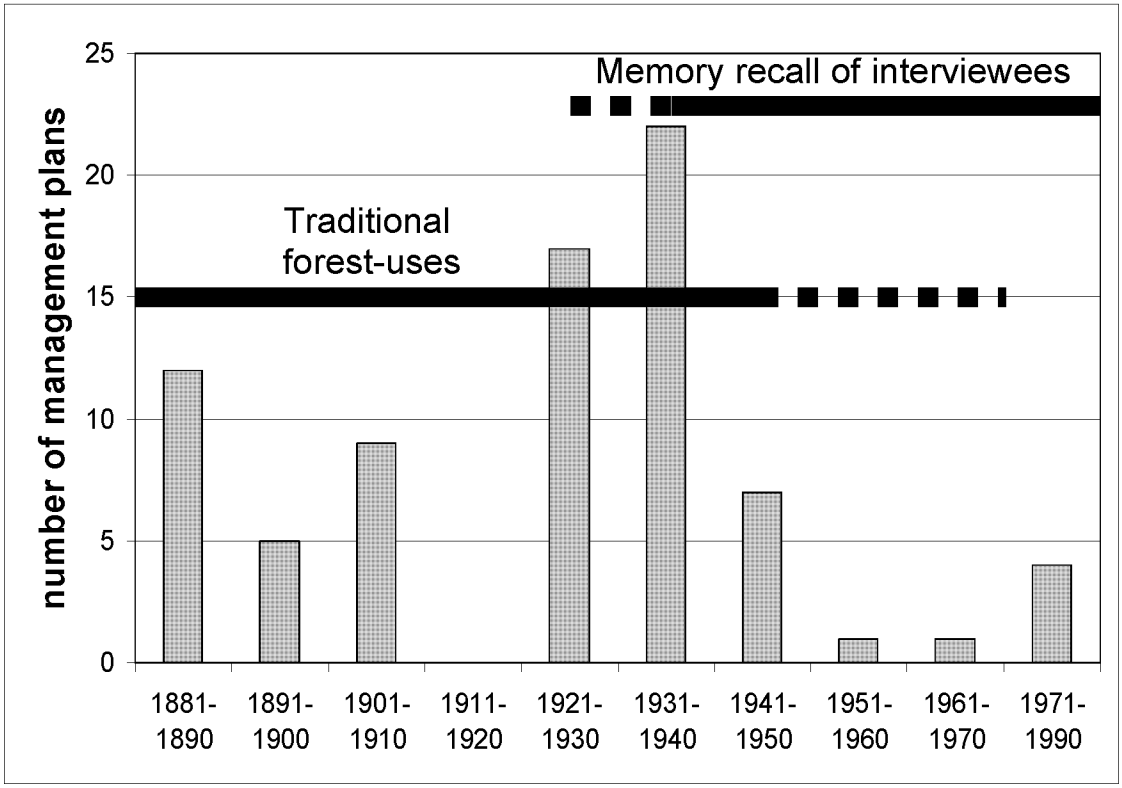
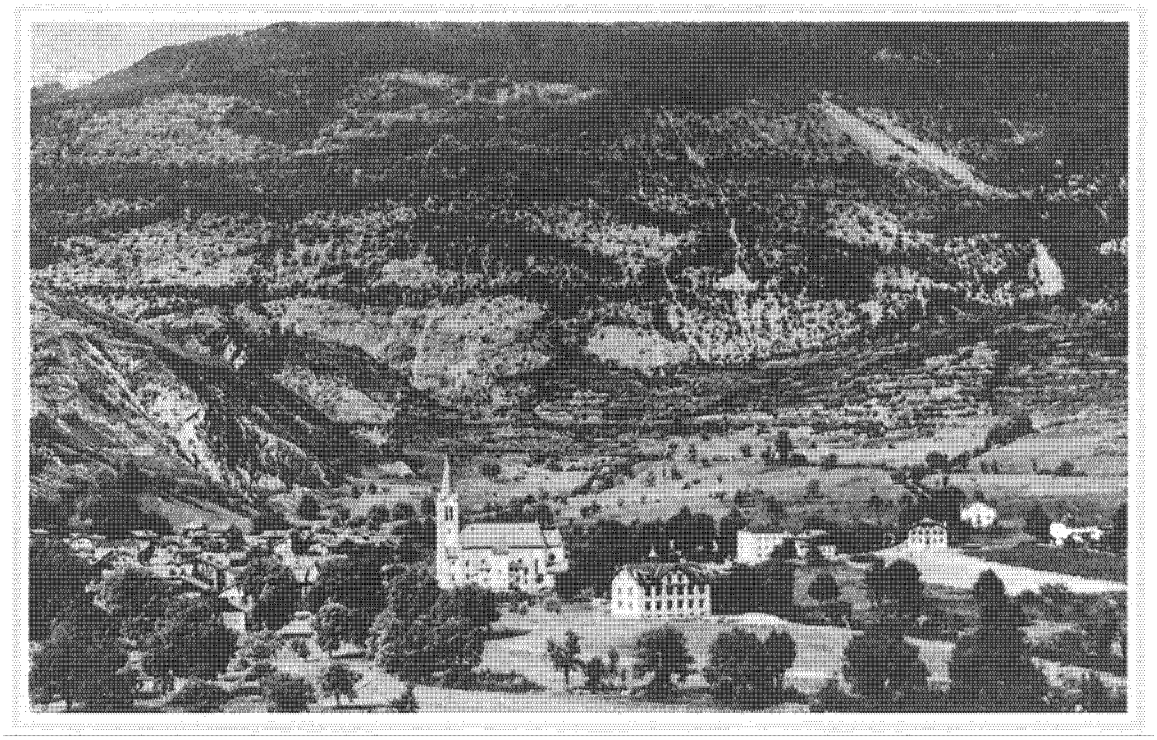


FIGURE 3: Oral history interviews and management plans in the context of traditional non-timber forest uses in the Valais.

RESULTS

First case study: the municipality of Salgesch



reproduced from Meichtry, W. (2002)

FIGURE 4: Salgesch in the late 19th century. In the background the extremely dry south exposed slopes of the upper forest. Clearly visible are the relatively densely stocked stands along the irrigation channels ("Varener Wasserleitung" and "Mengis Wasserleitung").

General description

The forested area of Salgesch is divided in three different sections (see Fig. 5). The upper forest (forest 1) is located on a southern exposure and is predominately stocked with pine. Two irrigation channels[47] ("Varener Wasserleitung" and "Mengis Wasserleitung") cross the area (see Fig. 4). The pure pine stands of the Pfynwald (forest 2) cover a hilly area on the right hand side of the Rhone. The Pfynberg (forest 3) situated on a northern exposure was almost completely destroyed by forest fire twice in 1921 and 1996 respectively[48]. After the first fire, the area was reforested with larches. In contrast, no reforestation was done after the second fire.

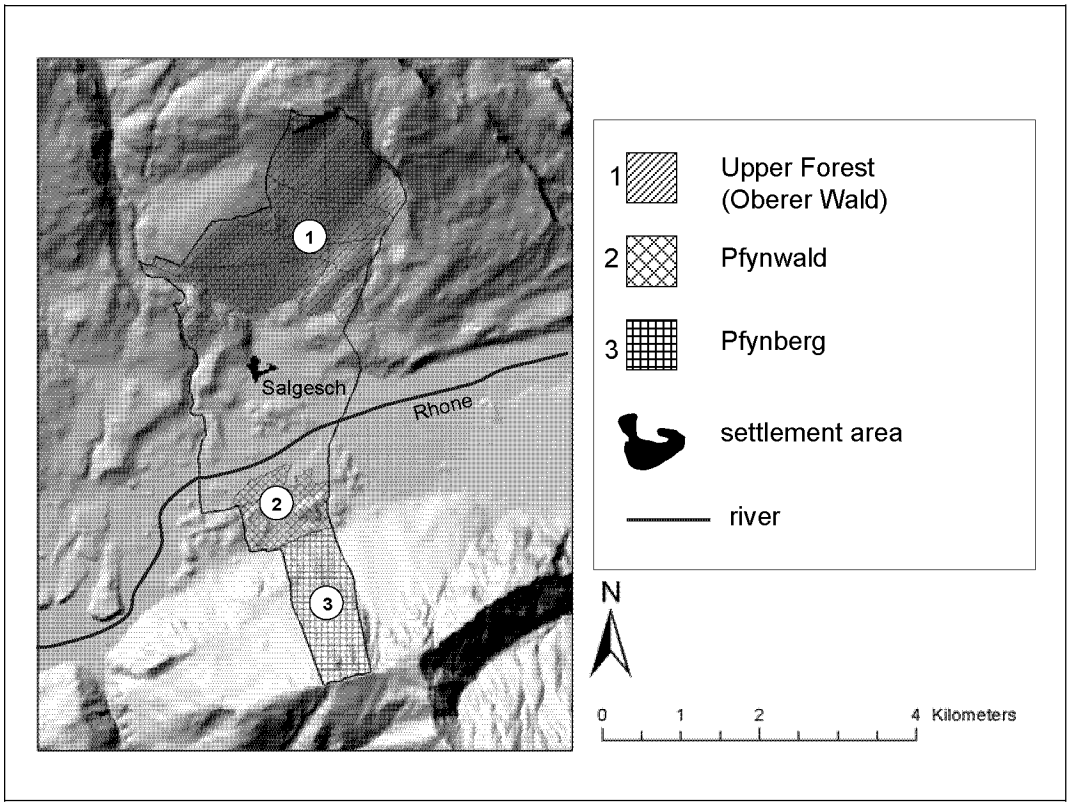


FIGURE 5: Forests of Salgesch.

Sources and material

To reconstruct the forest use history of the municipality of Salgesch four forest management plans (MP) were available: MP 1888 (provisional), MP 1932 (definite), MP 1973 (revision) and MP 1982 (revision). An exceptionally detailed interview was conducted with A.M. (born 1923) who employed by the municipality of Salgesch as local forester of from the early 1950s to the mid 1970s. The father of A.M. held this position until the interviewee took over the job. Basically the family lived on agriculture at a subsistence level and the earnings from viniculture. The interview included two half-day walks through the forests of Salgesch. Furthermore, A. M. provided personal documents (see Archival Sources) from his time as a forest supervisor.

The forest supervisor of such a small municipality was strongly imbedded in the local sociocultural structures, surrounding a typical agricultural lifestyle and livelihood. Therefore he was anxious to find a balance between the implementation of the ideas of the superior forest administration and the considerations of the resource needs of the local

community. This consideration should be taken into account when assessing the interviewee's statements from a source critical point of view.

Wood pasture

The first MP 1888 only provides some general references about the wood pasture in the forests of Salgesch. Grazing by goats and sheep should be restricted to areas "where the forests suffer as little as possible", but no specific regulation and spatial restrictions are given. The second MP 1932 highlights wood pasture as a central theme with a particular focus on the damaging impacts of this practise. Sparsely stocked stands were interpreted as the harmful consequences of browsing on trees and trampling on regeneration. These effects were located notably in the lower eastern sections of the upper forests (forest 1 in Fig. 5). In the guidelines for the future treatment of the forests, wood pasture had been excluded from the larger part of the forested area. Only on the sparsely stocked areas of the lowest part of the upper forest, grazing should be accepted further on. The forest authorities were ordered to strictly control these regulations. The guidelines do not mention specification on potential penalties in case of the violation of these restrictions. With the implementation of spatial restrictions in the MP 1932, the forest administration tried to displace the wood pasture to areas where the conflicts with timber management were negligible. In the MPs 1973 and 1982, wood pasture was not included anymore as a relevant topic – probably due to the rapidly decreasing number of goats shortly after World War II (Fig. 7).

The oral history interview confirms that wood pasture was practised above all in the eastern part of the upper forest (forest 1 in Fig. 5) and to a lesser extent in the Pfynwald (forest 2 in Fig. 5). In addition, along the upper irrigation channel ("Varener Wasserleitung") in the western part of the upper forest, goats from the neighbouring municipality regularly entered the forests of Salgesch. In spring, the municipality of Salgesch employed a goatherd to guide the animals on a defined route through the forests. Every morning, the farmers brought their goats and sheep to a pen constructed of stone ("Schafferrich") located at the lowest corner of the Blattenwald (lowest section of forest 1 in Fig. 5). Relicts of this gatherling place are still visible today in the forest. From there, the herder guided the animals up to the upper tree line of the upper forest and drove

them back to the "Schafferrich" in the evening. Interestingly, this traditional grazing route does not correspond to the spatial restriction made in the WP 1932 which restricted wood pasture to the lower part of the upper forest (see Fig. 6). Conflicts between herders and the forest authorities were inevitable. In 1943, a goatherd had to pay the penalty for guiding 102 goats and sheep to a prohibited area of the upper forest.[49] According to the evidences given by the interviewee, the area around the "Schafferrich" was a completely treeless pasture some 50 years ago. Nowadays, only a few bare areas remain, whereas the bigger part is covered with young pines and deciduous trees. While the sheep were driven to the alpine pastures in early summer, the goats stayed in the village all year round in order to provide the local people with milk. Especially the poor population depended on goat keeping. The goat as "the cow of the poor men" was a common phrase in many regions.[50]

Also in the Pfynwald (forest 2 in Fig. 5) some grazing was exercised although this practise was prohibited. From the few farms located in the Pfynwald, the cattle occasionally entered into the forest and grazed there. Furthermore, in autumn the sheep coming back from the alpine pastures were brought to a specific lake in the middle of the Pfynwald in order to wash the animals before shearing them. Interestingly the current name given to this lake "Schafsee" (Sheep's Lake) still reflects this past practise. Close to this lake two pens ("Schafferich") existed, where the sheep stayed and grazed during a few days in the end of October.

According to a report about wood pasture in Salgesch, in the late 1940s about 230 sheep during some days in spring and autumn and 42 goats over the whole year were still grazing in the upper forest.[51] In agreement with the findings from the forest management plans, A.M. dated the disappearance of wood pasture in the forests of Salgesch to the first decades after World War II.

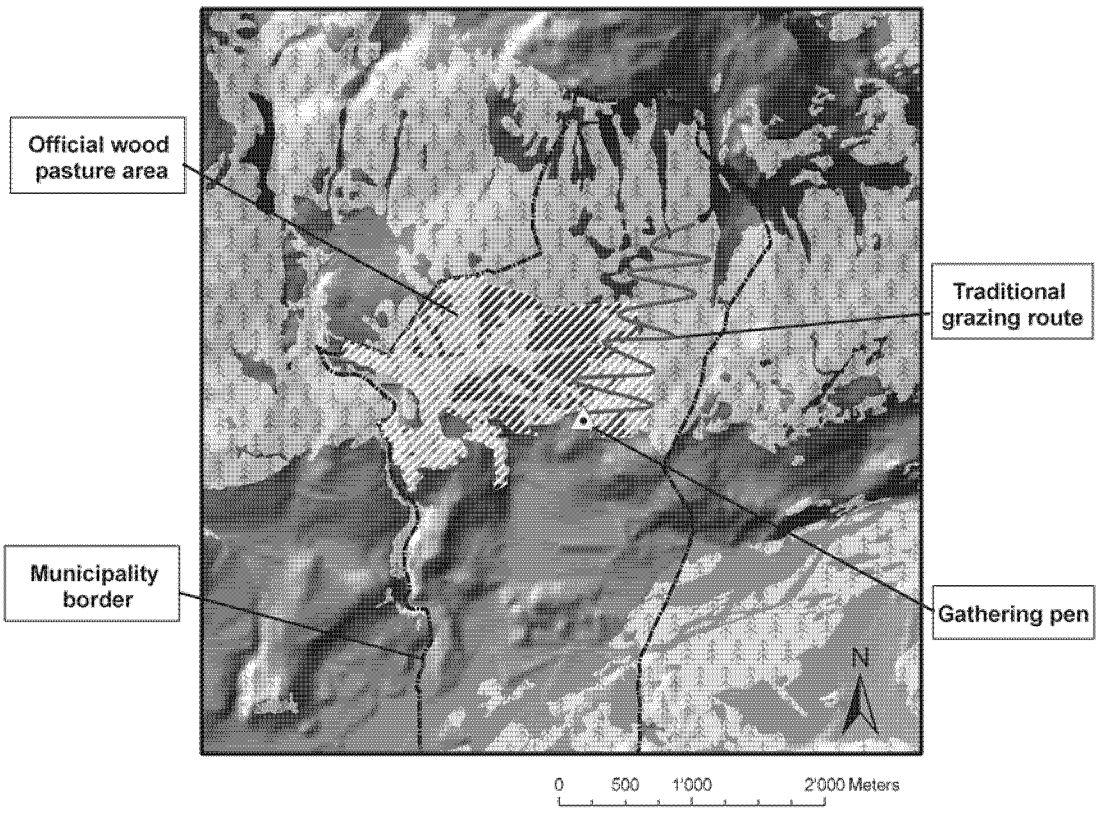
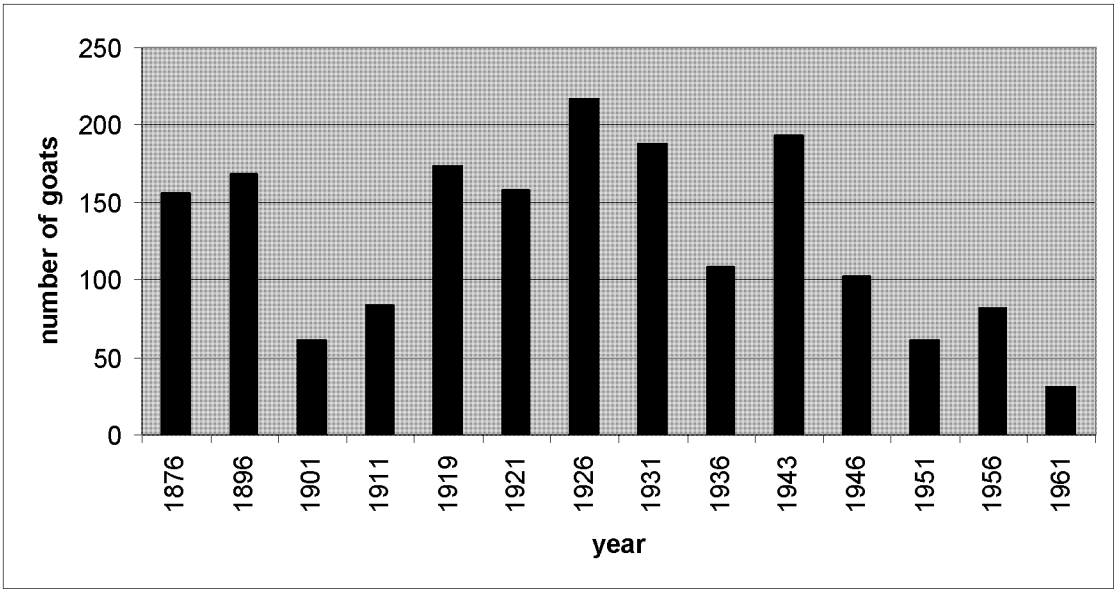


FIGURE 6: The MP of Salgesch 1932 restricted wood pasture to the lower part of the upper forest. From oral evidence we have knowledge about the traditional grazing route which obviously did not correspond to the official spatial restrictions.



Source: Eidg. Viehzählungen 1876-1966

FIGURE 7: Number of goats in Salgesch 1876-1966.

Litter collecting

The MP 1888 only gives some short general guidelines concerning the litter raking in the municipality forests of Salgesch. According to this MP, the forest administration designated every two to four years the districts where litter collecting was allowed. Litter raking should be restricted to the "minimal possible extent which is necessary" - a rather vague wording which is typical for the forest management plans of the late 19th and early 20th century. In sum its known that litter collecting was practised in Salgesch in the end of the 19th century, but we have little information about its intensity and spatial distribution. The MP 1932 indicates that the collecting of litter has been strictly prohibited some years before for the whole municipality forests. No information is given about the exact year of the implementation of this ban or about the adherence of the regulation. In the latest MPs of 1973 and 1982, litter collecting is not mentioned anymore. Obviously litter collecting disappeared during the second half of the 20th century and therefore lost its relevance for the forest administration.

The interviewee confirmed the relatively early ban on litter raking in the forests of Salgesch. Nevertheless, litter raking was apparently still practised to a limited extent, above all in the Pfynwald (forest 2 in Fig. 5) until the late 1950s. In contrast, the upper forest (forest 1 in Fig. 5) and the Pfynberg (forest 3 in Fig. 5) remained largely untouched by this forest use. Generally, litter raking seems not to have played an important role in the forests of Salgesch. Until the post-war period, the agricultural structure of Salgesch was geared to self-sufficiency. Large areas in the flatter part of the municipality which are today cultivated with vines, were covered with grain fields (rye and wheat) until the 1950s (see Fig. 4): "*In the flatter parts of the municipality large areas were cultivated with grain; everywhere you recognize vineyards today. It is incredible: the whole valley bottom was covered with grain fields.*"[52]

Therefore the demand for litter to be used in the barns was largely covered by straw from these crops.

Other non-timber forest uses

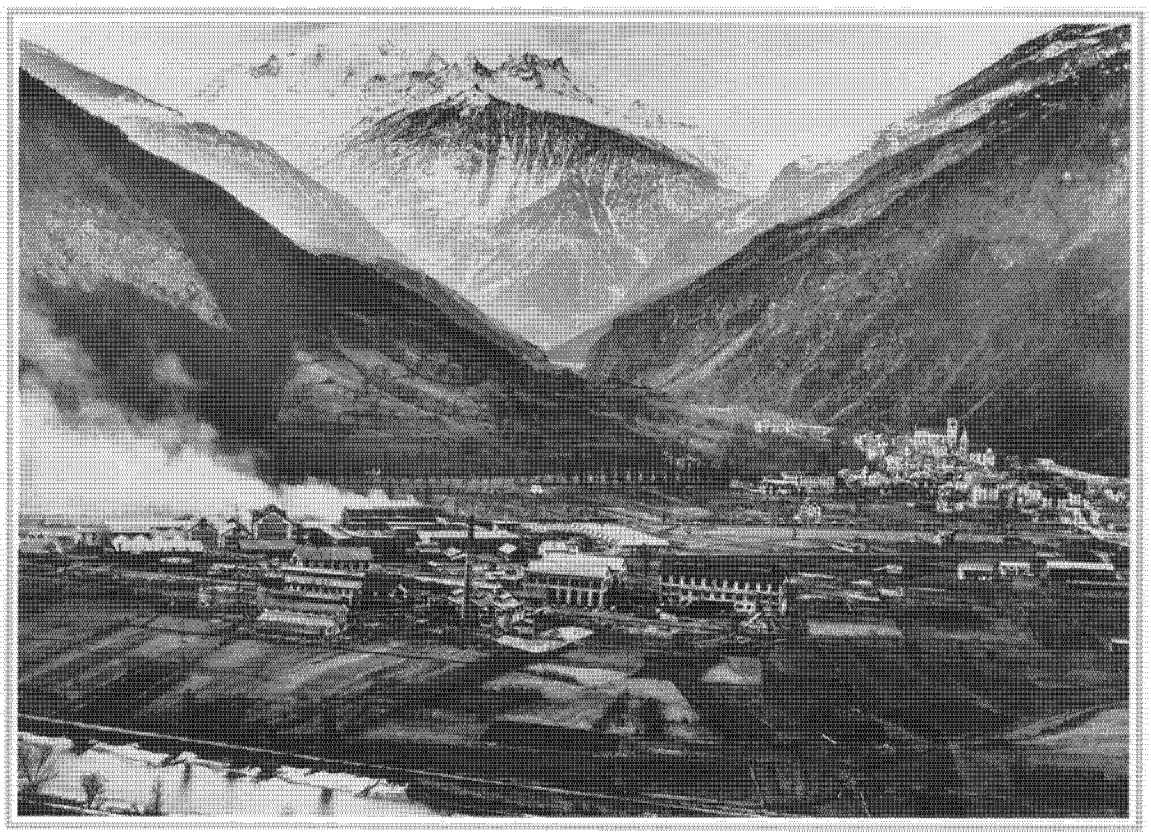
In all forest management plans no other non-timber forest uses than wood pasture and litter collecting are mentioned. In contrast, the oral history interview refers to a number of

additional traditional non-timber forest uses. On a small part in the lower east corner of the upper forest (forest 1 in Fig. 5) resin was extracted from spruces. Today's field name "Bächmannenwald" can be translated as 'resin-men forest' and therefore still refers to this practise, despite hardly any spruces being present today. The resin was used for the slaughter of pigs, where resin and hot water helped to remove the bristles of the pigs. The extraction of resin was practised until the late 1940s, when chemical products substituted the resin.

Mistletoes (*Viscum album* ssp. *austriacum*) were also collected for various purposes. The plants were used for fodder, for decoration on the occasion of several festive days (e.g. Christmas, Feast of Corpus Christi) and for different medicinal applications. *„We used the mistletoes to decorate the Christmas tree. Each tree had to have mistletoe"*[53].

In the Pfynwald (forest 2 in Fig. 5) some relicts of a former limekiln are still visible. Apparently other limekilns were in use at several places in the Pfynwald and in the upper forest (forest 1 in Fig. 5). Additionally, some charcoal also was produced in the Pfynwald. Lime and charcoal production were extremely wood consuming processes. According to the references of the interviewee these practises were abandoned at least 100 years ago. Thus, the information is not based on direct experience by the interviewee.

Second case study: the municipalities of Visp and Eyholz



Reproduced from Fux, C. (1996)

FIGURE 8: Visp in 1917. In the foreground the production plants of the Lonza SA. The chemical industry developed in the beginning of the 20th century. In the background the village of Visp and parts of the municipality's forests.

General description

The forested area is divided into six different sections (see Fig. 9). The lower part on the left hand side of the Vispa river (forests 1) is dominated by almost pure pine forests. In the upper part (forest 2) grow mixed stands with silver fir, spruce, and larch. In the forests of Visp on the right hand side of the Vispa river, we find almost pure pine forests in the lower and western part (forest 3) and mixed forests with silver fir, spruce, pine, and larch in the eastern part (forest 4). In the lower part of the municipality's forests of Eyholz (forest 5) we find mixed stands dominated by pine and downy oak. A significant part of the lower forests is privately owned and therefore not included in the forest management plans. The upper forests of Eyholz (forest 6) are predominately stocked with spruce, silver fir and near the upper tree line with stone pine.

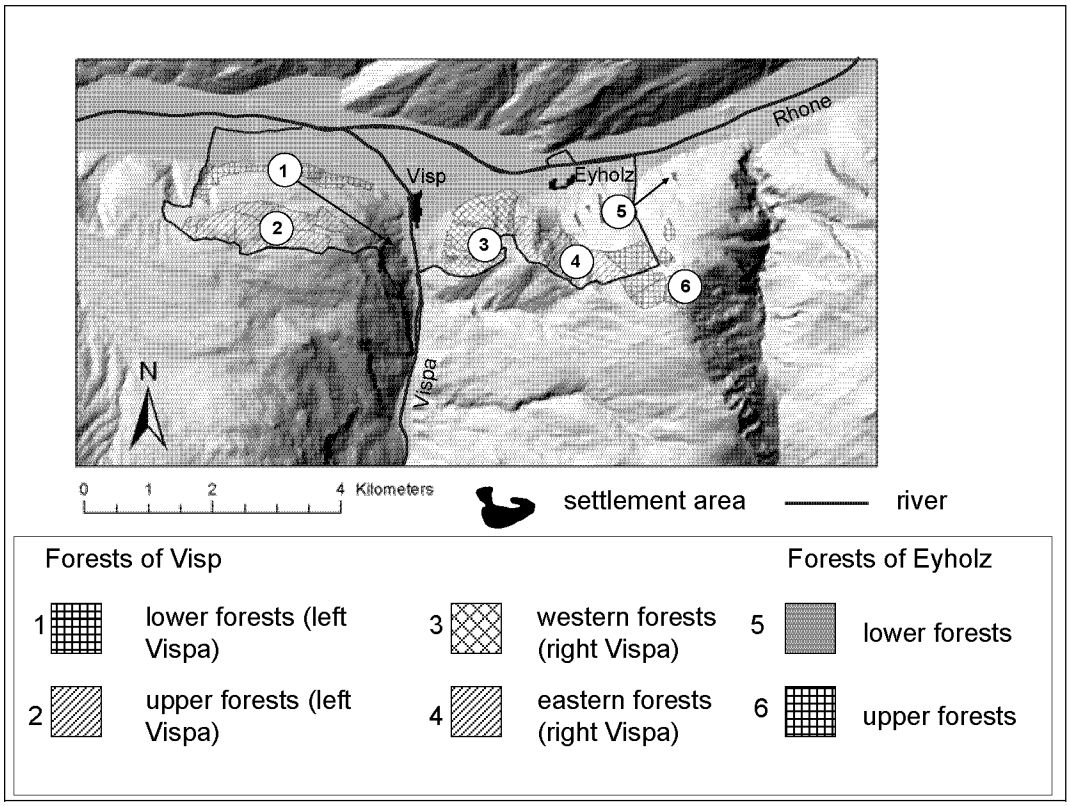


FIGURE 9: Forests of Visp and Eyholz.

Sources and material

The case study of Visp/Eyholz is based on three forest management plans from Visp - MP 1892 (provisional), MP 1924 (definite, left hand side of the Vispa river), and MP 1926 (definite, right hand side of the Vispa river) – and two plans from Eyholz – MP 1898 (provisional), and MP 1925 (definite). For Visp, an interview was conducted with T.W. (born 1915) who was a shift worker in the chemical industry and who avocationally practised agriculture and viniculture. The second interview with R.T (born 1928) covers the situation in the municipality of Eyholz, where R.T. worked as local forester from the mid 1950s to 1972. The father of the interviewee held this position from the 1930s. The family made a living from agriculture.

Wood pasture

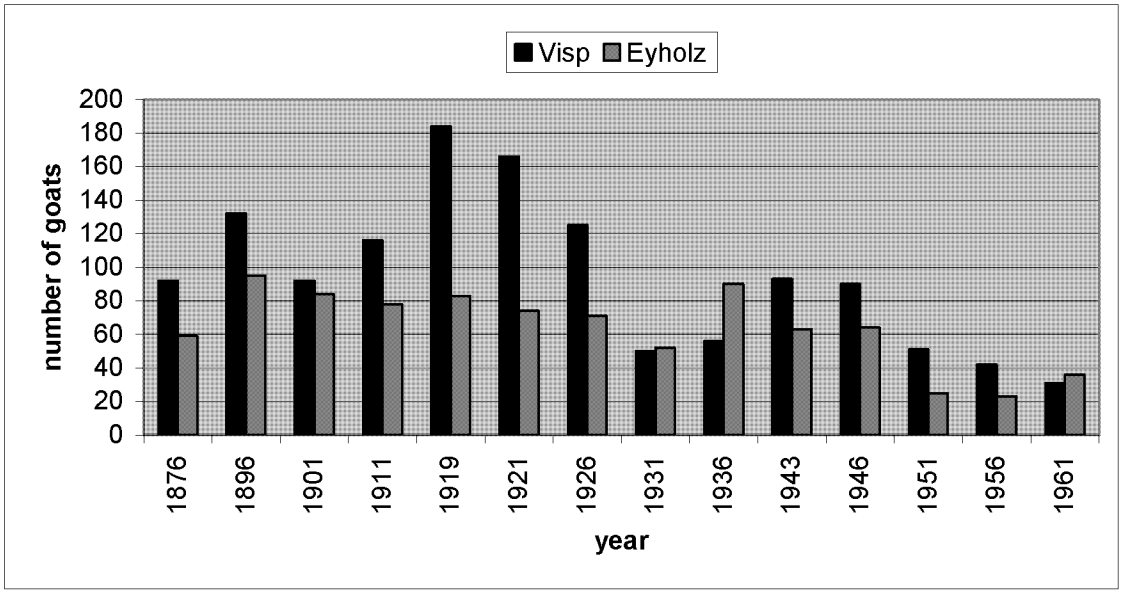
In the first MP of Visp dating from 1892, wood pasture is not mentioned at all. However, the MPs 1924 and 1926 refer to grazing as the most damaging forest use, which is not surprising considering a peak in goat number around 1920 (Fig. 10). The negative impacts of wood pasture such as missing or diminished regeneration and soil compaction were observed over large areas of the forests. These harmful consequences were already noticed earlier, as the MP 1924 refers to a series of regulations from the 19th century. The first restriction of wood pasture dates from 1848. Grazing was prohibited for the upper part of the forests on the left hand side of the Vispa river (forest 2 in Fig. 9). In case of violations a monetary fine was imposed. In 1849, the neighbouring municipality of Visperterminen got the permission for grazing sheep in the Thelwald, an almost pure pine forest on the right hand of the Vispa river (part of forest 3 in Fig. 9). In order to compensate for the negative impacts of wood pasture, a grazing charge was implemented in 1856 (only for non-citizens). In the 1880s, even a general ban on wood pasture was enacted. But already in 1891, this ban was cancelled at the request of several citizens and wood pasture was tolerated again in the lower forests on the left hand side of the Vispa river (forest 1 in Fig. 9) which are also predominately pine stands. This regulation persisted until the creation of the definite WPs in 1924 and 1926. The authors of the WPs 1924 and 1926 suggested the local permission of wood pasture to continue. Only for a small compartment an additional ban on grazing was implemented. Furthermore, the repeated penetration of goats and sheep from the neighbouring municipality of Eyholz was lamented (especially in the eastern part of forest 4 in Fig. 9).

The interview with T.W. from Visp indicates that grazing was practised up to the late 1950s when the number of goats rapidly declined (see Fig. 10). From the interviewee no further information was available about wood pasturing because he never personally owned goats or sheep.

The first MP for Eyholz, dated 1898, mentioned an easement for the neighbouring municipality of Visperterminen on wood pasturing by sheep in the Lindwald and the upper part of the Zügenwald (upper part of forest 6 in Fig. 9). This easement was combined with the right to use timber for repairing the irrigation channels. Otherwise wood pasturing was not widely practised in the forests of Eyholz according to the MP

1898. This is partially inconsistent with the general statement of the following MP 1925, which indicates that grazing had been tolerated without any confinement in all forests so far. According to the MP 1925, particularly two small, pine dominated compartments surrounded by private woods in forest 5 (see Fig. 9), were grazed heavily by goats. In the Lindwald (upper part of forest 6 in Fig. 9), the easement for Visperterminen on wood pasture by sheep still existed in 1925. In all the other forests of the municipality of Eyholz, grazing was allowed but apparently only practised on a limited scale. The MP 1925 suggests a restriction of wood pasture to the forested areas below approximately 1500 masl, which is the potential growing area of pine forests. Thus grazing was displaced to areas with a significant portion of pine forests.

From the oral history interview with R.T. from Eyholz it is known that in the 1940s, about 70 to 80 goats grazed in the forests of Eyholz (see Fig. 10). The grazing season (period of estivage) for goats lasted from April (when the snow cover had disappeared) to late autumn. In addition, the sheep were guided to the forest from April to May 24th when they were brought to the alpine pastures, and again from St. Moritz day (September 22nd) to the first snow. The pen for the animals was situated at the lowest edge of the forest near the village. Everybody who owned a goat or a sheep was bound to guide the animals through a defined grazing route at regular intervals. This work was mostly done by school children. The traditional route led through lower parts of the forests which were predominantly private woods. As in Visp, wood pasture disappeared in Eyholz at the end of the 1950s.



Source: Eidg. Viehzählungen 1876-1966

FIGURE 10: Number of goats in Visp and Eyholz 1876-1966.

Litter collecting

In the first MP for Visp of 1892, the problem of litter raking was not mentioned. The following definite MPs 1924 and 1926 attest that the forests did not suffer much from litter collecting. The interview with T.W. confirms these findings. Litter raking evidently was only rarely practised in the forests of Visp. The chemical industry arose at the beginning of the 20th century offered a lot of jobs to the people in the region (see Fig. 8). Consequently, many families gave up or significantly reduced their agricultural activities. Many households did not own livestock anymore. In addition, generally sufficient amounts of straw were available from the cultivation of grain.

The situation in Eyholz was in many ways different from Visp. In the first provisional MP 1898, no information about litter collecting can be found. But the MP 1925 complains that litter raking had been tolerated without any confinement so far and asks for regulations. The idea was to exclude litter collecting from the 3 compartments in the upper part of the municipality's forest (forest 6 in Fig. 9). Obviously, this idea was put into practice, as the consequences of this prohibition are mentioned in the interview with R.T. He points out that the exclusion of litter raking from the municipality forests caused a displacement of the practice to private forests. Almost every family owned a piece of

private wood mostly located below the irrigation channel (*suonen* or *wasserleitung*)– the "*Rohrbergerii*". Most of these forests are almost pure pine forests. The interview provides detailed information on the practice of litter collection and the socioeconomic background of the litter collecters. Litter raking was practised above all by women and children. The litter was collected in late summer and stored on a pile (see Fig. 11). Some information enables quantitative estimation about the size of these litter piles. According to an interviewee from the valley of Saas the piles measured about 2.5 m in height and 2.5 m in diameter[54]. This is in quite good agreement with corresponding figures for the municipiality of Zeneggen where in the beginning of the 20th century about 80 piles were counted that were 2.5 to 4 m high and measured 3 to 4 m in diameter.[55] Based on these quantities we assume an essential ecological significance taking into account that litter raking was practised above all in forests with a small natural productivity and in a dry region.

Source: A. Imboden, Zollikofen; repr. In Kempf 1985.

FIGURE 11: Litter pile in the valley of Saas (in about 1965)

According to the interview with R.T., litter from spruce, pine and birch were preferred whereas the needles of the larch were not collected because they were regarded as unfavourable.[56] Probably larch needles decompose too fast and therefore they are not very practical to bind the manure. Occasionally, the upper soil was carried away as well.[57] In autumn and winter, the litter was used in order to bind the livestock's (cows, sheep and even chicken) manure in the barn. Obviously forest litter was not used for pigs: *"Forest litter was not used for the pigs. The needles penetrated into their nostrils and they fell ill.*[58]*"* In order to overwinter a cow, at least 10 bags of litter were needed. The demand for forest litter depended on the availability of straw from the cultivation of grain. The family of the interviewee for example did not require much forest litter. Furthermore, the financial circumstances determined whether a family could afford to buy additional straw or not. In the period of World War II, generally more litter was collected in the forests. About the end of the 1950s the practise had completely disappeared in Eyholz.

Other non timber forest uses

The MP of Visp 1926 refers to the resin extraction practised in the Thelwald (part of forest 3 in Fig. 9) from 1874 to 1877 and again in the late 1890s. As raw material old pine stumps were cut just above the ground. As pine wood is extraordinarily rich in resin, the stumps were boiled in order to extract the resin. After the MP 1926, the forest authorities tolerated this practise. According to the interview with T.W. in certain forests of Visp resin from spruces was used for the same purposes as in Salgesch (see above) until World War II.

Main patterns of traditional non-timber forest use history in the pine forest belt of the Valais

Apart from the case studies, different factors determined the spatio-temporal patterns of traditional non-timber forest use history in the pine forest belt of the Valais. These factors were identified based on the analysis of all available forest management plans and the full sample of oral history interviews from the whole pine forest belt of the Valais.

Regulations

On the regulation level it is noteworthy that in the provisional forest management plans at the turn of the 20th century only a few restrictions were found concerning non timber forest uses. Most regulations refer to protected forests. Extensive regulation tended to provoke the resistance of the local people, e.g. the general ban on grazing enacted for Visp in 1880 (see above). Obviously, the practise of wood pasture and litter raking were a basic necessity for a significant part of the poor people. The definite forest management plans written between the mid 1920s and the mid 1940s contain numerous rules, restrictions and bans on litter raking and wood pasture. The MP for Feschel of 1929 for example defined that an upper limit of 10 bags ("Maltersäcke", 1 Malter ≈ 1.5hl) of litter could be collected by each legitimate person[59]. Similar quantitative limitations are given in several other forest management plans. Obviously, the forest administration tried to limit the amount of litter harvested and to generally exclude traditional non-timber forest uses from areas where they had a high potential of damaging timber growth. These intentions often led to a concentration of litter raking and wood pasture in sparsely stocked pine forests.

Accessibility of the forests

The easily reachable forests near the settlements were highly attractive for litter collecting as people were anxious to avoid long and arduous journeys. In the MP of Glis 1930 for example, it is noted that in the easily accessible forests close to the village the whole litter cover was removed each year[60].

Access to alternatives

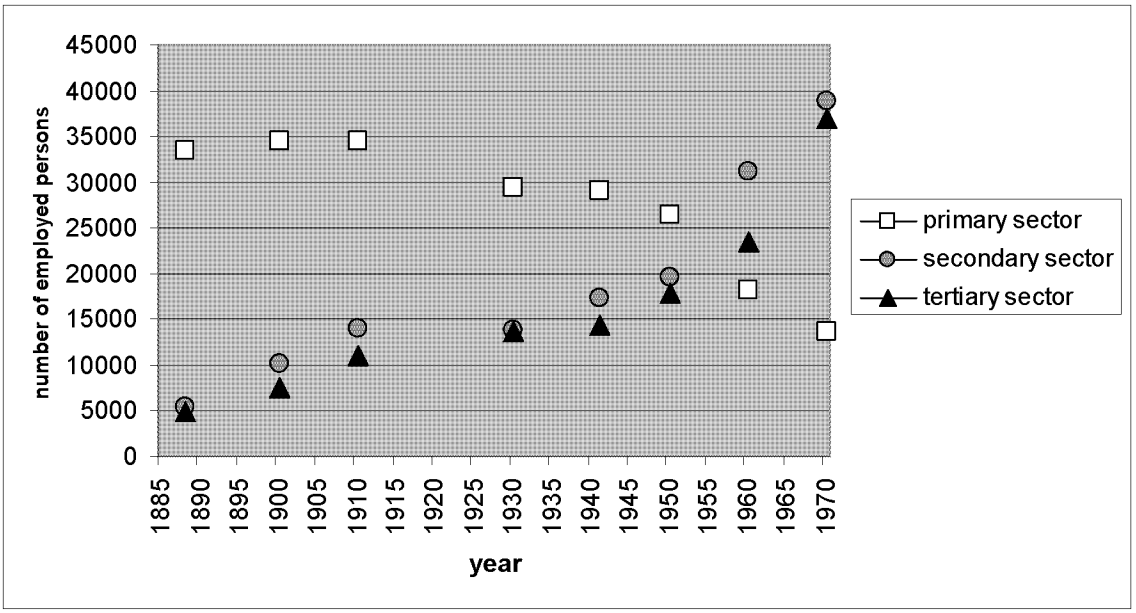
In most municipalities, the demand for litter was partially covered by straw from the cultivation of grain. The availability of straw essentially determined the intensity of litter collecting in the forests.

The accessibility of a municipality decided on the possibility of importing substitute products, such as straw instead of forest litter, in sufficient quantities and with competitive costs. According to the information taken from oral history interviews conducted in the municipality of Mund, litter raking immediately disappeared after 1975

as a consequence of the construction of a road which connected the village to the main transport infrastructure in the valley bottom[61]. In many regions, the connection to the traffic network did not only improve transport facilities for commodities, but initiated also the rise of winter tourism. This phenomenon is reported for the Saas valley: *„Fundamental changes of the traditional lifestyle and economic structure were strongly linked with the traffic development such as the construction of the road in 1951 and the railway connection in 1953. These changes went on extremely fastand they were also the starting point of the winter tourism*[62]*."*

Economic situation

The economic structure of the Valais was largely dominated by agriculture up to the mid 20th century (Fig. 12). The economic revival, essentially based on the rise of the hydroelectric industry and the rebound of the tourism sector after World War II, created a lot of new jobs in the Valais, and fostered indirectly the abandonment of traditional forest uses in many regions. The economic circumstances of the local people were decisive for determining if and how long litter raking was practised. In the first decades of the 20th century, litter raking was widespread. In regions where additional sources of income were early established, such as the chemical industry in Visp, agriculture became less important and the demand for forest litter and the need for wood pasture decreased.

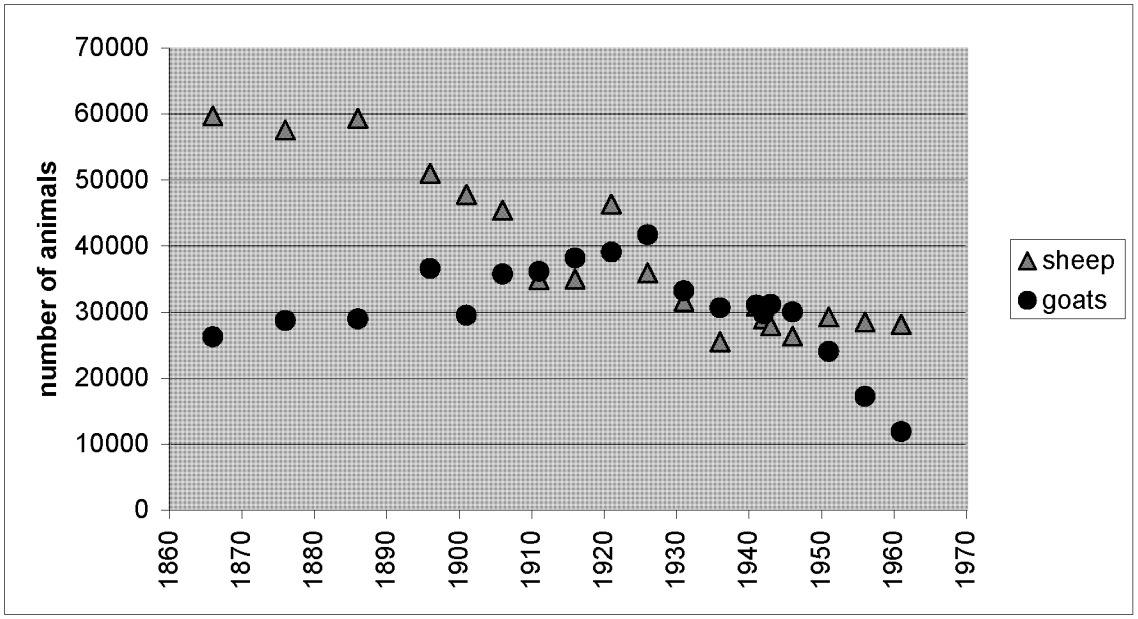


Source: Eidgenössische Volkszählung 1970.
FIGURE 12: Number of persons employed in the different sectors in the Canton of Valais from 1888 to 1970.

Changes in demand

Up to the first half of the 20th century, almost every family owned one goat for milk production. As already mentioned in the case studies, the number of goats decreased shortly after World War II (see Fig. 13) as a consequence of fundamental socioeconomic changes and structural changes to Valaisan agriculture[63]. Consequently, wood pasture was almost completely abandoned in the Valais up to the 1960s.

In time of scarcity such as World War I and World War II, traditional non-timber forest uses gained increased importance. In the municipality of Glis for example, wood pasture was partially reintroduced in 1943 for the wartime[64]. Similar effects for litter collecting were observed for the Swiss lowlands[65] and Germany during World War I.[66]



source: Ritzmann-Blickensdorfer (1996)

FIGURE 13: Changes in livestock of goats and sheep in the Canton of Valais from 1866 to 1961.

DISCUSSION

Wood pasture and litter collecting were the most important non-timber forest uses in the pine forest belt of the Valais during the late 19th and the first half of the 20th century. Other non-timber forest uses did not play an essential role, apart from the extraction of resin and the collecting of mistletoes, which were of local importance. The local and temporal intensity of these practices was influenced by legislative, topographical and socioeconomic factors.

A number of studies from Switzerland and neighbouring Alpine countries have shown that traditional non-timber forest uses were conducted much longer in remote mountainous regions than in more central areas.[67] This study confirms this fact. In most regions of the Valais the traditional non-timber forest uses were given up in the first decades after World War II. Only in extremely remote regions were wood pasture and litter raking still practised to a significant extent until the 1970s. Several socioeconomic drivers finally led to the disappearance of these practices. The level of accessibility was crucial if straw could be imported in sufficient quantities to a municipality. In many regions the extension of the transport infrastructure directly resulted in the disappearance of litter raking. The existence of supplementary sources of earning in addition to

agriculture (e.g. industry, tourism) was another decisive factor for determining when traditional non-timber forest uses were given up. Changes in demand of the society directly caused changes in land-use. In this context, Bürgi proposed a classification in three overlapping periods of forest use for the Swiss lowlands: the 'period of traditional multiple use', the 'period of primacy of timber production' and the 'period of modern multi-impact management'[68]. In the Valais the traditional multiple use lasted 50 to 100 years longer than in the lowlands of Switzerland. In consequence, a period with primacy of timber production was never completely established.

Ecological significance for pine forest ecosystems

From findings of this study it can be assumed that the practise and the abandonment of traditional non-timber forest uses has considerable impacts on pine forest ecosystems. The efforts of the forest authorities to displace traditional non-timber forest uses to areas with a minor importance of timber production during the first half of the 20th century resulted in an increased pressure on sparsely stocked pine forests. The practise of wood pasture and litter raking led to specific environmental conditions which favoured pine as a pioneer species. Damages to pine resulting from browsing were negligible in comparison to those on other tree species, particularly on deciduous trees. In addition, the continuous removal of the litter cover and parts of the upper soil led to excellent conditions for pine regeneration. After abandonment of these practises pine was subjected to increased competition. The recovery of the soil after a long period of massive biomass removal is a very long-term process[69].

In many regions mistletoes were collected for different purposes. Mistletoes are parasitic plants that deprive the host tree of water and nutritive salt which may lead to increased drought stress in extended dry periods. Therefore mistletoes are suspected of contributing to the pine decline in the Swiss Rhone valley.[70].

Strength and limitations of the two source types

All source-types have their specific strengths and limitations[71] – which also holds true for forest management plans and oral history interviews (Tab. 1).

	Management plans	Oral history interviews
Description of practices	★	★ ★ ★
Spatial information	★ ★	★ ★
Temporal information	★ ★	★ ★
Socioeconomic context	★	★ ★ ★
Quantification	★ ★	★ ★

TABLE. 1. Comparison between management plans and oral history interviews. The number of stars indicates a qualitative weighting of the applicability of the source type for a specific research aspect (tree stars: good applicability, two stars: medium, one star: strongly limited).

The description of the practices of the non-timber forest uses is generally more detailed in the interviews, as they provide detailed insights about the technique and the practical exercise of litter collection. Forest management plans, on the other hand, mostly simply mention if a practice took place or not.

Information about the spatial extent of the practices on a regional scale usually is given in forest management plans. But from local comparison with oral history interviews some inconsistencies can be noticed. The prohibition of a specific forest use in the forest management plan does not necessarily mean it was not practised. And vice versa if a practice was officially tolerated it was not inevitably executed. Here the interviews in many cases provide locally accurate information. With a larger number of interviews it would be possible to get this kind of information for the whole research area.

Both source-types have specific limitations with regards to information on the temporal development of traditional non-timber forest uses. Forest management plans cover a specific time frame for the period when they were written. Since the mid 1940s only a limited number of forest management plans is available. Therefore the forest management plans provide only sparse information concerning the question when traditional non-timber forest uses have been abandoned. The oral history interviews are

restricted to the interviewee's ability to remember (at most about 80 years). In addition the exact dating of the information was often very difficult. Thompson remarked that most people are less interested in calendar years than historians, and therefore do not arrange their memories with dates as markers.[72].

The socioeconomic context of a certain practice is best accessible through oral history interviews. In the forest management plans, non timber forest uses often are labeled and treated as minor forest uses, because the main focus of forest authorities was on timber production.[73] The harmful consequences of the non-timber forest uses are usually strongly emphasised. By contrast the interviewees are able to integrate the information into their own context of experiences and their way of life ('Lebenswelt').[74] They often point out the importance of traditional non-timber forest uses for the people's daily life.

Both source types provide a multitude of quantitative information about uses such as wood pasturing and litter raking. In forest management plans, quantitative information is mostly related to restrictions of a specific forest use (e.g. quantitative limitations). Quantitative evidences from oral history interviews are usually referring to practical aspects of the forest uses (e.g. how much litter was needed to overwinter a cow). This kind of information enables one to reconstruct traditional non-timber forest uses in terms of intensity as well as spatial and temporal distribution. Such quantitative information is essential for assessing the impact of these practises on forest ecosystems.

CONCLUSION

In order to reconstruct the history of traditional non-timber forest uses in the pine forest belt of the Swiss Rhone valley (Valais), official documentary sources (forest management plans) were combined with oral history interviews. The forest management plans represent the view of the forest administration whereas the oral history interviews provide first-hand information from people who had personally practised the traditional non-timber forest uses. The major strength of forest management plans are the spatial information on a regional scale and the description of legislative regulations. By contrast the main advantages of the interviews emerge in the detailed description of the practices and in the information about the socioeconomic background. Combining these two approaches allows the assessment of past forest use changes from different perspectives,

and allows a comprehensive reconstruction of the history of wood pasture and litter raking in the pine forests of the Valais.

The study revealed that wood pasture and litter raking have been the most important traditional non-timber forest uses in the pine forest belt of the Swiss Rhone valley during the late 19th and the first half of the 20th century. These practises were a basic necessity for a significant part of the population whose lifestyle was based on self-sufficiency. The local and temporal extent of traditional non-timber forest uses and their abandonment was determined by the regulations of the forest authorities, the accessibility of the forests, the access to substitute products, the economic situation of the local people and changes in demand.

From the findings of this study it can be assumed that traditional non-timber forest uses produced considerable impacts on pine forest ecosystems of the Valais. The recovery of the ecosystem after abandonment of these practises is still in progress. The results of this study therefore establish a basis for the understanding of current ecological processes.

Acknowledgments:

First of all we would like to thank our interviewees for providing such rich and helpful information. The insightful comments of Klaus C. Ewald, Anton Schuler and Marcus Hall on earlier drafts helped to improve the quality of this paper. We wish to thank also the two reviewers for their constructive comments and additions.

[1] Flühler et al. 1981; Rigling and Cherubini 1999.
[2] Rigling and Cherubini 1999.
[3] Weber et al. 2005.
[4] Rigling et al. 2006.
[5] Hasel 1985, 152; Radkau and Schäfer 1987, 19.
[6] Bühler 1889.
[7] Loup 1965, 160.
[8] Viazzo 1989.
[9] Netting 1981.
[10] Stuber and Bürgi 2001, 2002.
[11] Bürgi 1999 a; Stuber and Bürgi 2001
[12] Landolt 1862, 240.
„Die Zeit, in der man den Weide- und Streuertrag der Wälder höher achtete, als den Ertrag an Holz, ist in den meisten Gebirgsgegenden noch nicht weit hinter uns, an vielen Orten lebt man sogar noch mitten drin."
[13] Fankhauser 1887; Grossmann 1927.
[14] These goats were called 'Heerdgeissen', 'Heimgeissen', 'Dorfgeissen' or 'Kehrgeissen'. Fankhauser 1887, 30 ff.
[15] For the history of the concept of „Kornland" and „Hirtenland" see Mathieu 1992, 38-41.
[16] Pfister 1983, 1985.
[17] Delfs 2001. Radkau 1987, 63.
[18] Bürgi 1999a, 572.
[19] Howarth 1998.
[20] Fogerty 2001, 101.
[21] http://www.lib.duke.edu/forest/Research/ohiguide.html
[22] http://www.uea.ac.uk/~e490/eaeh.htm
[23] Carter 1974; Cregeen 1974; Faiers 1976.
[24] Evans 1965, 1966, 1970, 1975.
[25] Gant 1986; Preston 2002.
[26] Brummond 2000.
[27] Egoz 2000.
[28] Howarth 1998, viii.
[29] Fairhead and Leach 1996.
[30] Riley 2004.
[31] e.g. Calheiros et al. 2000 ; Fernandez-Gimenez 2000 ; Olsson and Folke 2001.
[32] Shindler and Aldred Cheek 1999; Lykke 2000; Robertson et al. 2000; Robertson and McGee 2003.
[33] Howarth 1998.
[34] Thompson 1978, 7.
[35] For the climatological data we refer to Rebetez and Dobbertin 2004.
[36] e.g. Östlund et al. 1997; Bürgi 1999 a & b; Axelsson and Östlund 2001.
[37] Bürgi 1999a, 568.
[38] The governmental instructions for the implementation of the definite forest management plans in 1923, asked for revising the plans every 10 years. (Kempf 1985, 57).
[39] Kempf 1985, 56. An overview of the development of the forest laws for the Canton of Valais is given in Kempf 1985, 45 ff.
[40] Kempf 1985, 56.
[41] Bürgi 1999 a, 569; Bürgi 1999 b, 150.
[42] Kempf and Scherrer 1982; Kempf 1985.
[43] Botz 1984; Howarth 1998.
[44] Yow 1994, 270 ff.
[45] Flick 1995, 99 ff.
[46] Thompson 1978, 126.

"The recording is a far more accurate and reliable account of an encounter then a purely written record and only the transcription of the interviews allows the recording to be cited in a book or article"
[47] to the importance of irrigation systems in the Valais see Mariétan 1948, Reynard 1995, Crook 1999 a&b, Crook 2001
[48] Gimmi, Bürgi and Wohlgemuth 2004, 438.
[49] PAM: Procès-Verbal, Délit de Bois No. 9 (15. Juni 1943)
[50] Radkau 1987, 63.
[51] PAM: Bericht über den Schafweidgang im "oberen Wald", Abt. 2. (7. Juni 1949)
[52] translated OHI A. M., Salgesch 2004
„Die ganzen flacheren Partien, wo heute vorwiegend Reben sind, waren Getreidefelder. Es ist unglaublich: Die ganze Ebene - Getreide."
[53] Translated OHI A.M., Salgesch 2003
„An Weihnachten hat man sie [die Mistel] auch zur Zierde genutzt. An jedem Baum musste eine Mistel sein."
[54] OHI F B., Saas Bidermatten 2004
[55] Stebler 1921.
[56] The composition of the forest litter strongly varied depending on which tree species were locally growing. For the Bernese Oberland the use of beech leaves is reported (Kasthofer 1822, 20-21) whereas in the people in the Engandin predominately collected litter from spruce, stone-pine, Scots pine and larch (Kasthofer 1825, 193)
[57] This practise is known as well for pine forests in Bavaria. Hölzel 1996, 46.
[58] Translated OHI M.F, Mund 2004
„Für die Schweine konnte man es nicht gebrauchen. Die haben die Nadeln in die Nasenlöcher gekriegt und wurden krank."
[59] MP Feschel 1929.
[60] MP Glis 1930.
[61] OHI M.F., Mund 2004.
[62] Translated OHI E. I., Saas Fee 2004.
„Ein Umbruch in der traditionellen Lebens- und Wirtschaftsweise trat mit der Erschliessung (Strasse 1951) ein und vollzog sich sehr rasch (1953 erste Bahn). Damit kam auch der Wintertourismus."
[63] Loup 1965, 245 ff.
[64] Weidgangreglement für die Waldungen der Burgschaft Glis für die Dauer des Krieges (1943).
[65] Bürgi 1999a, 571.
[66] Reuter 1920, 40.
[67] Waldmeier-Brockmann 1941; Glatzel 1990, 1991; Johann 2000, 2004a &b; Bürgi 1999 a; Stuber and Bürgi 2001, 2002; Bruckbauer 2003.
[68] Bürgi 1999 a, 573.
[69] Glatzel 1990, Glatzel 1991.
[70] Dobbertin et al. 2005.
[71] Sheail 1980.
[72] Thompson 1978, 157.
[73] see also Schuler 1998; Bürgi 1999 a.
[74] Vorländer 1990, 12.

ARCHIVAL SOURCES

Archives of the forest districts (AFD)

MP Eyholz 1898 (provisorisch)
MP Eyholz 1925 (definitiv)
MP Feschel 1929 (definitiv)
MP Glis 1930 (definitiv)
MP Salgesch 1888 (provisorisch)
MP Salgesch 1932 (definitiv)

MP Salgesch 1973 (Revision)
MP Salgesch 1982 (Revision)
MP Visp 1892 (provisorisch)
MP Visp 1924 (Waldungen auf der linken Seite der Vispa, definitiv)
MP Visp 1926 (Waldungen auf der rechten Seite der Vispa, definitiv)
Weidgangreglement für die Waldungen der Burgschaft Glis für die Dauer des Krieges (1943)

Private documents of Albert Matthier,Salgesch (PAM)
Procèss-Verbal, Délit de Bois No. 9 (15. Juni 1943)
Bericht über den Schafweidgang im "oberen Wald", Abt. 2. (7. Juni 1949)

ORAL HISTORY INTERVIEWS (transcribed OHI are added separately on CD-Rom)

OHI A.M. (Salgesch): 1. September 2003 und 28. Oktober 2004
OHI M.F.(Mund): 6. Juli 2004
OHI R.T (Eyholz): 27. Oktober 2004
OHI T.W (Visp): 27. Oktober 2004
OHI F.B. (Saas Bidermatten): 7. Juli 2004
OHI E. I. Saas Fee): 7. Juli 2004

STATISTICAL SOURCES (livestock statistics is added separately on CD-Rom)

Schweizerische Statistik:
Heft 31: Schweizerische Viehzählung 1876.
Heft 116: Schweizerische Viehzählung 1896
Heft 132: Schweizerische Viehzählung 1901
Heft 178: Schweizerische Viehzählung 1911
Schweizerische Statistische Mitteilungen:
Heft 3: Viehzählungen der Schweiz 1919
Heft 6: Viehzählungen der Schweiz 1921
Heft 8: Viehzählungen der Schweiz 1926
Statistische Quellenwerke der Schweiz:
Heft 46: Eidgenössische Viehzählung 1931
Heft 85: Eidgenössische Viehzählung 1936
Heft 152: Nutztierbestände in der Schweiz 1941-1943
Heft 218: Schweizerischer Nutztierbestand in der Kriegs- und Nachkriegszeit
Heft 271: Nutztierbestand der Schweiz 1951-1954
Heft 312: Nutztierbestand der Schweiz 1956
Heft 392: Nutztierbestand der Schweiz 1961-1964
Heft 421: Nutztierbestand der Schweiz 1966
Heft 514, vol. 3.23: Eidg. Volkszählung 1970. Kanton Wallis.

REFERENCES

Axelsson, A.L. and Östlund, L. 2001. 'Retrospective gap analysis in a Swedish boreal forest landscape using historical data'. *Forest Ecology and Management* 147, 109-122.

Botz, G. 1984. 'Oral History - Wert, Probleme, Möglichkeiten der mündlichen Geschichte'. In G. Botz, and J. Weidenholzer, J. (ed.), *Mündliche Geschichte und Arbeiterbewegungen.*

Eine Einführung in Arbeitsweisen und Themenbereiche der Geschichte 'geschichtsloser' Sozialgruppen. Wien, 23-37.

Bruckbauer, M. 2003. 'Waldweide im Unteren Bayrischen Wald in den frühen Jahren der Bundesrepublik Deutschland'. In M. Böhm et al. (ed.), *Auf der Hut. Hirtenleben und Weidewirtschaft*. Schriften Süddeutscher Freilichtmuseen 2. Neusath-Perschen , Oberpfälzer Freilandmuseum. 104-129.

Brummond, J. 2000. 'Liquidators, chronobylets and masonic ecologists: Ukrainian environmental identities'. *Oral History* 28/1, 52-62.

Bühler, A. 1889. 'Über Waldstreunutzung, Waldweide und Waldfeldbau'. *Landw. Jb. d. Schweiz* 3, 187-196.

Bürgi, M. 1999a. 'A case study of forest changes in the Swiss lowlands'. *Landscape Ecology* 14, 567-575.

Bürgi, M. 1999b. 'Methodische Überlegungen zum Umgang mit Bestockungsdaten und ihrer Zuordnung zu Waldtypen'. *Tübinger Geographische Studien* 125, 147-156.

Calheiros, D.F., Seidl, A.F., and Ferreira, C.J.A. 2000. 'Participatory research methods in environmental science: local anc scientific knowledge of a limnological phenomenon in the Pantanal wetland of Brazil'. *Journal of Applied Ecology* 37, 684-696.

Carter, I. 1974, 'Oral history and agrarian history - the North-East'. *Oral History* 2/1, 34-44.

Cregeen, E.R. 1974. 'Oral tradition and agrarian history in the west Highlands'. *Oral History* 2/1, 15-33.

Crook, D.S., Jones, A.M. 1999a 'Traditional irrigation and its importance to tourist landscape of Valais, Switzerland' *Landscape Research* 24, 49-65.

Crook, D.S, Jones, A.M. 1999b. 'Design principles from traditional mountain irrigation systems (bisses) in the Valais, Switzerland' *Mountain Research and Development* 19/2, 79-99.

Crook, D.S. 2001. 'The historical impacts of hydroelectric power development on traditional mountain irrigation in the Valais, Switzerland' *Mountain Research and Development* 21/1, 46-53.

Delfs,J. 2001. 'Ziegen - Rasiermesser des Waldes. Eine historische Betrachtung zur Waldweide'. *Forst und Holz* 56, 758-761.

Dobbertin, M., Hilker, N., Rebetez, M., Zimmermann, N.E., Wohlgemuth, T., Rigling, A. 2005. 'The upward shift in altitude of pine mistletoe (*Viscum album* ssp. *austriacum*) in Switzerland - the result of climate warming'? *Journal of Biometeorology,* submitted.

Egoz, S. 2000. 'Clean and green but messy: the contested landscape of New Zeeland's organic farms'. *Oral History* 28/1, 63-74.

Evans, G.E. 1965 *Ask the fellows who cut the hay.* Faber and Faber, 250 pp.

Evans, G.E. 1966. *The pattern under the plough: aspects of folk life in East Anglia*. London: Faber and Faber, 269 pp.

Evans, G.E. 1970. *Where Beards Wag All*. London: Faber and Faber, 296 pp.

Evans, G.E. 1975. *The days we have seen*. London: Faber and Faber, 224 pp.

Faiers, C. (1976): 'Persistence and change in farming methods in a Suffolk village'. *Oral History* 4/2, 52-62.

Fairhead, J., Leach, M. 1996. *Misreading the African landscape: society and ecology in a forest-savanna mosaic*. African Studies Series 90, Cambridge, 354 pp.

Fankhauser, F. (II) (1887) *Die Bedeutung der Ziegenwirtschaft für die schweizerischen Gebirgsgegenden in forstlicher und volkswirtschaftlicher Hinsicht.* Bern, 84 pp.

Fernandez-Gimenez, M.E. 2000. 'The role of Mongolian nomadic pastoralists' ecological knowledge in rangeland management'. *Ecological Applications* 10: 1318-1326.

Flick, U. 1995. *Qualitative Forschung. Theorie, Methoden, Anwendung in Psychologie und Sozialwissenschaften*. Hamburg: Rowohlt, 318 pp.

Flühler, H., Keller, T., Schwager, H. 1981. 'Die Immissionsbelastung der Föhrenwälder im Walliser Rhonetal (Schweiz)'. In W. Bosshard (ed.), *Waldschäden im Walliser Rhonetal (Schweiz)*. Mitteilungen der Eidgenössischen Anstalt für das forstliche Versuchswesen 57, 399-414.

Fogerty, J.E. 2001. 'Oral history: a guide to its creation and use'. In D. Egan and E.A. Howell (ed.), *The Historical Ecology Handbook. A restoration's guide to reference ecosystems.* Washington: Island Press, 101-120.

Fux, C. 1996. *Erinnern Sie sich? Visp*. Visp: Rotten Verlag.

Gant, R. 1986. 'Oral history and local meteorology'. *Oral History* 14/2, 67-69.

Gimmi, U., Bürgi, M., Wohlgemuth, T. 2004. 'Wie oft brannte der Walliser Wald im 20. Jahrhundert?' *Schweiz. Z. Forstwes*. 155, 437-440.

Glatzel, G. 1990. 'The nitrogen status of Austrian forest ecosystems as influenced by atmospheric deposition, biomass harvesting and lateral organomass exchange'. *Plant and Soil* 128, 67-74.

Glatzel, G. 1991. 'The impact of historic land use and modern forestry on nutrient relations of Central Europe forest ecosystems'. *Fertilizer Research* 27, 1-8.

Grossmann, H. 1927. *Die Waldweide in der Schweiz*. Zürich. 153 pp.

Hasel, K. 1985. *Forstgeschichte. Ein Grundriss für Studium und Praxis*. Pareys Studientexte 48, Hamburg und Berlin. 258 pp.

Hölzel, N. 1996. *Schneeheide-Kiefernwälder in den mittleren Nördlichen Kalkalpen*. Laufener Forschungsberichte 3, 192 pp.

Howarth, K. 1998. *Oral history: a handbook*. Stroud: Sutton Publishing, 214 pp.

Johann, E. 2000. 'Historical interactions between agricultural and forest utilization in the Austrian Alps and their impact on the present forest condition'. In M.Agnoletti and S. Anderson (ed.), *Forest History: international studies on socio-economic and forest ecosystem change*. IUFRO Research Series 2, 161-169.

Johann, E. 2004a. 'Landscape changes in the history of the Austrian Alpine regions: ecological development and the perception of human responsibility'. In K. Honnay, B. Bossuyt, M. Hermy (ed.), *Forest Biodiversity: Lessons from history for conservation*. IUFRO Research Series 10, 27-40.

Johann, E. 2004b. *Wald und Mensch. Die Nationalparkregion Hohe Tauern (Kärnten)*. Das Kärtner Landesarchiv 30, Klagenfurt, 812 pp.

Kasthofer, K. 1822. *Bemerkungen auf einer Alpenreise über den Susten, Gotthard, Bernhardin, Oberalp, Furka und Grimsel*. Aarau.

Kasthofer, K. 1825. *Bemerkungen auf einer Alpenreise über den Brünig, Bragel, Kirenzenberg, und über die Flüla, den Maloja und Splügen*. Aarau.

Kempf, A., Scherrer, H.U. 1982. *Forstgeschichtliche Notizen zum Walliser Wald. Literatur – und Quellenbericht über das Rhonetal zwischen Brig und Martigny seit 1800.* Berichte der Eidgenössischen Anstalt für das forstliche Versuchswesen 243, 123 pp.

Kempf, A. 1985. *Waldveränderungen als Kulturlandschaftswandel - Walliser Rhonetal. Fallstudien zur Peristenz und Dynamik des Waldes zwischen Brig und Martigny seit 1873.* Basler Beiträge zur Geographie 31, 262 pp.

Landolt, E. 1862. *Bericht an den hohen schweizerischen Bundesrath über die Untersuchung der Schweizerischen Hochgebirgswaldungen, vorgenommen in den Jahren 1858, 1859 und 1860*. Bern, 365 pp.

Loup, J. 1965. *Pasteurs et agriculteurs valaisans. Contribution à l'étude des problèmes montagnards*. Thèse pour le Doctorat. Grenoble. 679 pp.

Lykke, A.M. 2000. 'Local perceptions of vegetation change and priorities for conservation of woody-savanna vegetation in Senegal'. *Journal of Environmental Management* 59:107-120.

Mariétan, I. 1948. *Heilige Wasser*. Schweizer Heimatbücher 21, Verlag Haupt, Bern, 80 pp. (autorisierte Übersetzung)

Mathieu, J. 1992. *Eine Agrargeschichte der inneren Alpen. Graubünden, Tessin, Wallis 1500-1800*. Zürich: Chronos, 367 pp.

Meichtry, W. 2002. *Erinnern Sie sich? Leuk: Leukerbad, Inden, Albinen, Susten, Varen, Salgesch*. Visp: Rotten Verlag.

Netting, R. McC. 1981. *Balancing on an Alp. Ecological change and continuity in a Swiss mountain community*. Cambridge: University Press, 278 pp.

Olsson, P., Folke, C. 2001. 'Local ecological knowledge and institutional dynamics for ecosystem management: a study of Lake Racken watershed, Sweden'. *Ecosystems* 4, 85-104.

Östlund, L., Zackrisson, O., Axelson, A.-L. 1997. 'The history and transformation of a Scandinavian boreal forest landscape since the 19th century'. *Can. J. For. Res.* 27, 1198-1206.

Pfister, C. 1983. 'Changes in stability and carrying capacity of lowland and highland agro-systems in Switzerland in the historical past'. *Mountain Research and Development* 3, 291-297.

Pfister, C. 1985. *Das Klima der Schweiz von 1525-1860 und seine Bedeutung in der Geschichte von Bevölkerung und Landwirtschaft*. Bern, 2 vols.

Preston, J. 2002. 'Collecting personal accounts of the Lewes floods of October 2000'. *Oral History* 30/2, 79-84.

Radkau, J., Schäfer, I. 1987. Holz. *Ein Naturstoff in der Technikgeschichte*. Hamburg: Rowohlt, 313 pp.

Rebetez M., Dobbertin. M., 2004. 'Climate change may already threaten Scots pine stands in the Swiss Alps'. *Theoretical and Applied Climatology* 79, 1-9.

Reuter, M. 1920. 'Die Waldweide'. *Allg. Forst- und Jagdzeitung*, 40-45.

Reynard, E. 1995 'L'irrigation par les bisses en Valais. Approche géographique' *Annales Valaisannes* 70, 47-64.

Rigling, A., Cherubini, P. 1999. 'Wieso sterben die Waldföhren im 'Telwald' bei Visp? Eine Zusammenfassung bisheriger Studien und eine dendroökologische Untersuchung'. *Schweiz. Z. Forstwes.* 150, 113-131.

Rigling, A., Dobbertin, M., Bürgi, M., Feldmeier-Christie, E., Gimmi, U., Ginzler, C., Graf, U., Mayer, P., Zweifel, R., Wohlgemuth, T. 2006. 'Baumartenwechsel in den Walliser Waldföhrenwälder'. In T. Wohlgemuth (Ed.) *Wald und Klimawandel*. WSL Forum für Wissen 2006. 23-33.

Riley, M. 2004. 'Ask the fellows who cut the hay: farm practices, oral history and nature conservation'. *Oral History* 32/2, 45-53.

Ritzmann-Blickensdorfer, H. 1996. *Historische Statistik der Schweiz*. Zürich: Chronos, 1221 pp.

Robertson, H.A., McGee, T.K. 2003. 'Applying local knowledge: the contribution of oral history to wetland rehabilitation at Kanyapella Basin, Australia'. *Journal of Environmental Management* 69, 275-287.

Robertson, M., Nichols, P., Horwitz, P., Bradby, K., MacKintosh, D. 2000. 'Environmental narratives and the need for multiple perspectives to restore degraded landscapes in Australia'. *Ecosystem Health* 6, 119-133.

Schuler, A. 1998. 'Sustainability and biodiversity – forest historical notes on two main concerns of environmental utilisation'. In P. Bachmann et al. (ed.), *Assessment for biodiversity for improved forest planning*. European Forest Institute Proceedings 18, 353-360.

Sheail, J. 1980. *Historical Ecology: the documentary evidence*. Cambridge: Institute of terrestrial ecology, 20 pp.

Shindler, B., Aldred Cheek, K. 1999. 'Integrating citizens in adaptive management: a propositional analysis'. *Conservation Ecology* 3 (1), [online].
URL: http://www.consecol.org/vol3/iss1/art9

Stebler, F.G. 1921. *Die Vispertaler Sonnenberge*. Jahrbuch der Schweiz, 56. Jahrgang, Schweizer Alpenclub, Bern.
(available online: http://www.zeneggen.ch/stebler.htm)

Stuber, M., Bürgi, M. 2001. 'Agrarische Waldnutzungen in der Schweiz 1800-1950. Waldweide, Waldheu, Nadel- und Laubfutter'. *Schweiz. Z. Forstwes*. 152, 490-508.

Stuber, M., Bürgi, M. 2002. 'Agrarische Waldnutzungen in der Schweiz 1800-1950. Nadel- und Laubstreue'. *Schweiz. Z. Forstwes.* 153, 397-410.

Thompson, P. 1978. *The voice of the past: Oral History*. Oxford, 368 pp.

Viazzo, P.P. 1989. *Upland communities. Environment, population and social structure in the Alps since the sixteenth century*. Cambridge Studies in Population, Economy and Society in Past Time 8, Cambridge: University Press, 325 pp.

Vorländer, H. (ed.) 1990. *Oral History: Mündlich erfragte Geschichte*. Göttingen: Vandenhoeck und Ruprecht, 163 pp.

Waldmeier-Brockmann, A. 1941. *Sammelwirtschaft in den Schweizer Alpen. Eine Ethnographische Studie*. Basel, 151 pp.

Weber, P., Bugmann, H., Fonti, P., Rigling, A. 2005. 'Using a retrospective dynamic competion index to reconstruct forest succession'. *Ecological Applications*, submitted.

Werlen C. 1994. 'Elaboration de la carte de végétation forestière du Valais'. *Schweiz. Z. Forstwes*. 14, 607-617.

Yow, V.R. 1994. *Recording Oral History*. Thousand Oaks, 284pp.

Chapter II

Reconstructing anthropogenic disturbance regimes in forest ecosystems – a case study from the Swiss Rhone valley

Submitted to Ecosystems

URS GIMMI[1], MATTHIAS BÜRGI[1] and MARTIN STUBER[2]

[1]*Swiss Federal Research Institute WSL*
Department Landscape
Section Nature Protection and Historical Ecology
Zürcherstrasse 111
CH-8903 Birmensdorf, Switzerland

[2]*Historisches Institut*
Universität Bern
Abteilung für Wirtschafts-, Sozial- und Umweltgeschichte

ABSTRACT

Anthropogenic disturbances of forest ecosystems are increasingly recognized as fundamental ecological process with important long-term implications for biogeochemical cycles and vegetation patterns. This paper aims at reconstructing the extent and the intensity of forest litter collecting and wood pasture in the Swiss Rhone valley by i) identifying the spatiotemporal patterns, and ii) estimating the biomass removal through these practises. Detailed information on agricultural practices and socio-economic context are essential to develop reliable estimates of anthropogenic disturbance regimes. The results show that wood pasture and forest litter collecting were practised on a significant proportion of the forested landscape in the Valais up to the second half of the 20th century. Until the implementation of forest management plans in the 1930s almost half of the forests in the study area was affected by wood pasture and/or forest

litter collecting. The regulations in the management plans led to an essential reduction of this area but also to an increased pressure on the remaining areas. The results suggest that the notion of a slow but steady disappearance of traditional non-timber forest uses and the associated effects on forest ecosystems is oversimplified. Quantitative reconstructions of biomass output resulting from these practises confirm the importance of traditional non-timber forest uses for ecosystem development in this region. Furthermore it is very likely that similar effects have been widespread throughout regions with similar natural and socio-economic context, e.g., throughout a significant proportion of the European Alps. This study underlines the importance of environmental history for ecological sciences as well as for forest management and conservation planning.

Key words: historical ecology, disturbance, ecosystem change, woodland pasture, forest litter collecting, Switzerland

INTRODUCTION

Knowing the site history is often crucial for the understanding of current ecological processes. For instance long term impacts of land use changes are frequently discussed in the context of biogeochemical cycling (e.g. carbon and nitrogen cycles) and vegetation changes. In view of the widespread prevalence of land use and the ubiquity of land-use legacies, Foster et al. (2003) promote to address human activity as a fundamental ecological process and to apply lessons from land-use history to landscape conservation and management.

Substantial changes in land use can have important implication for biogeochemical cycles on local to global scale. Studying secondary forests growing on previous agricultural lands in France, Koerner et al. (1999) detected a strong influence of former land use on the N cycle in forest soils. Jussy et al. (2002) concluded that former cultivation could be a major factor influencing nitrogen availability in soils of secondary forests. Other studies found effects of previous logging on forest carbon and nitrogen cycling and on nutrient pools (Goodale and Aber 2001; Latty et al. 2004). Perruchod et al. (1999) included time series of anthropogenic litter removal in a model for 20th century carbon budget of forest

soils in the Alps. However, the authors mentioned the lack of reliable quantitative data on forest litter harvesting.

Historical land use has also been increasingly recognized as an important factor determining modern vegetation patterns. Vegetation response to land use history was studied at regional to landscape scale by Foster (1992). He found that community variation is best explained by different historical factors, such as logging history and timing of agricultural abandonment. Consequently, interpretations of regional differences in forest composition have to be based on information on regional differences in relevant human activities (Bürgi et al. 2000). Foster et al. (1998) concluded that historical land use has similarly altered vegetation-environment relationships across broader geographic regions and should be considered in studies of global change. Koerner et al. (1997) showed that as a consequence of nutrient transfer, previous cropland and gardens contain higher species richness than old forests, whereas previous pasture was very similar to old forests. Studying the invasion of longleaf pine ecosystems in Florida by sand pine, McCay (2000) showed that chronic human activities may result in new and persistent successional trajectories. For a costal landscape in New England, Eberhardt et al. (2003) detected striking relationship between 19th century land use and modern vegetation - largely independent of other site conditions. The intensity of former agricultural use was identified as key factor influencing plant composition and stand development in naturally regenerated woodland of the Massif Central, France by Prévosto et al.(2004). Graae et al. (2003) detected significant variation in vegetation between old forests and isolated new forests in Denmark. For northeastern Germany, Wulf (2004) found significant differences in vascular plant species composition in woodland formerly used as grassland in comparison to woodland formerly used as arable fields.

In recent times, the time-lag effects, i.e., land-use legacies, have gained special attention (e.g., Foster et al. 2003). Dupouey et al. (2002) showed that two centuries of farming during Roman times induced gradients in soil nutrient availability and plant diversity that are still measurable almost 2000 years later. They suggested that effects of past agricultural land use on forest biodiversity may be irreversible on an historical time scale. Various studies highlighted the long-term impact of former land use on the current state of ecosystems (e.g. Koerner et al. 1997, 1999; Compton and Boone 2000; Goodale and

Aber 2001). Compton et al. (1998) lamented that although former agricultural practises strongly affects important ecosystem processes such as biomass accumulation, soil organic matter dynamics, and nitrogen cycling, recovery of these processes after abandonment is insufficiently understood.

Facing the diverse and partly long-lasting impacts of land use on pattern and processes in ecosystems, several studies asked for a better implementation of land use history in ecosystem management (e.g. Dale et al. 2000; Cronon 2000, Foster et al. 2003). Eberhardt et al. (2003) concluded that the understanding of past land use should be integrated into ecological models used to advise the management of biological reserves. In accordance with the medium disturbance theory (Connell 1978), Wohlgemuth et al. (2002) consider dominance reduction of species and the resulting positive effects on species richness as a characteristic effect of natural as well as anthropogenic disturbance events. The authors proposed management principles for central European forests integrating information on natural as well as anthropogenic disturbances, their regimes and historical changes within (Wohlgemuth et al. 2002).

To assess the impact of anthropogenic disturbances, detailed information on forest use and management are needed. In the past, the forests of central Europe were not only sources of timber and fuel wood but also directly and indirectly supplied nutrients to sustain human population. Agrarian societies, which were largely based on self-sufficiency, depended heavily on traditional non-timber forest uses, such as wood pasture and forest litter collecting (Bürgi 1999, Stuber and Bürgi 2001, 2002; Bürgi and Stuber 2003). Different studies have shown that the practise of traditional non-timber forest uses have significant impact on forest ecosystems. Dzwonko and Gawronski (2002) showed that current vegetation composition in mixed oak-pine woodland in Poland is associated with past material removal by man. In a 16 years litter removal experiment, they found that continuous litter removal resulted in substantial soil impoverishment. Glatzel (1990, 1991) pointed at nutrient depletion and reduced acid neutralizing capacity as the most severe effects of biomass removal. The recovery of such forest ecosystems is an extremely long-lasting process and therefore the impact of past forest uses is still evident (Kreutzer 1972; Hüttl and Schaaf 1995).

Particularly in remote regions, such traditional non-timber forest uses were practised until only a few decades ago. This also holds true for the upper Swiss Rhone valley, the Valais (Gimmi and Bürgi 2006). In the same area, more specifically in the pine forest belt of the Valais, increased mortality of Scots pine (*Pinus sylvestris* L.) and significant shifts in tree species composition from the sub-Boreal Scots pine to the sub-Mediterranean pubescent oak (*Quercus pubescens* Willd.) have recently been observed (Rigling et al. 1999; Rigling and Cherubini 1999; Rigling et al. 2004). Complex interactions between different factors were suspected to contribute to these effects. Besides climate change (Rebetez and Dobbertin 2004; Dobbertin et al. 2005, Bigler et al. 2006), insects, fungal decay and phytopathogenes (Schönfeld et al. 2004), changes in forest use also were considered as potentially relevant. Therefore, Gimmi and Bürgi (2006) analysed the history of wood pasture and forest litter collecting in the Valais in the late 19th and the 20th century based on the information from forest management plans and interviews with contemporary witnesses. The results illustrate, how traditional non-timber forest uses were widespread, and besides forest fires (Gimmi et al. 2004), significantly shaped the disturbance regime in the forests of this region.

To increase the ecological relevance of historical information, it is important to go beyond qualitative information – as far as permitted by the historical sources available. Therefore, this paper aims at quantifying the impact of non-timber forest uses on forest ecosystems by a) reconstructing spatiotemporal patterns of forest litter collecting and wood pasture in the pine forest belt of the upper Swiss Rhone valley and b) estimating the biomass removal through these practises. Furthermore, we will discuss the relevance of the results in the context of the currently observed changes in the pine forest belt of the Valais.

STUDY REGION

"Valais" is the French name of a Swiss canton situated in the south-western part of the country bordering Haute-Savoie in France to the West, and the Val d'Aosta in Italy to the south (Fig.1). The Valais contains the main part of the catchment area of the upper Rhone to its mouth in the Lake of Geneva. The mountains surrounding the valley (highest top 4618 masl) shield the inner part of the valley from the moist oceanic air masses

transported by western winds. This inner-Alpine situation causes a rain shadow, making the central Valais a very dry region (annual precipitation at Sion = 598mm/yr) (Rebetez and Dobbertin 2004).

The area under investigation covers 9'468 ha of public forests in 22 municipalities in the upper central Valais (Fig. 1). These forests were chosen due to the excellent source availability (esp. forest management plans). These forests range in elevation from 540masl to the upper tree line at about 2390 masl.

Forests dominated by Scots pine (*Pinus sylvestris* L.) are an important forest type in the Valais, covering about 11% (12'000 ha) of the total forested area (Werlen 1994). These pine forests are located mainly in the main Rhone valley, ranging from the valley bottom up to altitudes around 1600 masl. About 40% of the forests included in the analyses consist of such pine dominated stands (more than 50% pine in the modern tree species composition). Mixed pine stands contain pubescent oak (*Quercus pubescens* Willd.) and other deciduous trees in lower elevations and in higher areas spruce (*Picea abies*) and larch (*Larix decidua*). Above 1500 masl, forests in the study area are mainly dominated by spruce and/or larch. In addition, fir (*Abies alba*) and Swiss stone pine (*Pinus cembra*) occur in smaller quantities.

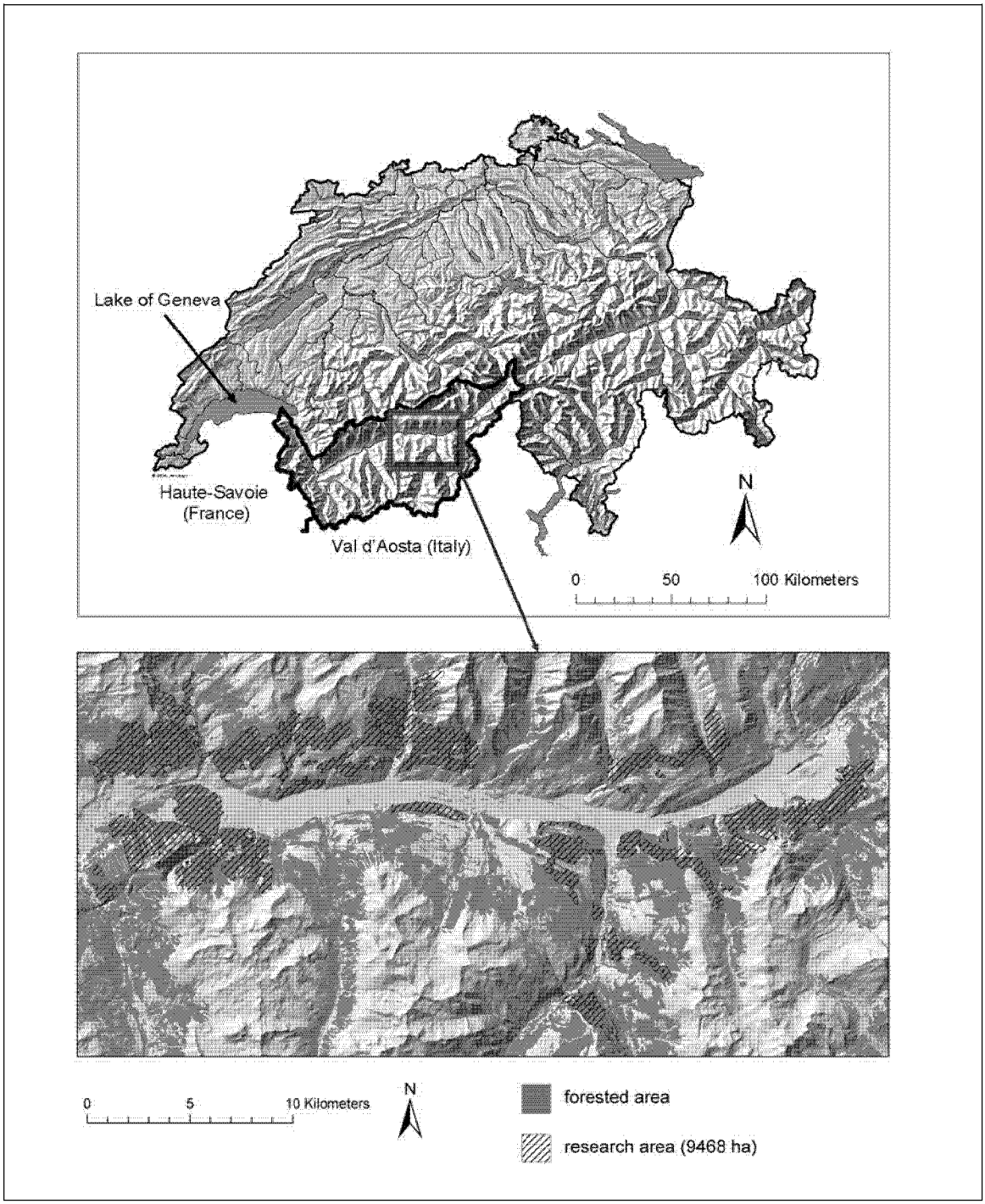


FIGURE 1: The study area (Canton of Valais) in the south-western part of Switzerland and the location of the forested area under investigation (9468ha).

DATA AND METHODS

Sources

The collection of quantitative information about traditional non-timber forest uses is mainly based on forest management plans (MPs) from 22 municipalities in the upper Swiss Rhone valley, complemented by oral history interviews with 12 contemporary witnesses from the same region and additional written sources. MPs are the main planning tool in forestry. The first MPs for the study area were written between the mid 1920s and the mid 1930s. These plans include a report on the previous use, a description of the current state of the forests (e.g. tree species composition) and guidelines for future management. This characteristic is especially valuable for our study as the MPs contain information of non-timber forest uses conducted before and after the implementation of the plans. Forest management plans largely represent the view of the forest administration whereas oral history interviews provide first-hand information from people who had personally practised the traditional non-timber forest uses. The combination the two source types leads to a comprehensive picture of the history and significance of traditional non-timber forest uses. More detailed source critical information on the two main source types, i.e., management plans and oral history interviews, is given in Gimmi and Bürgi (2006).

Information taken from the MPs and oral history interviews is complimented by additional written sources such as documents from the forest administration, recent and contemporary literature and statistical sources. Livestock statistics on the municipality level are available from the second half of the 19th century onwards, whereas the earliest statistics for grain production and litter meadows date from 1917 (Schweizerische Statistik, Schweizerische Statistische Mitteilungen, Statistische Quellenwerke der Schweiz/ a list of statistical sources is added separately in the references).

The spatial distribution of the forest uses is reconstructed for two time steps (before and after 1930, i.e. when MPs have been issued). The amount of biomass removal due to wood pasture is quantified for the period 1900-1960. Due to lack of source availability, the reconstruction of biomass removal from forest litter collecting is only possible for the period 1917-1960. The results for biomass removal are presented both in total biomass output per surface and time unit [t/ha per yr] and in carbon output per surface and time

unit [tC/ha per yr]. The conversion factors are defined as 0.5 C per biomass unit for forest litter and as 0.45 C per biomass unit for browsing material, based on Vogt (1991) who gives these ratios for different forest materials in temperate forests.

Reconstruction Techniques

Forest litter collecting. The reconstruction of the demand for forest litter, as well as the development of a reliable model of biomass removal by forest litter collecting, has to be based on basic considerations about the agricultural and socioeconomic context of these forest uses (Fig. 2). In Alpine regions, forest litter was mainly used in the stables to bind the livestock's dung and to produce farmyard manure. Therefore, the demand for litter depends on the number of local livestock and the length of the winter season, during which livestock was kept in the stables. Additionally, the demand for forest litter was driven by several socioeconomic factors. In certain areas, substitute products, such as straw from the cultivation of grain and litter from wet meadows reduced the demand for forest litter. Furthermore, the local income level determined whether the local people could afford to buy additional straw or not. The local intensity and spatial distribution of forest litter collecting also depended on legislative regulations concerning forest litter collecting (spatial, temporal, and quantitative limitation) as well as on geographic parameters such as the local topography and the accessibility of the forests. In addition, the spatial distribution of tree species composition determined where litter collecting was preferably practised. According to oral history interviews in the region, litter from spruce, pine and birch were preferred whereas the needles of the larch were not collected because they were regarded as unfavourable (Gimmi and Bürgi 2006).

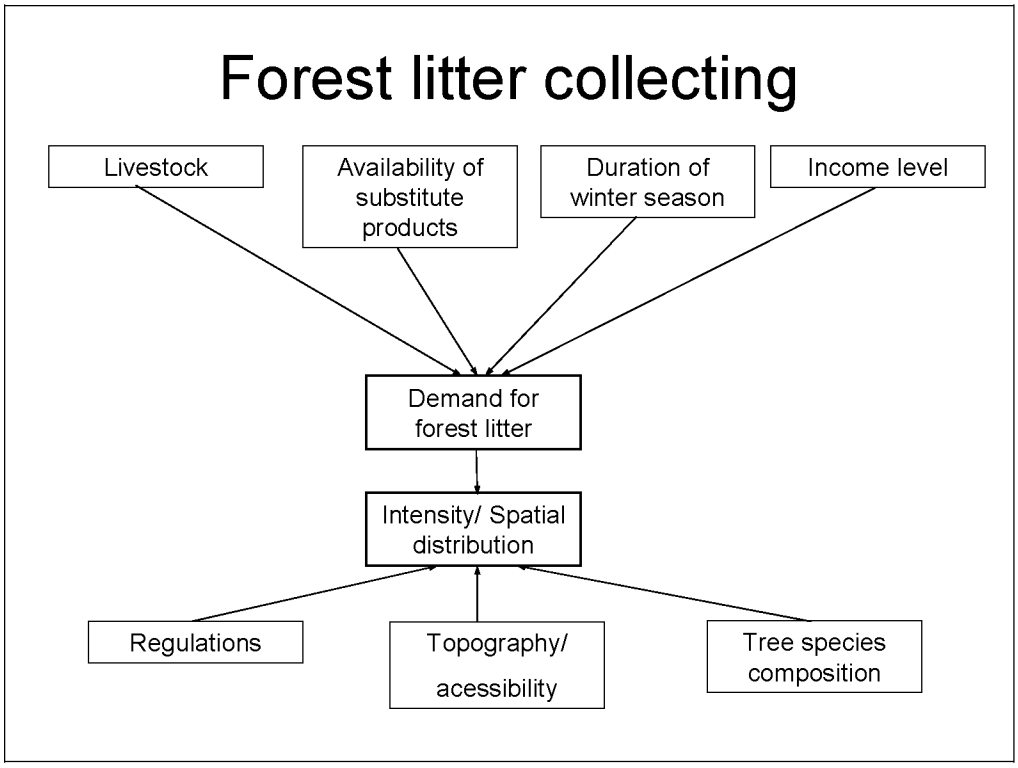


FIGURE 2: Conceptual graph of factors determining the demand for forest litter as well as the intensity and the spatial distribution of forest litter collecting.

The local intensity of forest litter collecting ($Intens_{flc}$) is basically expressed by the ratio of the local demand for forest litter ($LitDem_{forest}$) and the area where this practise was performed ($Area_{flce}$):

$$Intens_{flc} = LitDem_{forest} / Area_{flce} \quad (1)$$

Forest management plans and oral history interviews provide detailed information about the spatial extension of forest litter collecting for in the upper Swiss Rhone valley. Based on these sources we consider that forest litter collecting was actually practised ($Area_{flce}$) only on half of the area where it was legally allowed ($Area_{flcl}$):

$$Area_{flce} = Area_{flcl}/2 \quad (2)$$

The local demand for forest litter is calculated by subtracting the amount of locally available substitute products (SubstProd) from the total demand for litter ($LitDem_{tot}$) in a

specific municipality. Additional it has to be taken into account that with a quantum of forest litter a farmer could only replace 25-75% of a quantum of straw from grain production (Rebel 1920), as straw was more efficient for binding the dung to manure. In consequence, we implemented factor two for all substitute products in the model:

$$LitDem_{forest} = LitDem_{tot} - SubstProd*2 \quad (3)$$

Straw from the cultivation of grain was by far the most important substitute product for forest litter in the Valais - litter from wet meadows was only relevant in a few cases. The crop yield of straw essentially depends on which type of grain is cultivated (Table 1). In the Valais, predominately winter rye was cultivated. To avoid overestimating the straw production based on modern data, we use historical crop yield data (Becker-Dillingen 1927). As the environmental conditions for grain production in the Valais are rather unfavourable (mountainous/dry), we base our calculations of crop yields on data at the lower range of variability (Table 1).

Type of grain	**Lower range of variability**	Upper range of variability
Winter rye	**3.2 t/ha**	4.2 t/ha
spring rye	**1.4 t/ha**	3.2 t/ha
Winter wheat	**3.2 t/ha**	6.0t/ha
Spring wheat	**2.0 t/ha**	5.0 t/ha
Winter barley	**2.0 t/ha**	3.6 t/ha
Spring barley	**1.6 t/ha**	3.2 t/ha
Oat	**0.9t/ha**	2.0 t/ha

TABLE 1: Crop of straw for different types of grain (data from Becker-Dillingen 1927).

The total demand for litter in a specific municipality is calculated by multiplying the total number of large animal units (LUs) of the municipality (tot_{LU}) by the litter demand per LU ($LitDem_{LU}$ - calculations see below). As litter was mainly used during wintertime, the demand for litter depended on the length of the winter season, which differed depending

mainly on the altitude. A weighted index ($Index_{alt}$) is implemented to account for the altitudinal differences of the municipalities.

$$LitDem_{tot} = LitDem_{LU} * tot_{LU} * Index_{alt} \quad (4)$$

The LUs are calculated based on the so-called "Stosszahlen" for Alps in the upper Valais (Imboden 1972), which reflect the relative demand for fodder for the different types of livestock, i.e., horse=1.5LU; cattle=1LU; donkey and mule= 0.83 LU; sheep and goat =0.17 LU. The sources containing data about the $LitDem_{LU}$ show a certain range of variability (Table 2). Some sources give data on the $LitDem_{LU}$ in volumes (e.g. bags or litter piles), which first has to be converted to weight. For this purpose, 12 litter samples have been collected at different pine dominated sites in the Valais. From this sample a conversion factor from volume to weight of 15 kg/hl has been determined. This factor has been applied to information indicating litter demand in terms of volume per LU. Based on the sources given in Table 2, it seems reasonable to estimate an average litter demand of 200 kg/LU.

Source	**Information**	**Volume/LU**	**Weight/LU**
OHI Eyholz	At least 10 bags of forest litter to overwinter a cow	6.67 -10 hl/LU	100-150 kg/LU
Stebler (1921)	1 litter pile per cow and winter	8.2 hl/LU	123 kg/LU
Johann (2004b)			260-378 kg/LU
Mean			189 kg/LU

TABLE 2: Range of variability in information from different sources about litter demand per large animal unit (LU). Where the volumes/LU have been given in the sources the conversion factor of 15 kg/hl has been applied to calculate weight/LU (details given in the text)

Evidence from forest management plans and oral history interviews both indicate that after the Second World War forest litter was successively replaced by grain straw due to improved import and transport facilities (Gimmi and Bürgi accepted). For the 1960s, forest litter collecting is only reported for a small number of extremely remote municipalities. Therefore, we introduced a yearly decrease of the demand for forest litter of ten percent after 1945 for all municipalities.

Wood pasture. In comparison to forest litter collecting, the reconstruction of wood pasture is relatively simple. Nevertheless, it is again necessary to consider the agricultural context of this traditional form of forest use. In the pine forest belt of the Valais, grazing was almost exclusively done by goats and sheep. Whereas the sheep together with the cattle were driven to the alpine pastures during the summer, and grazed in the forests for only about two month per year, most of the goats stayed in the villages and provided the local population with milk. The goats were kept grazing in the forests during the whole year except for a few days with high snow cover in winter and some extremely hot days in summer. Therefore, the lenght of the grazing season (Dur_{graz}) is determined by 330 days for goats and 60 days for sheep.

The basic data to calculate the local intensity of wood pasture ($Intens_{graz}$) are livestock statistics on the municipality level, the same as used in the model for forest litter collecting. The fodder requirement (Fodreq) is estimated by 1.25 kg/d (dry substance) for goats and 1.5 kg/d for sheep (Landwirtschaftliche Beratungsstelle Lindau 2002). In contrast to the reconstruction of forest litter collecting, we make the assumption that wood pasture was uniformly practised on the whole area where it was legally allowed ($Area_{graz}$).

$$Intens_{graz} = Livestock * Fodreq * Dur_{graz} / Area_{graz} \quad (5)$$

RESULTS

Spatiotemporal Extent of Non-timber Forest Uses

The spatiotemporal distribution of forest litter raking and wood pasture is reconstructed for 22 municipalities with a total forested area of 9'468 ha. According to the forest management plans, a forth of it (2'413 ha) was covered with almost pure pine forests (≥ 80% pine) around 1930. The results are shown in two time steps, before 1930 and after 1930 (Figure 3 a&b). The first time step represents the spatial distribution of the forest uses for the period 1900-1930, and the second time step shows the distribution for the period 1930-1960.

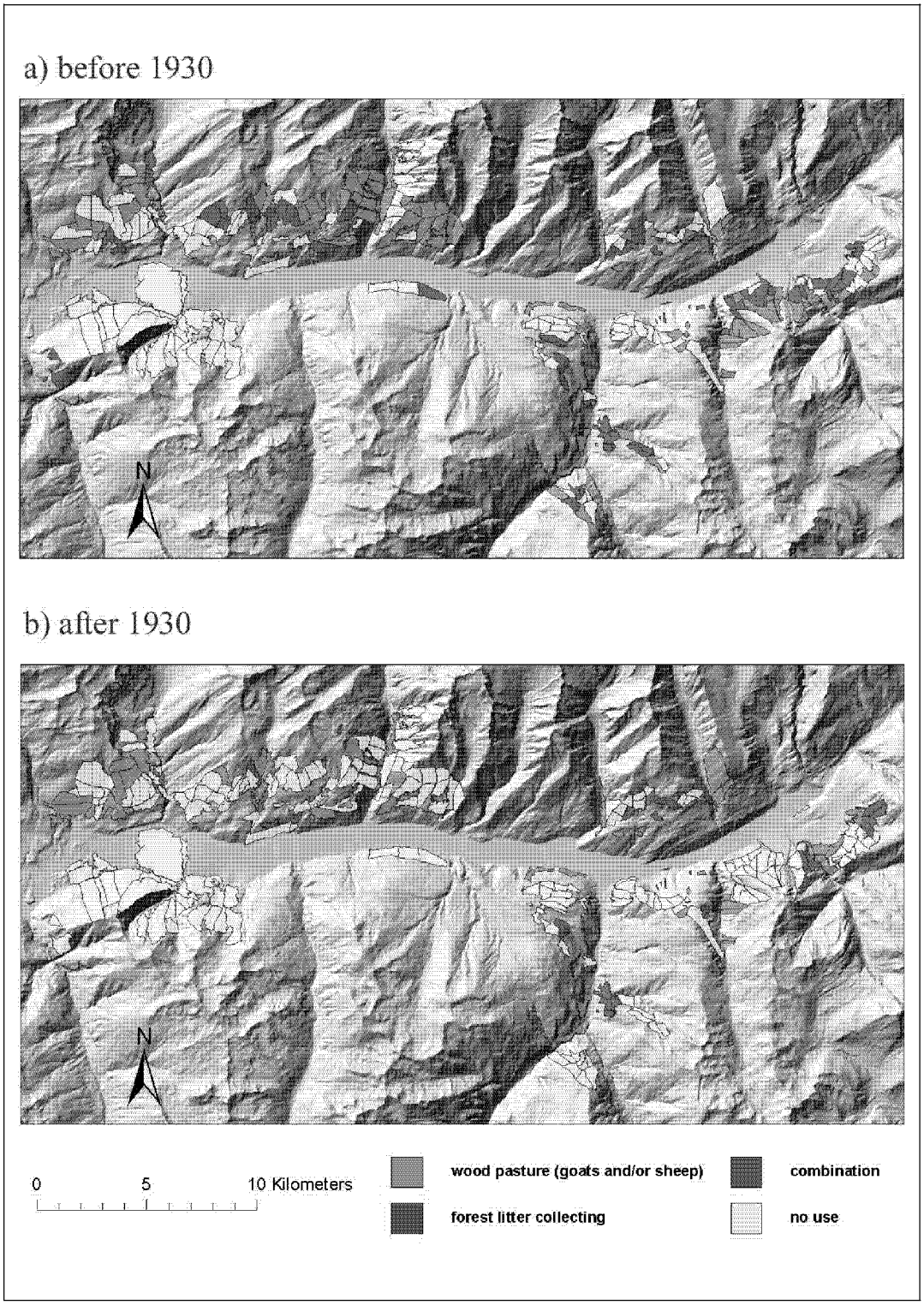


FIGURE 3: Spatiotemporal distribution of wood pasture and forest litter collecting in the upper central Valais before and after 1930.

The total area where forest litter collecting was practised decreased from 1'606 ha (17%) to 605 ha (5%) (Fig. 4). In pine dominated forests, the respective areas decreased even stronger from 471 ha (20%) to 113 ha (5%). Goats grazed during the first period on totally 3'612 ha (38%) and during the second period on 1'990 ha (21%). For this use, the decline in pine stands was smaller, as only a slight decrease from 829 ha (34%) to 756 ha (31%) can be observed. Grazing by sheep even increased in pine forests from 104 ha (4%) to 165 ha (7%). Regarding to the total forest area, sheep grazing slightly decreased from 1'284 ha (14%) to 957 ha (10%). Before 1930, on 1'050 ha (11%) of all forests wood pasture and forest litter collecting were practised both in combination – a number that dropped to 440 ha (5%) after 1930. In pine forests the decline was even more pronounced from 306 ha (13%) to 100 ha (4%). Consequently the total area where no traditional non-timber forest uses were practised increased on the total area from 5'300 ha (56%) to 7'312 ha (77%). In contrast this fraction only slightly increased in pine forest from 1'419 ha (59%) to 1'644 ha (68%).

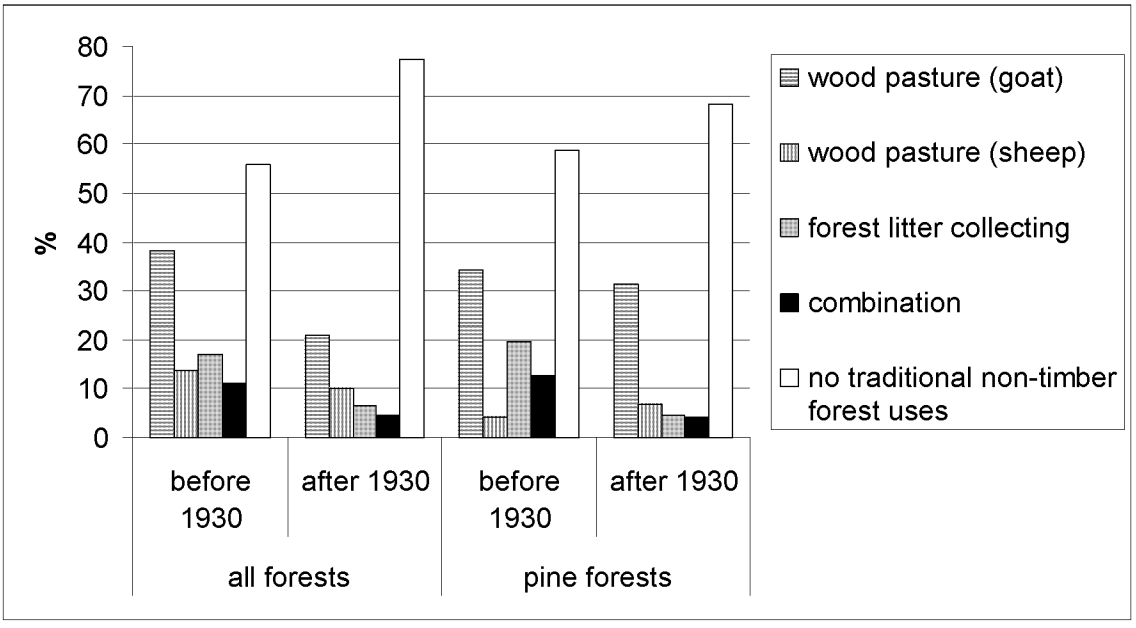


FIGURE 4: Comparison between the total forest area with pine forest stands concerning spatiotemporal extent of non-timber forest.

Intensity of Non-timber Forest Uses

Forest litter collecting. The MPs from the 1930s limited the area where it was allowed to collect forest litter substantially. This reduction in area resulted in an average increase of biomass removal on the remaining areas from about 2 t/ha per yr (1 tC/ha per yr) in the late 1910s to approximately 2.9 t/ha per yr (1.45 tC/ha per yr) in the 1930s (Figure 5). During the Second World War, grain production increased (Figure 6), making more straw locally available which lowered the demand for forest litter. Therefore the average biomass removal decreased to 2.2 t/ha per yr (1.1 tC/ha per yr) until 1946. During the post war period, grain production became less important whereas the livestock number remained quite stable (Figure 6). Consequently the demand for forest litter again slightly increased in the first years after the Second World War.

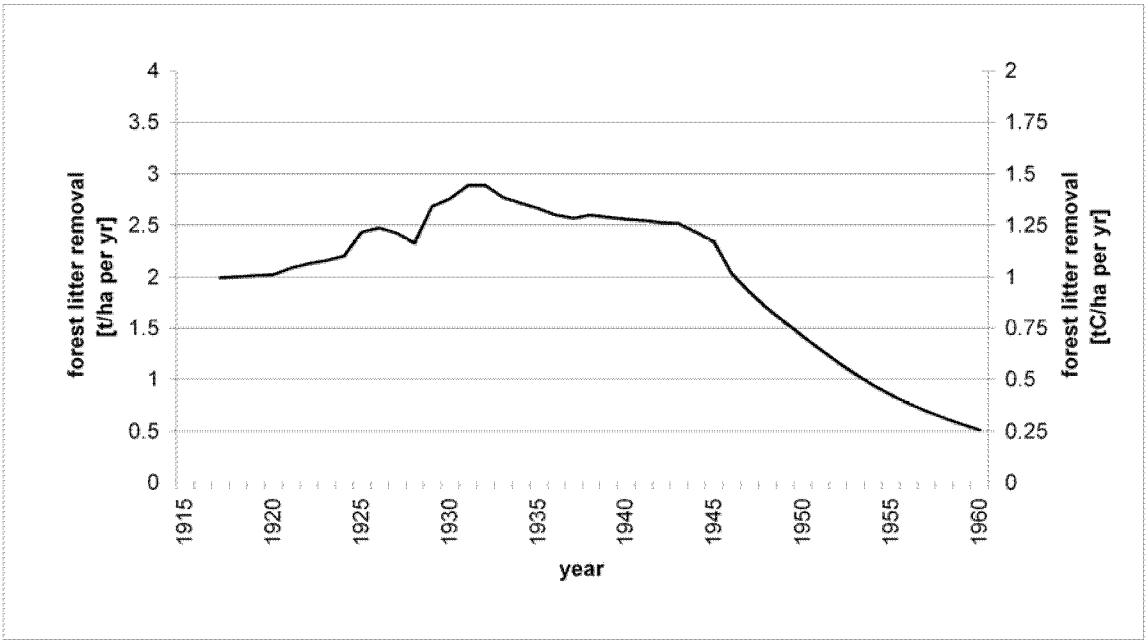


FIGURE 5: Average biomass and carbon removal due to forest litter raking for the period 1917 to 1960

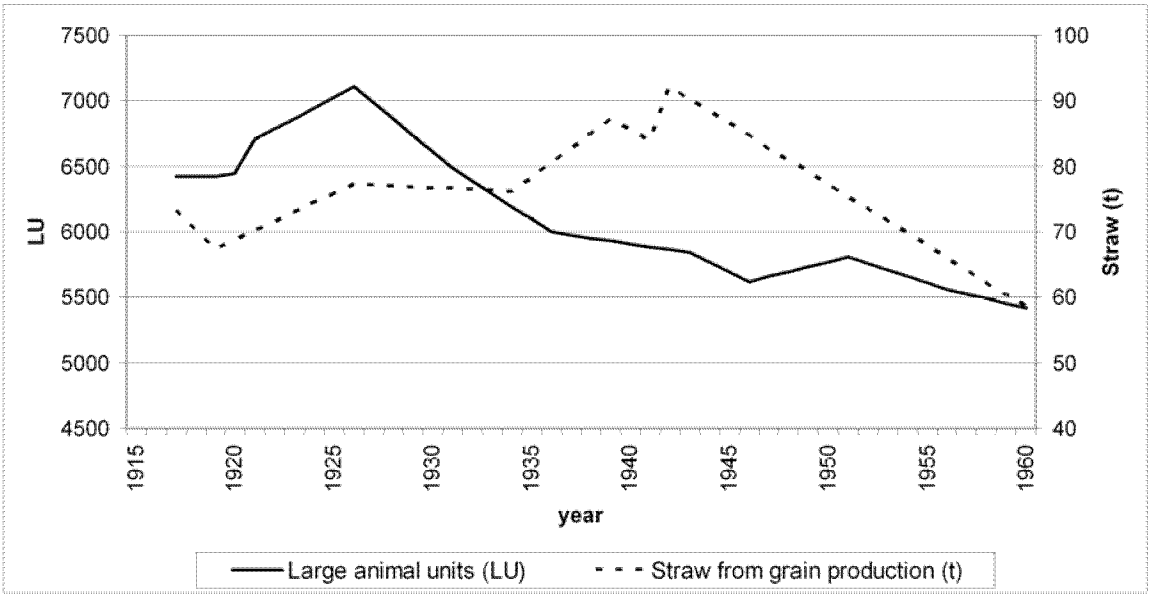


FIGURE 6: Changes in large animal units (LU) and straw production for 22 municipalities in the upper central Valais in the period 1917-1960

Wood pasture. The intensity of goat grazing increased continuously but slightly during the first quarter of the 20th century (Figure 7 a&b) in consequence of rising numbers of goats (Figure 7c). The grazing pressure increased in this period from 0.95 goats/ha to 1.35 goats/ha which resulted in an increase in biomass consumed by goats from 380 kg/ha per yr (170 kg C/ha per yr) to 550 kg/ha per yr (250 kg C/ha per yr). After a short decline around 1930, the grazing pressure increased again until the mid 1940s to 1.4 goats/ha which corresponds in terms of biomass removal to 600 kg/ha per yr (270 kg C/ha per yr). Two main reasons are responsible for this effect. First, the area where grazing by goats was practised, was significantly reduced by the regulations of the management plans. Secondly, the beginning decrease of goat livestock in the late 1920s was decelerated by the crisis of the Second World War. In the post war period, numbers of goats and grazing pressure decreased rapidly.

Grazing by sheep was generally restricted to much smaller area than grazing by goat (Figure 3). But the number of animals was always clearly higher (Figure 7c). In contrast to the goats, the sheep only grazed in the forests for a short period in spring and autumn. In consequence the grazing pressure is generally higher in terms of animals per area but

lower in respect to the amount of biomass and carbon consumed annually. Changes in the intensity of grazing by sheep reflects mostly changes in sheep livestock, because the area where grazing by sheep was practised only slightly decreased over the study period. A peak in intensity is observed in the beginning of the 1950s with 2.8 sheep/ha or 250 kg biomass/ha per yr (110 kg C/ha per yr). A minimum in intensity occurred around 1910 with 1.4 sheep/ha or 125 kg biomass/ha per yr (55 kg C/ha per yr).

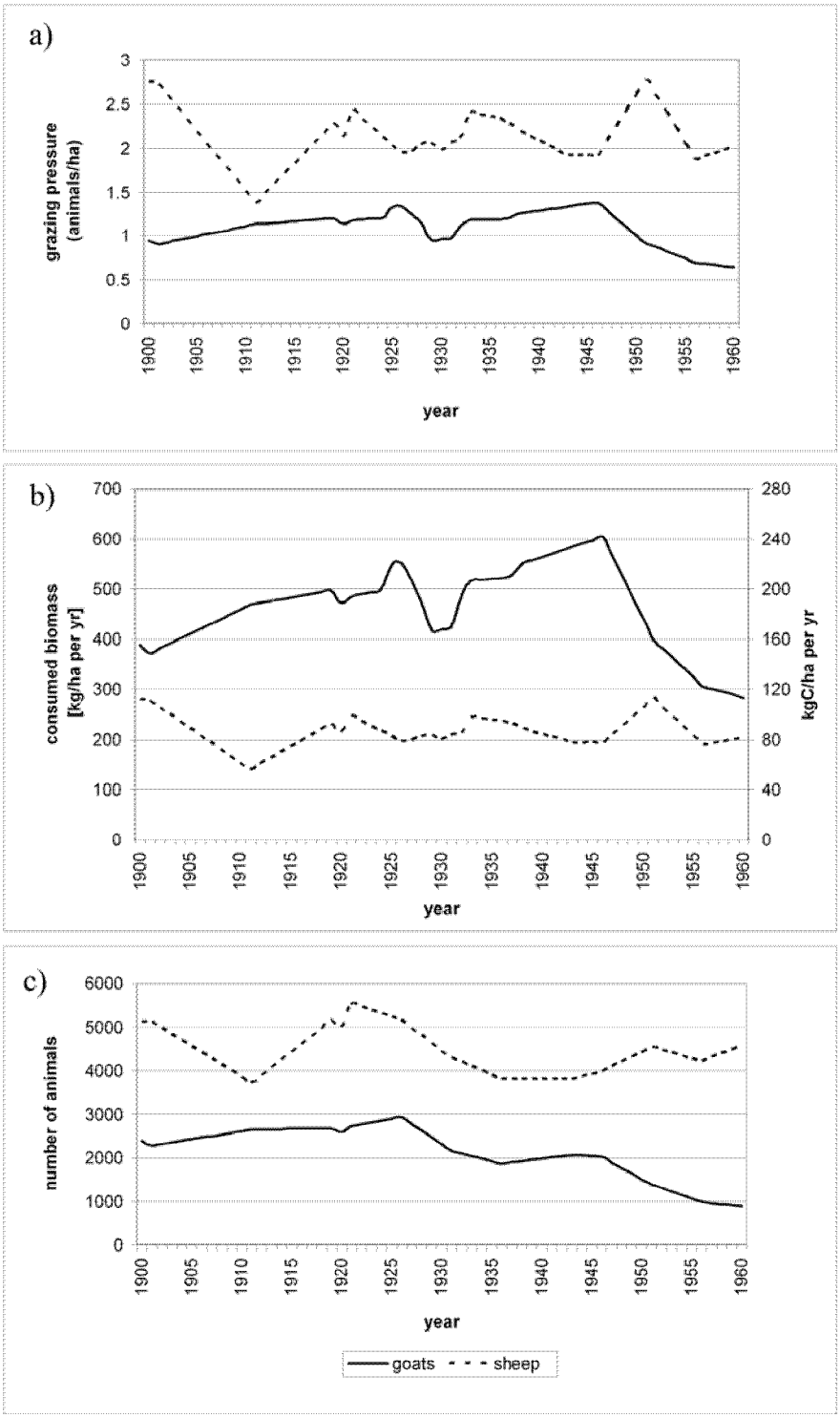


FIGURE 7: a) Animal density on grazed areas in the period 1900-1960 and b) biomass and carbon output due to wood pasture by goats and sheep for the same period. c) changes in goat and sheep number for 22 municipalities in the upper central Valais

DISCUSSION

Our results show that forest litter collecting and wood pasture was practised on a substantial portion of the forested area in the upper Swiss Rhone valley during the first half of the 20th century. Around 1930, the area where these forest uses could be practised was essentially reduced by regulations in the forest management plans. But at the same time, the demand for forest litter and wood pasturing remained stable. Consequently the pressure on the remaining areas significantly increased. It was the intention of the forest administration to exclude non-timber forest uses particularly from forest which were important for timber production. Consequently, forests with lower productivity, such as pine forests, were disproportionately affected by this increasing pressure of forest uses.

Whereas the local intensity of wood pasture is just a function of the livestock number and the local extent of the grazed area, the reconstruction of biomass removal through forest litter collecting is much more complex. The most important variables such as livestock number and straw production could be integrated in the model. But due to the limits of the available sources some specific gaps remained. Particularly historical data on socioeconomic factors such as the local income level and the accessibility of a municipality would provide important information to assess how much substitute products (straw) could be imported. Based on such information it would for example be possible to assess if and how during the First and Second World War reduced import and transport facilities led to an increased demand for forest litter.

The results confirm that forest litter collecting and wood pasture are important factors in the anthropogenic disturbance regime in the region. What is the significance of these findings in the context of the recently observed mortality of pine and shifts in tree species composition from pine to pubescent oak and other deciduous trees in the pine forest belt of the Valais (Rigling et al. 2004)? The continuous biomass and nutrient output caused by forest litter collecting led to ideal conditions for the regeneration of pine as a pioneer species on raw soils. In contrast acorns were mechanically removed in great quantities, hindering regeneration of oak. Wood pasture also has highly species-specific consequences, as damages to pine regeneration resulting from browsing are negligible in comparison to those to deciduous trees. Consumed biomass amounts by goats as assessed in this paper are comparable with biomass consumption by red deer recently found in the

Swiss National Park (Schütz et al. 2006). But goats seem to have a much higher proportion of browsing on woody species (up to 50%) than ungulates such as red deer (Stuber and Bürgi 2001; Sutter et al. 2004). Additionally, historic goat densities in the forests calculated in this paper is much higher than modern average ungulate densities in temperate forests (e.g. Reimoser and Gossow 1996, Côté et al. 2004, Fankhauser and Enggist 2004). Therefore the impact of woodland pasture on tree species composition might have been even more pronounced compared to browsing by ungulates. Thus, it seems highly plausible that the abandonment of wood pasture and forest litter collecting initiated the shift if species composition from pine to oak as pine was subjected to increased competition.

CONCLUSION

Wood pasture and forest litter collecting affected a significant proportion of the forested landscape in the upper central Valais up to the second half of the 20th century. Quantitative reconstruction of biomass and carbon output resulting from these practises confirm the importance of traditional non-timber forest uses for ecosystem development in this region, and it is very likely that similar effects have been widespread throughout regions with similar natural and socio-economic context, e.g., throughout a significant proportion of the European Alps.

In the Valais, the area where wood pasture and forest litter collecting could be practised was essentially reduced in consequence of the implementation of forest management plans around 1930. In combination with the times of crisis during the Second World War this led to an increased pressure on the remaining areas. Thus, the notion of a slow but steady disappearance of traditional non-timber forest uses and the associated effects on forest ecosystems is oversimplified. The effects of theses uses on specific forests or forest types might even increase temporally due to changes in regulation or demand. Detailed information on agricultural practices and socio-economic context is needed to develop sound estimates of anthropogenic disturbance regimes.

Further, our results suggest that forest litter collecting and wood pasture may essentially contribute to the recently observed changes in tree species composition from pine to deciduous trees. The practise of wood pasture and litter raking led to specific

environmental conditions which favoured pine as a pioneer species. After abandonment of these practises pine was again subjected to increased competition.

Reconstructing anthropogenic disturbance regimes requires detailed historical information on a set of parameters which characterize the society-nature interaction in a given region. This underlines the importance of environmental history for ecological sciences as well as forest management and conservation planning as stated by Foster et al. (2003).

REFERENCES

Bigler C, Bräker OU, Bugmann H, Dobbertin M, Rigling A. 2006. Drought as an inciting mortality factor in Scot pine stands of the Valais, Switzerland. Ecosystems 9, in press.

Becker-Dillingen, J. 1927. Handbuch des Getreidebaues. Berlin: Parey. 627p.

Bürgi M, 1999. A case study of forest change in the Swiss lowlands. Landscape Ecology 14:567-575.

Bürgi M, Russell EWB, Motzkin G. 2000. Effects of postsettlement human activities on forest composition in the north-eastern United States: a comparative approach. Journal of Biogeography 27:1123-1138.

Bürgi M, Stuber M. 2003. Agrarische Waldnutzungen in der Schweiz 1800-1950. Waldfeldbau, Waldfrüchte und Harz. Schweiz. Z. Forstwes. 154: 360-375.

Compton JE, Boone RD, Motzkin G, Foster DR. 1998. Soil carbon and nitrogen in a pine-oak sand plain in central Massachusetts: Role of vegetation and land-use history. Oecologia 116: 536-542.

Compton JE, Boone RD. 2000. Long-term impacts of agriculture on soil carbon and nitrogen dynamics in New England forests. Ecology 81: 2314-2330.

Connell JH. 1978. Diversity in tropical rain forests and coral reefs. Science 199: 1302-1310.

Côté SD, Rooney TP, Trembley J-P, Dussault C, Waller DM. 2004. Ecological impacts of deer overabundance. Annual Review of Ecology, Evolution, and Systematics 35: 113-147.

Cronon W. 2000. Resisting monoliths and tabulae rasae. Ecological Applications 10: 673-675.

Dale VH, Brown S, Heauber RA, Hobbs NT, Huntly N, Naiman RJ, Riebsame WE, Turner MG, Valone TJ. 2000. Ecological principles and guidelines for managing the use of land. Ecological Applications 10: 639-670.

Dobbertin M, Mayer P, Wohlgemuth T, Feldmeyer-Christe E, Graf U, Zimmermann N, Rigling A. 2005. The decline of Pinus sylvestris L. forests in the Swiss Rhone valley - a result of drought stress? Phyton 44: 153-156.

Dupouey JL, Dambrine E, Laffite JD, Moares C. 2002. Irreversible impact of past land use on forest soils and biodiversity. Ecology 83: 2978-2984.

Dzwonko Z, Gawronski S. 2002. Effect of litter removal on species richness and acidification of a mixed oak-pine woodland. Biological Conservation 106: 389-398.

Eberhardt RW, Foster DR, Motzkin G, Hall B. 2003. Conservation of changing landscapes: Vegetation and land-use history of Cape Cod and National Seashore. Ecological Applications 13: 68-84.

Fankhauser R, Enggist P. 2004. Simulation of alpine chamois *Rupicapra r. rupicapra* habitat use. Ecol Model 175: 291-302.

Foster DR. 1992. Land-use history (1730-1990) and vegetation dynamics in central New England, USA. Journal of Ecology 80: 753-772.

Foster DR, Motzkin G, Slater B. 1998. Land-use history as long-term broad-scale disturbance: regional forest dynamics in central New England. Ecosystems 1: 96-119.

Foster DR, Swanson F, Aber J., Burke I., Browaw N., Tilman D., Knapp A. 2003. The importance of land-use legacies to ecology and conservation. Bioscience 53: 77-88.

Gimmi U, Bürgi M, Wohlgemuth T. 2004. Wie oft brannte der Walliser Wald im 20. Jahrhundert? Schweiz. Z. Forstwes. 155: 437-440.

Gimmi U, Bürgi M. 2006. Using oral history and forest management plans to reconstruct traditional non-timber forest uses in the Swiss Rhone valley (Valais). Environment and History: submitted.

Glatzel G. 1990. The nitrogen status of Austrian forest ecosystems as influenced by atmospheric deposition, biomass harvesting and lateral organomass exchange. Plant and Soil 128: 67-74.

Glatzel G. 1991. The impact of historic land use and modern forestry on nutrient relations of Central Europe forest ecosystems. Fertilizer Research 27: 1-8.

Goodale CL, Aber JD 2001. The long-term effects of land-use history on nitrogen cycling in northern hardwood forests. Ecological Applications 11: 253-267.

Graae BJ, Sunde PB, Fritzbøger B. 2003. Vegetation and soil differences in acient opposed to new forests. Forest Ecology and Management 177: 179-190.

Hüttl RF, Schaaf W. 1995. Nutrient supply of forest soils in relation to management and site history. Plant and Soil 168: 31-41.

Imboden, A. 1972 Die Land- und Alpwirtschaft im Oberwallis. Bern: Schweizerischer Alpkataster. 259p.

Johann, E. 2004. Wald und Mensch. Die Nationalparkregion Hohe Tauern (Kärnten). Klagenfurt: Das Kärntner Landesarchiv 30. 812p.

Jussy JH, Koerner W, Dambrine E, Dupouey JL, Benoit M. 2002. Influence of former agricultural land use on net nitrate production in forest soils. European Journal of Soil Science 53: 367-374.

Koerner W, Dupouey JL, Dambrine E, Benoit M. 1997. Influence of past land use on the vegetation and soils of present day forest in the Vosges mountains, France. Journal of Ecology 85: 351-358.

Koerner W, Dambrine E, Dupouey JL, Benoit M. 1999. δ15N of forest soil and understorey vegetation reflect the former agricultural land use. Oecologia 121: 421-425.

Kreutzer K. 1972. Über den Einfluss der Streunutzung auf den Stickstoffhaushalt von Kiefernbeständen (Pinus sylvestris L.). Forstw. Cbl. 91: 263-269.

Landwirtschaftliche Beratungsstelle Lindau, editor. 2002. Wirz Handbuch: Pflanzen und Tiere. Basel: Verlag Wirz. 766p.

Latty EF, Canham CD, Marks PL. 2004. The effects of land-use history on soil properties and nutrient dynamics in northern hardwood forests of the Adirondack mountains. Ecosystems 7: 193-207. doi:10.1007/s10021-003-0157-5

MacCay DH. 2000. Effect of chronic human activities on invasion of langleaf pine forests by sand pine. Ecosystems 3: 283-292. doi:10.1007/s100210000026

Perruchod D, Kienast F, Kaufmann E, Bräker OU. 1999. 20th century carbon budget of forest soils in the Alps. Ecosystems 2: 320-337.

Prévosto B, Dambirne E, Moares C, Curt T. 2004. Effects of volcanic ash chemistry and former agricultural use on the soils and vegetation of naturally regenerated woodlands in the Massif Central, France. Catena 56: 239-261. doi:10.1016/j.catena.2003.10.014

Rebel, K. 1920. Streunutzung, insbesondere im bayerischen Staatswald. Diessen vor München. 172p.

Rebetez M, Dobbertin M. 2004. Climate change may already threaten Scots pine stands in the Swiss Alps. Theoretical and Applied Climatology 79: 1-9. doi:10.1007/s00704-004-0058-3

Reimoser F, Gossow H. 1996. Impact of ungulates on forest vegetation and its dependence on the silvicultural system. Forest Ecology and Management 88: 107-119.

Rigling A, Cherubini P. 1999. Wieso sterben die Waldföhren im „Telwald“ bei Visp? Eine Zusammenfassung bisheriger Studien und eine dendroökologische Untersuchung. Schweiz. Zeitschrift Forstwes. 150 4: 113-131.

Rigling A, Forster B, Wermelinger B, Cherubini P. 1999. Grossflächige Veränderung des Landschaftsbildes im Kanton Wallis - Waldföhrenbestände im Umbruch. Wald und Holz: 8-12.

Rigling A, Dobbertin M, Wohlgemuth T. 2004. Waldföhrenwälder der Alpen im Umbruch – eine Bioindikation für Global Change? Bauhinia 18: 56-57.

Schönfeld U, Rigling D, Polomski J. 2004. Eine neue Gefahr für die Föhren der Schweiz? Der Kiefernholznematode. Wald und Holz 85: 35-37.

Schütz M, Risch AC, Achermann G, Thiel-Egenter C, Page-Dumroese D, Jurgensen MF, Edwards PJ. 2006. Phosphorus translocation by red deer on a subalpine grassland in the Central European Alps. Ecosystems, in press.

Stebler, F.G. 1921. Die Vispertaler Sonnenberge. Jahrbuch der Schweiz 56. Bern: Schweizer Alpenclub.

Stuber M, Bürgi M. 2001. Agrarische Waldnutzungen in der Schweiz 1800-1950. Waldweide, Waldheu, Nadel- und Laubfutter. Schweiz. Z. Forstwes. 152: 490-508.

Stuber M, and Bürgi M. 2002. Agrarische Waldnutzungen in der Schweiz 1800-1950. Nadel- und Laubstreue. In: Schweiz. Z. Forstwes. 153: 397-410.

Suter W, Suter U, Krüsi B, Schütz M. 2004. Spatial variation of summer diet of red deer Cervus elaphus in the eastern Swiss Alps. Wildlife Biology 10: 43-50.

Vogt K. 1991. Carbon budget of temperate forest ecosystems. Tree Physiology 9: 69-86.

Wohlgemuth T, Bürgi M, Scheidegger C, Schütz M. 2002. Dominance reduction of species through disturbance - a proposed management principle for central European forests. Forest Ecology and Management 166: 1-15.

Wulf M. 2004. Plant species richness of afforestations with different former use and habitat continuity. Forest Ecology and Management 195: 191-204.

STATISTICAL SOURCES

Schweizerische Statistik
Heft 31: Schweizerische Viehzählung 1876
Heft 116: Eidgenössische Viehzählung 1896
Heft 132: Allgemeine Schweizerische Viehzählung 1901
Heft 178: Allgemeine Schweizerische Viehzählung 1911
Heft 208: Schweizerische Anbaustatistik 1917

Schweizerische Statistische Mitteilungen

II. Jahrgang, Heft 2: Anbaustatistik der Schweiz 1919
II. Jahrgang, Heft 3: Viehzählung der Schweiz 1919
II. Jahrgang, Heft 10: Viehzählung der Schweiz 1920
IV. Jahrgang, Heft 6: Viehzählung der Schweiz 1921
IX. Jahrgang, Heft 3: Anbaustatistik der Schweiz 1926
X. Jahrgang, Heft 2: Viehzählung der Schweiz 1926

Statistische Quellenwerke der Schweiz
Heft 46: Eidgenössische Viehzählung 1931

Heft 72: Anbaustatistik der Schweiz 1934
Heft 85: Eidgenössische Viehzählung 1936
Heft 134: Utilisation du sol 1939 et cultures des champs 1940-1943
Heft 136: Nutztierbestände der Schweiz 1941-1943
Heft 218: Eidgenössische Viehzählungen 1944-1948
Heft 271: Nutztierbestand der Schweiz 1951-1954
Heft 312: Nutztierbestand der Schweiz 1956
Heft 392: Nutztierbestand der Schweiz 1961-1964
Heft 406: Eidgenössische Betriebszählung 1965, Band 1 Landwirtschaft

Chapter III

Impact of anthropogenic disturbances on tree species composition in the upper Swiss Rhone valley

To be submitted to Landscape Ecology

URS GIMMI, MATTHIAS BÜRGI, ANDREAS RIGLING, CHRISTIAN W. HOFFMANN and THOMAS WOHLGEMUTH

Swiss Federal Research Institute WSL
Zürcherstrasse 111
CH-8903 Birmensdorf, Switzerland

ABSTRACT

In the last decades, significant shifts in tree species composition from Scots pine (*Pinus sylvestris* L.), to pubescent oak (*Quercus pubescens* Willd.) and other deciduous trees have been observed in the pine forest belt of the Swiss Rhone valley. This paper examined the contribution of anthropogenic disturbances to this change. We particularly focused on past traditional non-timber forest uses (wood pasture and forest litter collecting) and on silvicultural management techniques. Based on historical sources and a modern vegetation map, tree species composition on about 9'500 ha of forest land was compared for two time steps (1930 and 1994). Significant decrease of pine (-11.1%) and increase of deciduous trees (+10.8%) was found for forests in lower altitudes (below 1200 m asl). In higher elevations a shift from spruce (*Picea abies*) (-8.1%) to larch (*Larix deciduas*) (+8.3%) occurred. Whereas the decrease in pine is not significantly correlated with former anthropogenic practises, the increase of deciduous trees was more pronounced in stands formerly not used for grazing and litter collecting. This correlation is interpreted as a result of wood pasture and litter collecting hindering the regeneration

of deciduous trees until the abandonment of these practises a few decades ago. The increase of larch to the disadvantage of spruce can be explained through specific silvicultural management schemes which aimed at the promotion of larch recruitment. The findings from this study from the Swiss Rhone valley are of high importance for other inner-alpine regions of the European Alps, where similar ecosystem processes are running.

Key words: anthropogenic disturbance, ecosystem change, historical ecology, woodland pasture, forest litter collecting, *Pinus sylvestris*, Switzerland

INTRODUCTION

Most European forests are affected by human activities since centuries (e.g. Rackham 1980, Radkau and Schäfer 1987, Birks et al. 1988, Kirby and Watkins 1996), i.e., forest ecosystem change is strongly influenced by anthropogenic disturbances. Anthropogenic disturbances that cause the limitation of plant biomass (Grime 1979) or disrupt an ecosystem, community or population structure (Pickett and White 1985) are considered to be the strongest driving force to change forest ecosystems. In this context, land use history is increasingly recognized as a key factor to understand present forest patterns on the landscape scale. Changes in the use and function of forests can affect both the composition and the diversity of forests vegetation. In beech forests of the Vosges mountains in France, Koerner et al. (1997) showed the influence of previous land use on the present vegetation in the Vosges Mountains in France. As a consequence of nutrient transfer, actual forest areas that were previously used as cropland and gardens display higher species richness today than old-growth forests or forests that were used previously used as pastures. Bürgi (1999) linked changes in forest uses with changes in forest types and composition in the Swiss lowlands. Dupouey et al. (2002) showed that two centuries of farming during Roman times induced gradients in soil nutrient availability and plant diversity that are still measurable almost 2000 years later. A litter removal-experiment in a mixed oak-pine woodland in Poland proved how past anthropogenic forest use causes differences in vegetation patterns (Dzwonko and Gawronski 2002). In naturally regenerated woodland of the French Massif Central , the intensity of former agricultural

use was identified as key factor influencing plant composition and stand development (Prévosto et al. 2004). Graae et al. (2003) detected significant variation in vegetation comparing old forests and new forests with different land use histories in Denmark. For northeastern Germany, Wulf (2004) found significant differences in vascular plant species composition in woodland formerly used as grassland in comparison to woodland formerly used as arable fields. Motta and Edouard (2005) detected shifts in species dominance and forest structure that are consistent with land use changes in the Piedmont Alps of Italy. Beyond Europe, particularly for central New England vegetation responses on land use history are reported on various scales. Foster (1992) found that community variation is best explained by different historical factors such as logging history and timing of agricultural abandonment. Motzkin et al. (1996) suggested that land use explains the greatest variation in modern vegetation as well as the distribution and abundance of many taxa in a New England sand plain. Foster et al. (1998) concluded that historical land use has similarly altered vegetation-environment relationships across broader geographic regions and should be considered in studies of global change. Studying vegetation patterns in heterogeneous landscapes Motzkin et al. (1999) evaluated the importance of historical factors for the interpretation of modern vegetation. Bürgi et al. (2000) linked species-specific changes in forest composition with species-specific human activities on the same scale in the north-eastern United States. Eberhardt et al. (2003) detected striking relationship between 19th century land use and modern vegetation - largely independent of other site conditions - for a costal landscape in New England. Studying the invasion of longleaf pine ecosystems in Florida by sand pine, McCay (2000) suggested that chronic human activities may result in new and permanent successional trajectories.

In the Swiss Rhone valley increased mortality of Scots pine (*Pinus sylvestris* L.) and a significant shift from the sub-boreal pine to the sub-mediterrean pubescent oak (*Quercus pubescens* Willd.) have been observed in the last decades (Rigling et al. 1999; Rigling and Cherubini 1999; Rigling et al. 2004). Complex interactions between climate change (Rebetez and Dobbertin 2004; Dobbertin et al. 2005, Bigler et al. 2006) and natural disturbances (Gimmi et al. 2004; Schönfeld et al. 2004) as well as anthropogenic disturbances are suspected to drive these changes. This paper focuses on the potential

impact of human activities on pine forest ecosystems in the region. Traditional non-timber forest uses such as wood pasture and forest litter collecting have been identified as important types of anthropogenic disturbances in the forests of the upper Swiss Rhone valley during the first half of the 20th century (Gimmi and Bürgi 2006). Until a few decades ago, these uses were practised in varying intensities on an essential portion of the forested area of the region (Gimmi et al. 2006). We presume that both disturbance agents grazing and forest litter collecting significantly shaped the forest stands in this region, beyond episodic forest fires (Gimmi et al. 2004). Therefore we addressed the following goals: i) identifying the patterns of changes in forest composition of the upper Swiss Rhone valley, ii) linking the main features of changes in tree species composition with land use change in the region and iii) discussing the ecological background behind these links.

STUDY AREA

The canton of Valais is situated in the south-western part of Switzerland bordering Haute-Savoie in France to the West, and the Val d'Aosta in Italy to the south (Fig.1). The Valais contains the main part of the catchment area of the upper Rhone to its mouth into the Lake of Geneva. The mountains surrounding the valley (highest top 4618 masl) shield the inner part of the valley from the moist oceanic air masses transported by western winds. This inner-Alpine situation causes a rain shadow, making the central Valais a very dry region (annual precipitation at Sion = 598mm/yr) (Rebetez and Dobbertin 2004). The area under investigation covers 9'468 ha of public forests in 22 municipalities in the upper central Valais (Fig. 1). These forests were chosen due to the excellent source availability (esp. forest management plans). These forests range in elevation from 540masl to the upper tree line at about 2390 masl.

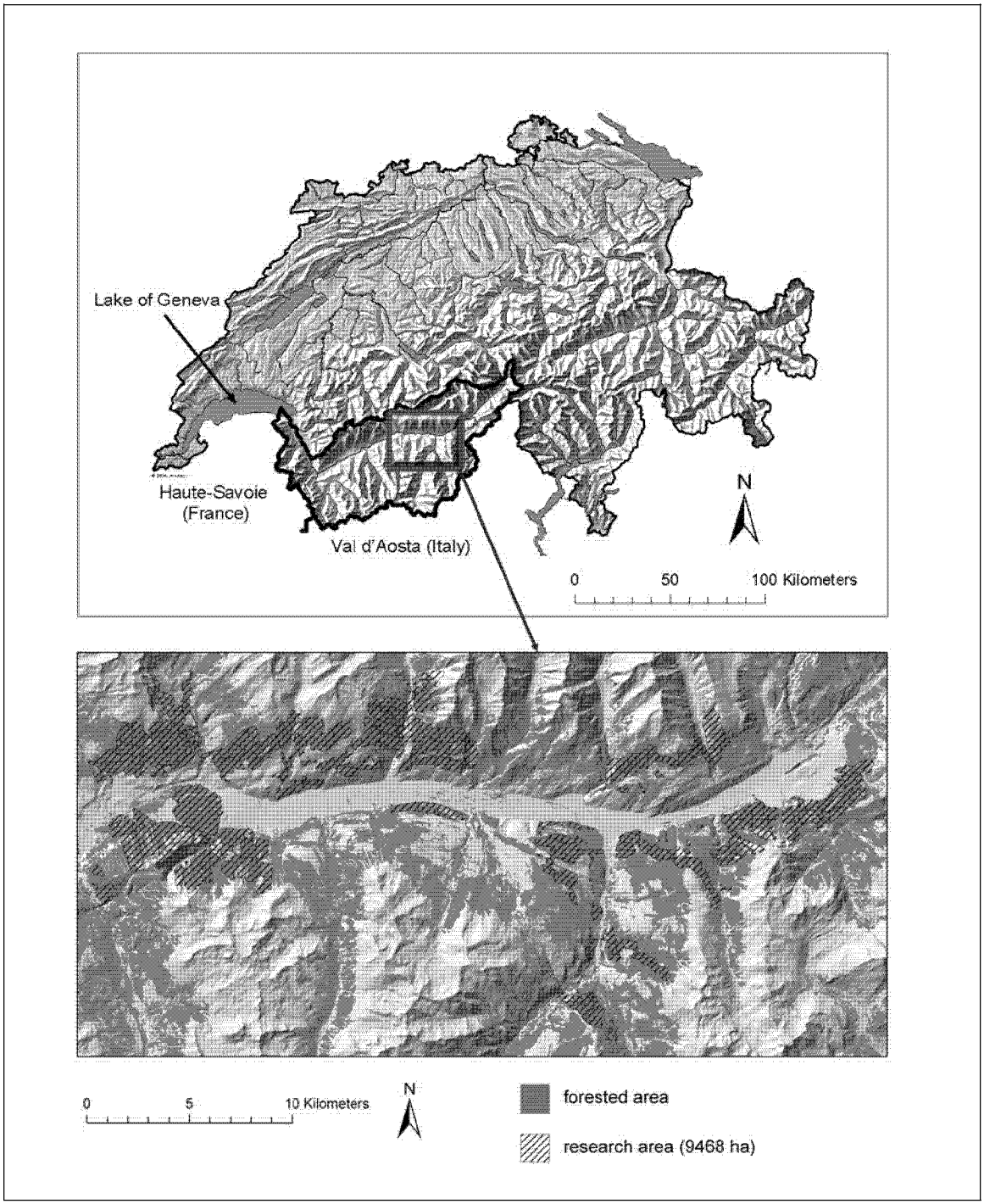


FIGURE 1: The study area (Canton of Valais) in the south-western part of Switzerland and the location of the forested area under investigation (9468ha).

DATA AND METHODS

Forest Composition

The forest composition was evaluated spatially for two time steps for a total area of 9468 ha by using geographic information systems (GIS, ArcGis© 8.3). Forest composition for the first time step is based on information taken from forest management plans written between the mid 1920s and the 1930s from 22 municipalities in the upper central Valais. These forest management plans contain full enumeration of all trees with a diameter ≥ 12 cm. The results of the enumeration are reported in percentage of stem number per tree species for 316 forest compartments. In the following, this time step is referred to as "tree species composition 1930". Forest management plans distinguish five different conifer species: Scots pine (*Pinus sylvestris* L.), spruce (*Picea abies*), larch (*Larix decidua*), fir (*Abies alba*) and Swiss stone pine (*Pinus cembra*). Unfortunately the differentiation of deciduous trees in the plans is often missing and all deciduous trees had to be subsumed in a single class.

Forest composition in the second time step is based on the vegetation map of Werlen (1994). This map provides information about the occurrence of tree species given in a ranking according to their dominance. This information was converted into percentage per tree species using the conversion key shown in Table 1. The spatial resolution of the modern vegetation map is higher than those of the forest compartments in the forest management plans. Therefore modern tree species composition on the perimeters of the forest compartments were calculated by spatially weighting the species percentages.

Number of tree species mentioned in Werlen 1994	Conversion to percentage
1	100
2	70, 30
3	50, 30, 20
4	40, 30, 20, 10

TABLE 1: Conversion key for tree species mentioned in Werlen (1994) into percentage of tree species.

Land Use History

In addition to the tree species composition the forest management provide information about traditional non-timber forest uses such as wood pasture and forest litter collecting (Gimmi and Bürgi 2006; Gimmi et al. 2006). In the plans both the description of previous use and guidelines for future management is reported. Therefore, a differentiation between the practise of traditional non-timber forest uses before 1930 and after 1930 is possible. A quantitative estimation about the biomass output due to wood pasture and forest litter collecting was conducted by Gimmi et al. 2006). This information allows including in the analyses the intensity of former practises.

Topography

Mean altitude, mean slope, northness and eastness for each forest compartment were derived from the digital elevation model (DHM-25; © Bundesamt für Landestopographie).

Soil Properties

Information about the soil type and the water storage capacity was gained from the soil aptitude map (BFS GEOSTAT 2001). A rough geologically differentiation into the substrates crystalline, intermediate and calcareous was derived from the geotechnical map of Switzerland (De Quervain et al. 1963-1967; BFS GEOSTAT / BUWAL 2001).

Natural Disturbance

The most important type of natural disturbance in the region is forest fires. The forest fire database (Gimmi et al. 2004) includes a compilation of fire events for the 20th century in the Valais. For this study only forest fires reaching a spatial extent of more than 10 ha were taken into account (five events). Because we expected an essential impact on tree species composition from forest fires that may bias the effect of anthropogenic disturbances on vegetation change, we excluded all forest compartments that have been affected by large forest fires during the last 100 years.

Data Analysis

Redundancy analysis (RDA) - also called reduced-rank regression - was used to evaluate the impact of different land use regimes and other environmental parameters on changes in tree species composition. RDA is a multivariate statistical method frequently used in community ecology to analyse relationships between species variables and environmental variables. In this context redundancy expresses how much of the variance in one set of variables can be explained by the other. RDA served to examine how tree species composition in two time steps is related to a set of environmental variables including anthropogenic practises and geographic site parameters described above. Furthermore, the means of changes in tree species proportion per compartment regarding different anthropogenic disturbance regimes were tested by t-test.

RESULTS

Changes in Tree Species Composition

Figure 2 shows the changes in tree species proportion between the two time steps 1930 and 1994. The rates of change for all tree species are given in Figure 3 The most striking pattern in forests in lower altitudes (below 1200 m asl) is the decrease of pine (-11.1%) and the increase of deciduous trees (+10.8%). In higher elevations (above 1200 m asl) larch increased (+8.3%) and spruce decreased (-8.1%). Other tree species show only moderate rates of change. Fir decreased uniformly but only to a small amount (-2.9%) in all elevations. Stone pine was sparsely present near the upper tree line in both time steps.

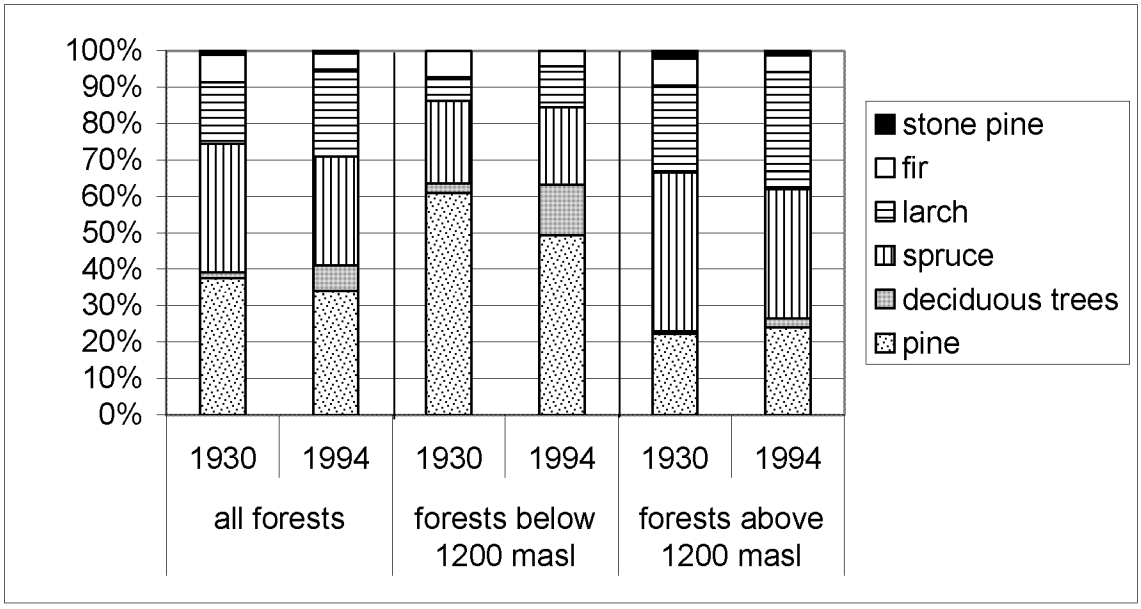


FIGURE 2: Tree species composition in 1930 and in 1994. Comparison of forest below and above 1200 m asl.

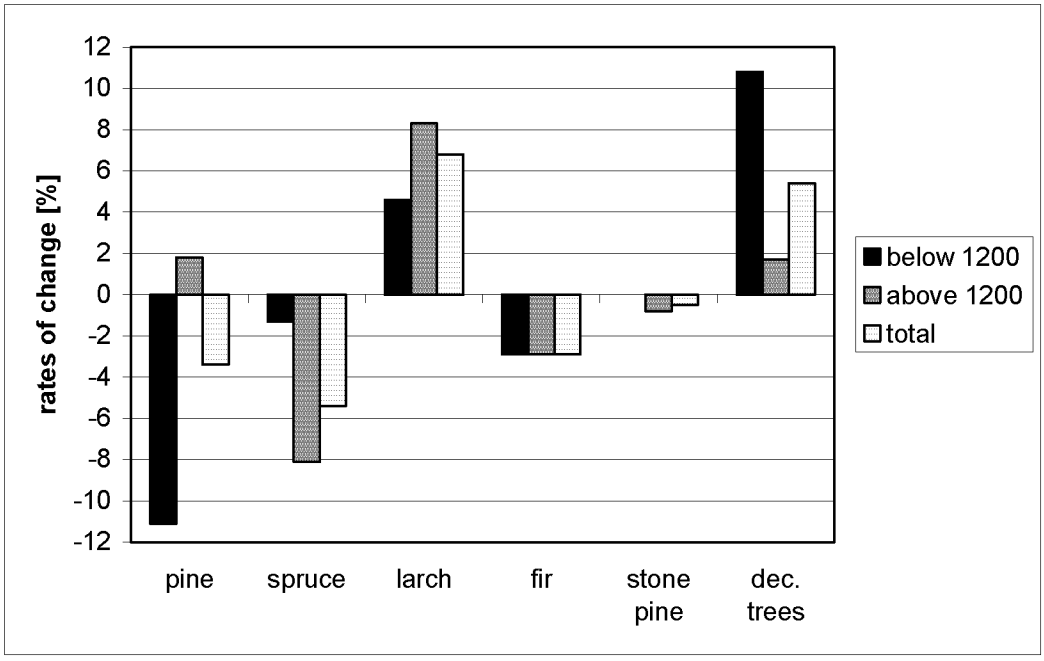


FIGURE 3: Rates of change in tree species composition between 1930 and 1994. Comparison of forest below and above 1200 m asl.

Impact of Land Use History on Tree Species Composition

Redundancy analysis (RDA) for tree species composition and environmental variables was calculated for the total number of 310 forest compartments (Figure 4a), for compartments below 1200 m asl (Figure 4b; n=123) and for compartments above 1200 m asl (Figure 4c; n=187). Figure 4a shows that the altitude is the most important environmental factor determining tree species composition. Scots pine and to a smaller extent deciduous trees dominate in lower elevations. In higher altitudes forest composition is dominated by spruce and larch. Scots pine predominately occur on calcareous substrates whereas spruce and larch stands are largely restricted on crystalline and intermediate substrates. The results for forest below 1200 m asl (Figure 4b) indicate that the increase of deciduous trees is more pronounced in lower elevations and is more distinct in areas formerly not affected by grazing and litter collecting. In contrast, the pine decrease seems to occur in all altitudes largely independent from land use history. For forests above 1200 m asl (Figure 4c) a clear relation between land use regime and spruce decrease is visible in forests above 1200 m asl. Furthermore, spruce presence is more persistent on rather north exposed slopes.

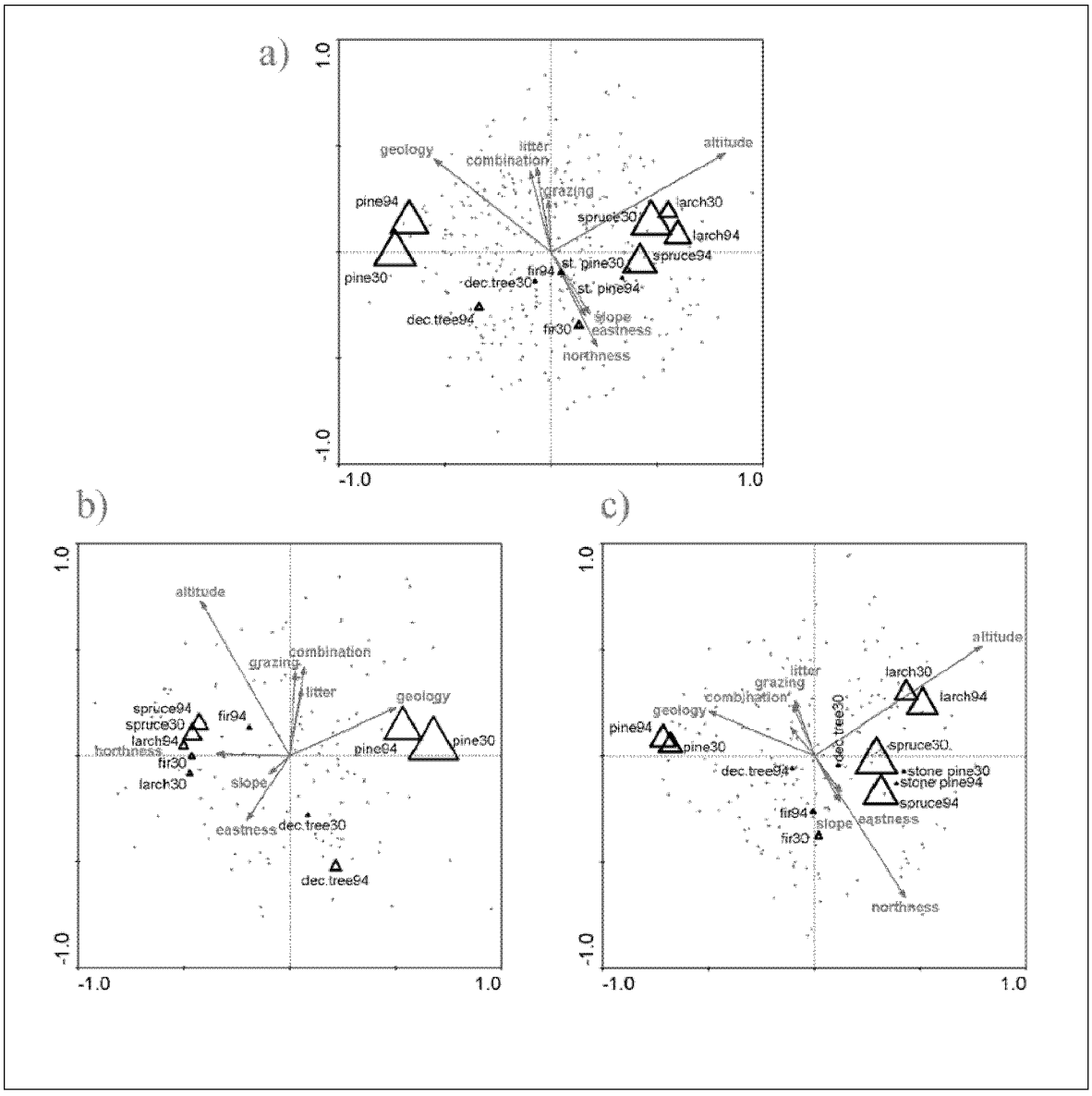


FIGURE 4: Redundancy analysis ordination a) of all 310 forest compartiments (variance explained: 0.37), b) of forest compartiments below 1200 m asl (n=123) (variance explained: 0.33) and c) of forest compartiments above 1200 m asl (n=187) (variance explained: 0.34).

Comparisons of the mean changes in tree species composition in areas under different land use regimes are listed in Table 2. In forests below 1200 m asl, the portion of deciduous trees increased in significantly smaller rates on areas that were previously affected by litter collecting. The lowest rate of increase in deciduous tree (+4.8%) were found in stands formerly used for litter collecting and wood pasture as well ("combination" in Fig. 4). In contrast, the decrease of pine in lower elevations seems not to be related to different land use regimes. In higher altitudes forest litter collecting and

the combined practise of litter collecting and wood pasture showed a highly significant decrease of spruce proportion. In contrast, the increase of larch is not significantly related grazing or litter raking and the combined practise.

	Forests below 1200 m asl (pine proportion 1930 ≥ 20%)				
		No such use (n=46)	Wood pasture (n=45)	Litter collecting (n=27)	Combination (n=23)
pine	mean	-13.7	-17.8	-15	-12.8
	stdv	24.8	28.4	26.7	23.4
deciduous trees	mean	12.8	10.9	5.3*	4.8*
	stdv	20.6	19.6	11.5	11
	Forests above 1200 m asl (spruce proportion 1930 ≥ 20%)				
		No such use (n=56)	Wood pasture (n=72)	Litter collecting (n=36)	Combination (n=26)
spruce	mean	-9.8	-16.4	-24.4**	-25.8**
	stdv	32.6	28.1	22.7	21.7
larch	mean	14.8	8.5	10.9	6.3
	stdv	26	24.7	29.5	28.8

t-test significance * α=5%; ** α=1%

TABLE 2: Comparison of mean changes in tree species proportion in areas under different anthropogenic disturbance regimes. Values are given in mean changes in percentage between 1930 and 1994.

Effects of different anthropogenic disturbance regimes are corresponded with the specific intensity of grazing and forest litter collecting (Table 3a&b). In lower elevations, the practise of forest litter collecting particularly in high intensity leads to significantly lower rates in the increase of deciduous trees. On areas formerly intensively affected by the combination of forest litter collecting and wood pasture the increase of deciduous trees was even virtually absent (+1.2%). In a similar way, the decrease of spruce was strongly correlated to the intensity of past forest uses. The intensive exercise of wood pasture, forest litter collecting, and the combination of both practises lead to significant higher rates of spruce decrease.

	Forests below 1200 m asl (pine proportion 1930 ≥ 20%)			
		No wood pasture or litter collecting (n=46)	Wood pasture, low intensity (n=27)	Wood pasture, high intensity (n=18)
pine	mean	-13.7	-21.7	-12.1
	stdv	24.8	22.5	34.7
deciduous trees	mean	12.8	12.8	8
	stdv	20.6	17.5	22
		No wood pasture or litter raking (n=46)	Litter collecting, low intensity (n=14)	Litter collecting, high intensity (n=13)
pine	mean	-13.7	-16.6	-13.3
	stdv	24.8	24.2	29
deciduous trees	mean	12.8	5.9	4.6*
	stdv	20.6	13.2	9.3
		No wood pasture or litter raking (n=46)	combination, low intensity (n=10)	combination, high intensity (n=13)
pine	mean	-13.7	-21.1	-7.1
	stdv	24.8	21.7	23.8
deciduous trees	mean	12.8	8.7	1.2**
	stdv	20.6	15.8	2.2

t-test significance * α=5%; ** α=1%

TABLE 3a: Comparison of mean changes in tree species proportion for Scots pine and deciduous trees in areas under different intensities of anthropogenic disturbance regimes. Values are given in mean changes in percentage between 1930 and 1994.

	Forests above 1200 m asl (spruce proportion 1930 ≥ 20%)			
		No wood pasture or litter collecting (n=56)	Wood pasture, low intensity (n=53)	Wood pasture, high intensity (n=19)
spruce	mean	-9.8	-13.7	-23.9*
	stdv	32.6	29.5	22.2
larch	mean	14.8	8.5	8.4
	stdv	26	25.7	21.6
		No wood pasture or litter raking (n=56)	Litter collecting, low intensity (n=16)	Litter collecting, high intensity (n=20)
spruce	mean	-9.8	-23.1*	-25.6**
	stdv	32.6	25.8	19.9
larch	mean	14.8	11.6	10.3
	stdv	26	30.2	29
		No wood pasture or litter raking (n=56)	combination, low intensity (n=10)	combination, high intensity (n=16)
spruce	mean	-9.8	-25.5	-25.9**
	stdv	32.6	25.1	19.3
larch	mean	14.8	16.2	0.2*
	stdv	26	26.7	28.4

t-test significance * α=5%; ** α=1%

TABLE 3b: Comparison of mean changes in tree species proportion for spruce and larch in areas under different intensities of anthropogenic disturbance regimes. Values are given in mean changes in percentage between 1930 and 1994.

DISCUSSION

The results suggest that the practise of wood pasture and litter raking may have suppressed recruitment of deciduous trees on large areas of the lower part of the research area. With the removal of forest litter also seedlings, particularly acorns, were removed in large quantities. Additionally, deciduous trees are more vulnerable for browsing damages than pine. Substantial recruitment of pubescent oak seems to have started after the abandonment of grazing and forest litter collecting. The practise of non-timber forest uses has delayed the succession from pine to pubescent oak. The underlying general driving force behind the shift from Scots pine to deciduous trees is climate warming (Rebetez and Dobbertin 2004). However differences in the anthropogenic disturbance regime clearly shape the local characteristic of this change.

The strong increase of larch in the upper forests is a result of selective forest management techniques. As larch was seen as the most valuable tree species by foresters, the promotion of larch recruitment - mainly to the disadvantage of spruce and fir - was

mentioned as a central silvicultural aim in almost all forest management plans in the research area. Decline in spruce fraction is significantly related to past forest uses. The decrease is much more pronounced in previously grazed and litter raked forests. That is possibly an indirect effect, as non-timber forest uses were practised above all in forests with minor importance for timber production. It can be assumed that in these forests the active support of larch regeneration trough specific silvicultural techniques was not consequently executed.

CONCLUSION

In areas exposed to anthropogenic impacts, the effects of climate changes are often accompanied or even superposed by land use changes. Our results show that anthropogenic disturbances have significant impact on changes in tree species composition in the Swiss Rhone valley. Forest litter collecting, wood pasture, and particularly the combination of these practises essentially contribute to the recently observed changes in tree species composition from pine to deciduous trees. The practise of wood pasture and litter raking - particularly if intensively exercised - led to specific environmental conditions which hindered regeneration of deciduous trees and favoured pine as a pioneer species. After abandonment of these practises the recruitment of pubescent oak could establish and pine was again subjected to increased competition. It can be assumed that in stands previously affected by non-timber forest uses, the shift from pine to pubescent oak has started with a decadal time lag and will continue in accelerated rates in the next decades. The increase of larch and decrease of spruce could be ascribed to selective silvicultural management methods aiming at the promotion of larch recruitment. The presented results from the Swiss Rhone valley are of high importance for other inner-alpine valleys of the European Alps, where similar processes are running. This study highlights the importance of historical ecology research for the understanding of current ecosystem processes and changes.

REFERENCES

Bigler C, Bräker OU, Bugmann H, Dobbertin M, Rigling A. 2006. Drought as an inciting mortality factor in Scot pine stands of the Valais, Switzerland. Ecosystems 9, in press.

Birks, H.J.B., Line, J.M., Persson, T. (1988) The cultural landscape, past, present and future. Cambridge University Press.

Bürgi, M. (1999) A case study of forest change in the Swiss lowlands. Landscape Ecology 14: 567-575.

Bürgi, M., Russell, E.W.B., Motzkin, G. (2000) Effects of postsettlement human activities on forest composition in the north-eastern United States: a comparative approach. Journal of Biogeography 27: 1123-1138.

De Quervain, F. et al. (eds.) (1963-1967) Geotechnische Karte der Schweiz. Schweizerische Geotechnische Kommission, Bern.

Dobbertin M, Mayer P, Wohlgemuth T, Feldmeyer-Christe E, Graf U, Zimmermann N, Rigling A. 2005. The decline of Pinus sylvestris L. forests in the Swiss Rhone valley - a result of drought stress? Phyton 44: 153-156.

Dupouey JL, Dambrine E, Laffite JD, Moares C. 2002. Irreversible impact of past land use on forest soils and biodiversity. Ecology 83: 2978-2984.

Dzwonko Z, Gawronski S. 2002. Effect of litter removal on species richness and acidification of a mixed oak-pine woodland. Biological Conservation 106: 389-398.

Foster DR. 1992. Land-use history (1730-1990) and vegetation dynamics in central New England, USA. Journal of Ecology 80: 753-772.

Gimmi U, Bürgi M, Wohlgemuth T. 2004. Wie oft brannte der Walliser Wald im 20. Jahrhundert? Schweiz. Z. Forstwes. 155: 437-440.

Gimmi, U., Bürgi, M. (2006) Using oral history and forest management plans to reconstruct traditional non-timber forest uses in the Swiss Rhone valley (Valais). Environment and History: accepted.

Gimmi, U., Stuber, M., Bürgi, M. (2006) Reconstructing anthropogenic disturbance regimes in forest ecosystems – a case study from the Swiss Rhone valley. Ecosystems: submitted.

Graae BJ, Sunde PB, Fritzbøger B. 2003. Vegetation and soil differences in acient opposed to new forests. Forest Ecology and Management 177: 179-190.

Grime, JP. (1979) Plant strategies and vegetation processes. Wiley, Chichester.

Kirby KJ, Watkins C. 1998. The ecological history of European forests. CAB International, Cambridge.

Koerner W, Dupouey JL, Dambrine E, Benoit M. 1997. Influence of past land use on the vegetation and soils of present day forest in the Vosges mountains, France. Journal of Ecology 85: 351-358.

MacCay DH. 2000. Effect of chronic human activities on invasion of langleaf pine forests by sand pine. Ecosystems 3: 283-292. doi:10.1007/s100210000026

Motta, R. and Edouard, J.L. (2005) Stand structure and dynamics in a mixed and multilayered forest in the Upper Susa Valley, Piedmont, Italy. Canadien Journal of Forest Research 35: 21-36. doi: 10.1139/X04-153

Motzkin, G., Foster, D., Allen, A., Harrod, J., Boone, R. (1996) Controlling site to evaluate history: vegetation patterns of New England sand plain. Ecological Monographs 66: 345-365.

Motzkin, G, Wilson, P., Foster, D.R., Allen, A. (1999) Vegetation patterns in heterogeneous landscapes: the importance of history and environment. Journal of Vegetation Science 10: 903-920.

Pickett, STA and White, PS. (1985) The ecology of natural disturbances and patch dynamics. Academic Press, New York.

Prévosto B, Dambirne E, Moares C, Curt T. 2004. Effects of volcanic ash chemistry and former agricultural use on the soils and vegetation of naturally regenerated woodlands in the Massif Central, France. Catena 56: 239-261. doi:10.1016/j.catena.2003.10.014

Rebetez M and Dobbertin M. 2004. Climate change may already threaten Scots pine stands in the Swiss Alps. Theoretical and Applied Climatology 79: 1-9. doi:10.1007/s00704-004-0058-3

Rigling A, Cherubini P. 1999. Wieso sterben die Waldföhren im „Telwald“ bei Visp? Eine Zusammenfassung bisheriger Studien und eine dendroökologische Untersuchung. Schweiz. Zeitschrift Forstwes. 150 4: 113-131.

Rigling A, Forster B, Wermelinger B, Cherubini P. 1999. Grossflächige Veränderung des Landschaftsbildes im Kanton Wallis - Waldföhrenbestände im Umbruch. Wald und Holz: 8-12.

Rigling A, Dobbertin M, Wohlgemuth T. 2004. Waldföhrenwälder der Alpen im Umbruch – eine Bioindikation für Global Change? Bauhinia 18: 56-57.

Rackham, O. (1980) Ancient woodland: its history, vegetation and uses in England. Edward Arnold, London: 402 pp.

Radkau, J. and Schäfer, I. (1987) Holz. Ein Naturstoff in der Technikgeschichte. Rowohlt, Hamburg: 313 pp.

Schönfeld U, Rigling D, Polomski J. 2004. Eine neue Gefahr für die Föhren der Schweiz? Der Kiefernholznematode. Wald und Holz 85: 35-37.

Werlen, C. (1994) Elaboration de la carte de végétation forestière du Valais. Schweiz. Z. Forstwes. 14: 607-617.

Wulf M. 2004. Plant species richness of afforestations with different former use and habitat continuity. Forest Ecology and Management 195: 191-204.

Synthesis

The history of anthropogenic disturbances in the pine forest belt of the Valais

The first aim of this thesis was to identify the ecologically relevant human activities in pine forests of the Swiss Rhone valley during the late 19th and the 20th century. For this purpose the analysis of documentary evidence particularly forest management plans and several statistical sources were combined with oral history interviews. The two source types complemented and often called into question one another. The combination of different sources provided a multi-perspective and therefore a more comprehensive picture about past forest uses in the region.

Wood pasture and forest litter collecting were identified as the most important traditional non-timber forest uses in the pine forest belt of the Valais. Other practises such as resin extraction and the collecting of mistletoes were of local socio-cultural relevance but of minor ecological importance. The spatial and temporal extent of traditional non-timber forest uses was determined by the regulation of the forest authorities, the accessibility of the forests, the access to substitute products, the economic situation of the local people and changes in the demand. The results of this qualitative study established the basis for the understanding of current ecological processes and specifically for the subsequent studies aiming at the quantification of traditional non-timber forest uses and the assessment of the impact of these practises on the recently observed changes in tree species composition.

Quantification of traditional non-timber forest uses

To increase the ecological relevance of historical information, it is important to go beyond qualitative information. Therefore, it was a central aim of this thesis to gain quantitative information about non-timber forest uses in the Valais. In this context, we reconstructed the spatiotemporal patterns of forest litter collecting and wood pasture in the pine forest belt of the Valais and estimated the biomass removal through these practises. Detailed information on agricultural practices and socio-economic context gained in the first study were essential to develop reliable estimates of anthropogenic disturbance regimes.

The study shows that wood pasture and forest litter collecting were practised on a significant proportion of the forested landscape in the Valais up to the second half of the 20th century. Until the implementation of forest management plans in the 1930s almost half of the forests in the study area was affected by wood pasture and/or forest litter collecting. The regulations in the management plans led to an essential reduction of this area but also to an increased pressure on the remaining areas. The results suggest that the notion of a slow but steady disappearance of traditional non-timber forest uses and the associated effects on forest ecosystems is oversimplified. Quantitative reconstructions of biomass output resulting from these practises confirm the importance of traditional non-timber forest uses for ecosystem development in this region. Furthermore it is very likely that similar effects have been widespread throughout regions with similar natural and socio-economic context, e.g., throughout a significant proportion of the European Alps.

Impact of wood pasture and forest litter collecting on changes in tree species composition

The final aim of this thesis was to assess the impact of anthropogenic disturbances on pine forest ecosystems. For this purpose tree species composition in 1930 is reconstructed using information from contemporary forest management plans and compared with a modern vegetation map. Significant decrease of Scots pine (-11.1%) and increase of deciduous trees (+10.8%) is found for forests in lower altitudes (below 1200 m asl). In higher elevations a shift from spruce (-8.1%) to larch (+8.3%) occurred. The increase of deciduous trees is more pronounced in stands formerly not used for grazing and/or litter collecting whereas the decrease in Scots is not significantly correlated with former anthropogenic practises. This correlation is interpreted as a result of wood pasture and litter collecting hindering the regeneration of deciduous trees until the abandonment of these practises a few decades ago. The increase of larch to the disadvantage of spruce can be explained through specific silvicultural management schemes which aimed at the promotion of larch recruitment. The findings from this study from the Swiss Rhone valley are of high importance for other inner-alpine regions of the European Alps, where similar ecosystem processes are running.

Implications for forest management

Traditional non-timber forest uses were widespread, and besides forest fires (Gimmi et al. 2004), significantly shaped the disturbance regime in the pine forest belt of the Valais. Several possible benefits for forest management and conservation derive from historical ecology research in general and specifically from the findings of this thesis. First, it should be noticed that the recovery of forest ecosystems from former anthropogenic practices is a long-lasting process (e.g. Koerner et al. 1997, 1999; Compton and Boone 2000; Goodale and Aber 2001, Dupouey et al. 2002). Therefore detailed information on historical forest uses is crucial for the understanding of current ecosystem changes. Intimate knowledge about the disturbance history of forest ecosystems helps to appropriately estimate the temporal dynamics of ecosystem changes and forms the baseline for more informed prediction about the future development of ecosystems (e.g. Bürgi and Russell 2001). In this context forest managers in the Valais are confronted with the following specific questions:

- Is it realistic and reasonable to conserve pine forests?
- And when yes, what would be the efforts for conserving pine forests?
- Is the reintroduction of wood pasture or even forest litter collecting an option?
- Are there other methods that can mimic the ecological effects of traditional non-timber forest uses?

Further studies e.g., long-term grazing and litter removal field experiments (e.g. Dzwonko and Gawronski 2002) would be helpful for answering these questions.

Implications for global change studies

Long-term impacts of land use changes from regional to landscape scales are frequently discussed in the context of biogeochemical cycles (e.g. carbon and nitrogen) (e.g. Koerner et al. 1999, Goodale and Aber 2001, Jussy et al. 2002, Latty et al. 2004) and vegetation changes (e.g. Foster 1992, Koerner et al. 1997, Bürgi et al. 2000, Eberhardt et al 2003, Graae et al. 2003). Perruchod et al. (1999) modelled carbon budget of forest soils for the 20th century including time series of anthropogenic litter removal. However, the authors lamented the lack of reliable quantitative data on forest litter collecting. Recovering nutrient pools. Foster et al. (1998) concluded that historical land use should

be increasingly considered in studies of global change. Possible fruitful contributions of historical ecology research could be integrated in global change studies in the context of recovering forest nutrient pools and in the discussion about forest and forest soils in their function as potential carbon sink. As human activities are strongly differentiated from place to place we need regional and case study based approaches to improve our understanding about human-environment interactions on larger scales.

Data derived from historical ecology studies are especially valuable in the field of ecological modelling. Ecosystem models need to be calibrated and their projections need to be evaluated (or validated) against independent data (Bugmann 2000, Anderson et al. 2006). One source of such records is found in environmental archives (e.g. pollen, tree rings etc.) another source are historical records. Here historical ecology called to improve communication between natural sciences and social sciences (Crumley 2000).

References

Anderson N.J., Bugmann H., *Dearing J.A., Gaillard M-J.* 2006: Linking palaeoenvironmental data and models to understand the past and to predict the future. Trends in Ecology and Evolution (in press).

Bugmann H. 2000: The role long time series of ecological data for the calibration and evaluation of ecological models. PAGES 8: 26-28.

Bürgi M., Russell E.W.B., Motzkin G. 2000: Effects of postsettlement human activities on forest composition in the north-eastern United States: a comparative approach. Journal of Biogeography 27:1123-1138.

Bürgi, M. and Russell, E.W.B. 2001: Integrative methods to study landscape changes. Land Use Policy 18: 9-16.

Compton J.E., Boone R.D. 2000: Long-term impacts of agriculture on soil carbon and nitrogen dynamics in New England forests. Ecology 81: 2314-2330.

Crumley C.L. 2000: Bridging the biophysical-cultural divide: the role of historical ecology. PAGES 8: 8-9.

Dupouey J.L., Dambrine E., Laffite J.D., Moares C. 2002: Irreversible impact of past land use on forest soils and biodiversity. Ecology 83: 2978-2984.

Dzwonko Z. and Gawronski S. 2002: Effect of litter removal on species richness and acidification of a mixed oak-pine woodland. Biological Conservation 106: 389-398.

Eberhardt R.W., Foster D.R., Motzkin G., Hall B. 2003: Conservation of changing landscapes: Vegetation and land-use history of Cape Cod and National Seashore. Ecological Applications 13: 68-84.

Foster D.R. 1992: Land-use history (1730-1990) and vegetation dynamics in central New England, USA. Journal of Ecology 80: 753-772.

Foster D.R., Motzkin G., Slater B. 1998: Land-use history as long-term broad-scale disturbance: regional forest dynamics in central New England. Ecosystems 1: 96-119.

Gimmi U., Bürgi M., Wohlgemuth T. 2004: Wie oft brannte der Walliser Wald im 20. Jahrhundert? Schweizerische Zeitschrift für Forstwesen 155: 437-440.

Goodale C.L. and Aber J.D. 2001: The long-term effects of land-use history on nitrogen cycling in northern hardwood forests. Ecological Applications 11: 253-267.

Graae B.J., Sunde P.B., Fritzbøger B. 2003: Vegetation and soil differences in acient opposed to new forests. Forest Ecology and Management 177: 179-190.

Jussy J.H., Koerner W., Dambrine E., Dupouey J.L., Benoit M. 2002: Influence of former agricultural land use on net nitrate production in forest soils. European Journal of Soil Science 53: 367-374.

Koerner W., Dupouey J.L., Dambrine E., Benoit M. 1997: Influence of past land use on the vegetation and soils of present day forest in the Vosges mountains, France. Journal of Ecology 85: 351-358.

Koerner W., Dambrine E., Dupouey J.L., Benoit M. 1999: δ15N of forest soil and understorey vegetation reflect the former agricultural land use. Oecologia 121: 421-425.

Latty E.F., Canham C.D., Marks P.L. 2004: The effects of land-use history on soil properties and nutrient dynamics in northern hardwood forests of the Adirondack mountains. Ecosystems 7: 193-207. doi:10.1007/s10021-003-0157-5

Perruchod D, Kienast F, Kaufmann E, Bräker OU. 1999. 20th century carbon budget of forest soils in the Alps. Ecosystems 2: 320-337.

Acknowledgments

Diese Arbeit wäre ohne die Unterstützung einer Reihe von Menschen nicht zu einem glücklichen Ende gekommen. Ich möchte hier allen direkt und indirekt beteiligten Menschen danken.

Prof. Dr. Klaus C. Ewald nahm mich als Doktorand in seiner Gruppe auf und unterstützte meine Forschung durch seine kritisch-konstruktiven Beiträge zu meinen Manuskripten. Zudem ermöglichte er es mir während zwei Semestern an der Lehrveranstaltung Natur- und Landschaftsschutz II mitzuarbeiten.

PD Dr. Matthias Bürgi möchte ich für seine und motivierende und freundschaftliche Betreuungsarbeit danken. Er hatte stets eine offene Tür für meine Anliegen. Zudem hat er mich in die internationale Forschungsgemeinschaft eingeführt.

Prof. Dr. Anton Schuler und Prof. Dr. Christian Pfister betreuten die Arbeit als Korreferenten. Toni unterstützte mich mit seinem enormen forstgeschichtlichen Wissen. In Erinnerung bleiben mir auch die inspirierenden Diskussionen mit ihm während den Kongressen in Prag und Florenz. Christian weckte mein Interesse für umweltgeschichtliche Fragen bereits während meines Studiums an der Universität Bern und prägte damit meinen wissenschaftlichen Werdegang.

Dr. Andreas Rigling und Dr. Matthias Dobbertin leisteten eine grossartige Arbeit als Projektleiter des interdisziplinären Waldföhrenprojekts an der WSL. Sie integrierten die historischen Aspekte der Föhrenproblematik bereits früh und in vorbildlicher Weise im Gesamtprojekt. An dieser Stelle sei auch allen weiteren MitarbeiterInnen im Waldföhrenprojekt für ihren Einsatz gedankt. Speziell danken will ich Pascale Weber für die lehrreichen Ausflüge ins Wallis und die Gespräche über Föhren, Eichen, Gott und die Welt.

Dr. Thomas Wohlgemuth dem Koordinator des Forschungsprogramms Walddynamik an der WSL danke ich für seine wichtigen Beiträge insbesondere zum letzten Teil der Dissertation. Er ermöglichte mir durch seine Unterstützung auch den Aufbau einer historischen Waldbranddatenbank für das Wallis.

Allen ehemaligen und aktuellen Mitgliedern der Forschungsgruppe "Naturschutz und Historische Ökologie" danke ich für die kollegiale Arbeitsatmosphäre während der vergangenen Jahre. Liebe Anna, Sigrun, Nina, Bea, Claude, Susi, Franziska, Daniel, Monika und Maria-Pia: herzlichen Dank für die schöne Zeit. Natürlich muss ich meine Bürokollegin Maria-Pia besonders lobend erwähnen, denn sie brachte einen mediterranen Hauch in meinen bis dahin grauen Büroalltag.

Meine Freunde und Familie haben mir geholfen auch in stressigen Zeiten auf andere Gedanken zu kommen und die nötige Distanz zur Wissenschaft zu wahren. Zuhause bei meiner Frau und meinen Kindern relativierte sich so manches akademische Problem und ich konnte neue Energie tanken.

Curriculum vitae

Urs Gimmi
Tulpenweg 1
CH-8645 Jona

1979-1985	Primary school in Bad Ragaz and Nesslau
1985-1988	Post-primary school in Nesslau and Wil
1988-1994	Cantonal teacher training in Wattwil
1994-1996	Teacher at the "Heilpädagogisches Zentrum Johanneum" in Neu St. Johann
1996-2002	Study at the University of Berne: Geography and History
2002	Diploma thesis: A method to reconstruct long precipitation series of Berne, Switzerland (1760-2000), under guidance of Prof. Dr. H. Wanner and Dr. J. Luterbacher (Institute of Geography, University of Berne)
2003-2006	PhD-thesis at the SwissFederal Institute for Forest, Snow and Landscape Research (WSL), under the supervision of Prof. Dr. K.C. Ewald (ETH Zürich), Dr. Matthias Bürgi (WSL Birmensdorf), Prof. Dr. A. Schuler (ETH Zürich) and Prof. Dr. C. Pfister (University of Berne)