Using the Past to Understand the Present Land Use and Land Cover

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Abstract
Landscapes must be understood as dynamic time-dependent entities rather than static associations of biotic and abiotic elements. In particular, former human activities must be better appreciated and better incorporated in descriptions of landscape processes. To describe past landscapes, oral, written, (carto-)graphic and ecological sources can be used. Combinations of these sources usually provide reliable historical information, if based on a critical analysis of the quality and background of the data, including cross-checking information from the different data sources. The general public, planners, politicians, land managers, ecological modelers, and restoration ecologists are just some of the potential users of landscape history.

Keywords: landscape history, land use change, source types, historical ecology

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Relevance and Methods of Landscape History

The potential contribution of landscape history – the study of the evolution of landscapes and ecosystems over centuries – to provide a better understanding of the present land use and land cover is increasingly recognized (Russell 1997; Swetnam *et al.* 1999). Most landscapes are cultural landscapes, shaped over time, in an interactive process linking human needs with natural resources in a specific topographic and spatial setting. Periods of distinct use and management of the land can often be distinguished, with some human activities leaving only a short imprint on the scenery and ecosystems, whereas others remaining visible over thousands of years depending on their level of impact. Thus, current pattern and processes of landscapes as well as ecosystem functions should be interpreted and understood with an integrative historic-ecological approach (Swetnam *et al.* 1999; Bürgi and Russell 2001).

It is not easy to incorporate the temporal dimension – which is inevitably process-oriented – into landscape studies, as the concept of landscape is usually rather static (Cosgrove 1984). Several authors discuss the problems of historic, process oriented approaches in landscape studies, such as Hobbs (1997), who state that in many landscape ecological studies processes are often afforded less attention than landscape pattern or may even be ignored altogether. Crumley (1998) points out that landscape ecologists either tend to ignore people or assume their effect to be negative. Meine (1999) states that if natural scientists and historians look at the same landscape they see different things and draw different lessons from what they see. Some of the differences in their landscape perception arise from the differences in the academic cultures of science and humanities. Whereas natural scientists are interested in finding generalized processes forming patterns of predictable events, historians typically focus their work on the particularities of a locality. In landscape ecology, human activities are regarded at best as one factor among many that have an impact on the system under study. Similarly in history, the spatial setting of historical events is just one among many aspects considered. For an integrative understanding of landscape changes, the two perspectives of science and humanities have to be combined.

Several fields of research, such as historical geography, environmental history, human ecology and historical ecology have a long tradition of considering humans as a biotic factor (McDonnell and Pickett 1993). In these fields, methods and approaches have been developed for combining information from different sources (Sheail 1980; Russell 1997; Egan and Howell 2001). In the following sections we provide an overview of the sources of information about past landscapes, as well as a survey of the uses and applications of this information.

Voices from the Past

Written and oral information

Many public and privately owned archives are replete with documents containing information about past land use and land management. A farmers' diary may be as valuable as contemporary newspaper reports or official agricultural statistics in contributing towards the reconstruction of past land-use practices and human impacts on the land (Russell 1997; Edmonds 2001). By combining different source types, often a more complete picture of landscape evolution can be gained.

Whereas it may be sufficient for a historian or a folklorist to describe and document a specific land use, a historical ecologist is interested in intensity, frequency and spatial extent, i.e. the disturbance regime of a specific land use. Only by collecting such detailed information, it is possible to incorporate the human impact fully in a study of ecosystem change (e.g., Wohlgemuth *et al.* 2002). However, even then, it is often hard or even impossible to meet the rigorous needs of quantification that is characteristic of ecological studies (Bürgi and Russell 2001). In many cases, researchers have to estimate and make informed guesses in order to fill in the lacuna in data left by discontinuous documentation or ways have to be found to incorporate qualitative information.

Written sources contain information that was regarded as relevant in the past. The content of these sources cannot be changed or extended – we have to take whatever there is. In contrast, this limitation does not exist when contemporary witnesses are asked about how, when, and where they have used and shaped the land. Therefore, oral history bears the potential to provide valuable information about the human impact on the land (Fogerty 2001). An obvious limitation of oral history is that the temporal span is limited by life expectancy. Furthermore, any interpretation of oral histories must address the question of faulty memories, biases etc (Perks and Thomson 1998).

Combining oral and written information often provides further potential to reconstruct past landscapes. These can then be combined with historical maps and pictures, which are described in the next section.

Historical maps and pictures

Historical maps are useful for retrospective analysis of landscape patterns and their change over time (e.g., Kienast 1993; Petit and Lambin 2002). Comparisons of old and modern maps highlight the major changes in land use (Fig. 1). However, the mapping criteria of the past need not have been the same as today and it is often impossible to find the historic mapping instructions. Thus, direct comparisons of old and modern maps in a Geographical Information System (GIS) often requires a procedure called "rubber sheeting" to correct for spatial mismatches and generate an estimate of the comparability of the maps.

Pictures, especially photographs, often provide greater detail and realism about a landscape than maps. All the same, they are subject to distortion, since photographs are taken for a purpose, and this purpose may bias the information provided in the photograph. The use of historical aerial photographs to study landscape change (Fig. 2) is a well-established method in vegetation science (e.g., Swetnam *et al.* 1999) and has also been applied in erosion monitoring (e.g., Thee *et al.* 1990). In more recent times, landscape change studies increasingly made use of satellite imagery and remote sensing (e.g., Serneels and Lambin 2001; Turner *et al.* 2001; Nagendra *et al.* 2004). This is described in detail in Zimmermann *et al.* (2007).

Qualitative interpretations of repeated terrestrial photographs (Fig. 3) have been used in several studies of landscape change (e.g., Tanner 1999; Nüsser 2001). Photographs, whether of aerial or terrestrial origin, are generally easier to interpret for studies of landscape change than works of art. Some authors have successfully evaluated paintings and etchings from the 17th and the 18th century (e.g., Zumbühl 1980), but the appropriate interpretation of these sources in the context of landscape change remains highly challenging.

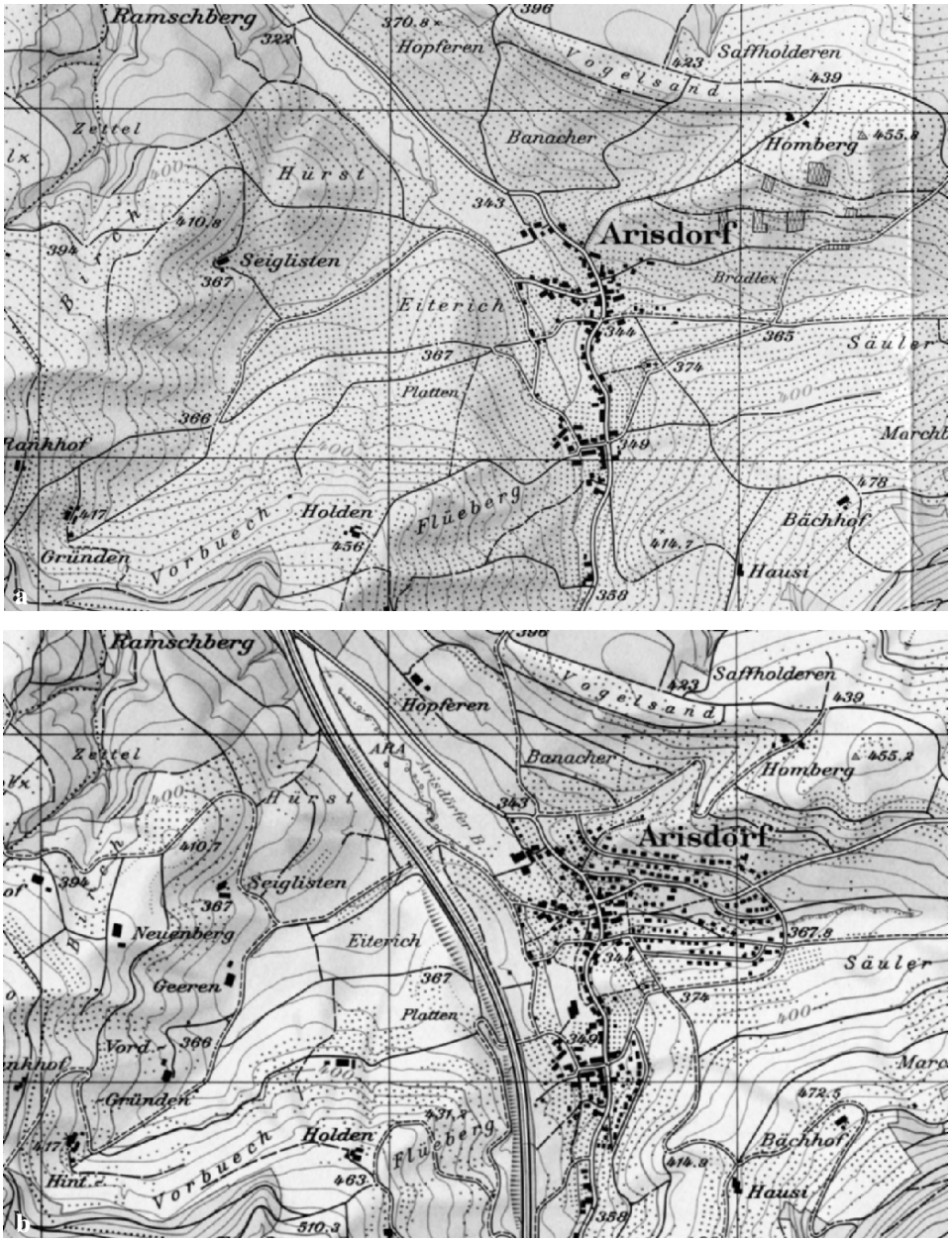

Fig. 1. Landscape change in the Swiss community of Arisdorf as shown in maps from 1955 (a, top) and 1988 (b, bottom). The landscape, in 1955 dominated by orchards (depicted as points) today is dominated by the newly constructed highway. (Source: Swiss National Maps 1:25 000, 1068 Sissach, reproduced with permission of the Federal Office of Topography, swisstopo (BA046410)).

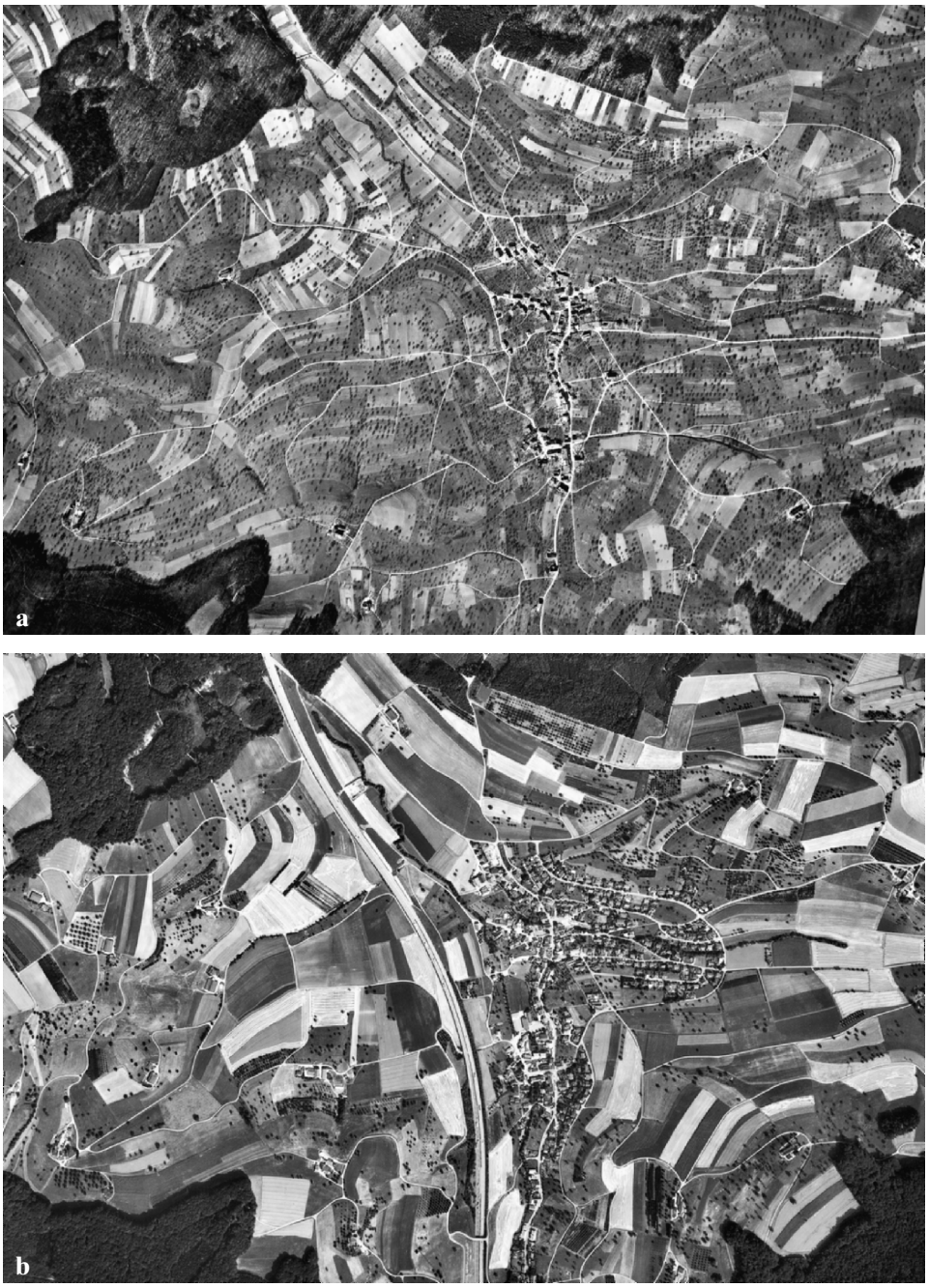

Fig. 2. Landscape change in the Swiss community of Arisdorf as shown in aerial photographs from 1953 (a, top) and 1994 (b, bottom). Aerial photographs allow the analysis of field pattern. In the present case, the average size of the fields increased significantly. (Source: (a) Federal Office of Topography, swisstopo, SA 28, Aufn. 1839, 23.3.1953 (b) Federal Office of Topography, swisstopo, Linie 64, Aufn. 6662, 27.7.1994. Reprinted in Tanner 1999).

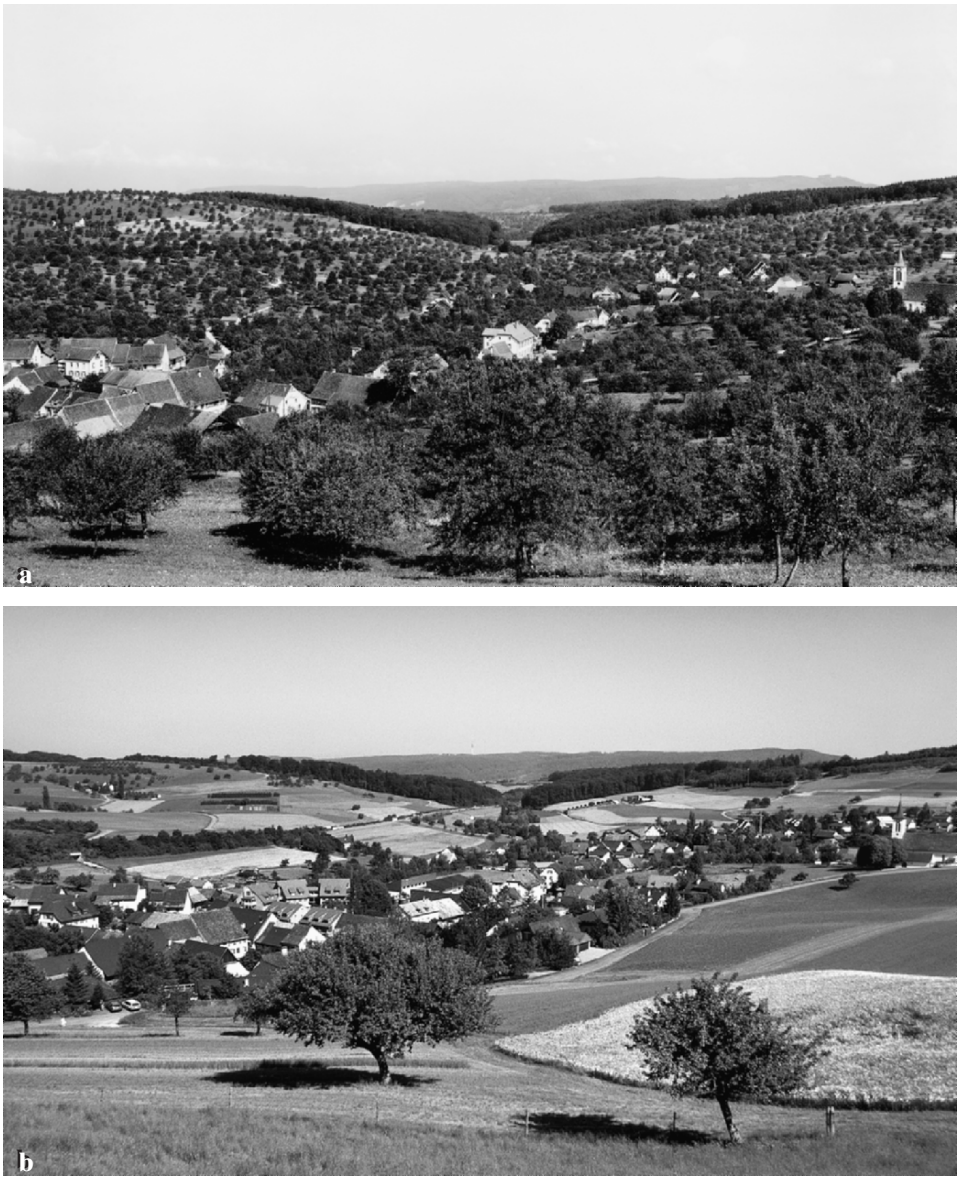

Fig. 3. Landscape change in the Swiss community of Arisdorf as shown in terrestrial photographs from 1941 (a, top) and 1999 (b, bottom). Unlike maps and aerial photographs, terrestrial photographs allow evaluating landscapes from a human perspective. Repeat terrestrial photography therefore is a powerful tool to analyse landscape change including qualitative and aesthetic aspects. In the example of Arisdorf the points on the map (Fig. 1a) become visible as three dimensional fruit trees, making the village be set in a forest of orchards. (Source: (a) Photo by Kling/Hans Eppens, Denkmalverzeichnis des Kantons Baselland 1941/1942, Photoarchiv Denkmalpflege des Kantons Basel-Landschaft, Liestal, Switzerland, reproduced in Tanner 1999, (b) Photo by Karl Martin Tanner, Seltisberg, Switzerland).

Reading the landscape

For landscape history, the most important physical evidence is the landscape as it presents itself today. As a result of century-long human activities, the current landscape contains a wealth of information about these activities, their intensity and spatial context in which they were conducted. Stone walls, for example, even if standing in a dense forest give exact information about how a former pasture land was spatially organized (e.g., Raup and Carlson 1941). Terraces, now in pastureland, show where more intensive agriculture was once common (Zimmermann 1972). In forests, the stand structure often reflects a long history of forest use and management.

The prime sources of information about forest development are tree rings (Esper *et al.* 2007). They contain information not only about climate, but also about fire frequency and intensity (e.g., Swetnam 1993), natural or anthropogenic changes in water regime (e.g., Rigling *et al.* 2002), forest use and management (e.g., Rigling and Schweingruber 1997), and the timing of forest succession after land abandonment (e.g., Iseli and Schweingruber 1990). Like many written documents, tree rings allow precise dating of events. Therefore, combining dendrochronological information with historical documents is of high interest for landscape history and ecological history in general.

Not only the trees, but also the ground they stand on contain information about past land use and land cover. One might utilize traces of plough horizons, or anomalies in nutrient content due to agricultural impacts that depleted the soils over a long period of time (Compton and Boone 2000; Koerner *et al.* 1999). Other natural archives include the sediments of ponds and lakes, peat in mires and small hollows, and soils, where pollen and macrofossils have been deposited and preserved. The pollen and macrofossil record can allow the reconstruction of the local and regional vegetation composition, and can reflect a region's changing human activities (e.g., Davis 1973; Russell 1993; Fuller *et al.* 1998; Lotter 1999).

Using a source-critical approach

All these sources of information about past landscapes are subject to several levels of interpretation. Historical sources, after all, reflect the past but are not the past itself. Natural evidence (such as tree rings) and human evidence (such as early meteorological data) (Egan and Howell 2001) therefore depend on the accuracy of the measurements, as well as on the attitude, bias, and agenda of the measurers. A measurement may vary according to tool, season, or calibration; a description of the former landscape may be scientific or lyric, detailed or general, but perhaps very pertinent to the questions being asked. Researchers using historical sources must also pay special attention to correlations masked as causations: in the example of measuring medieval climate change by tracing archival dates of annual grape harvests, the causal chain will depend on such factors as, 1) the accuracy and consistency of recording the harvest date, 2) the recorder's possible motives for falsely listing earlier or later dates, 3) the species of grapes or the height of vines, and 4) the synergy of precipitation, temperature, soil, sunlight, and wind on grape maturity (Ladurie 1972).

To help compensate for the subjectivity of historical documents, researchers will often combine several sources of information. Moreover, because most archival records provide only partial answers to historic questions, researchers often speak in terms of likelihood, probability, and plausibility (Bürgi and Russell 2001). By paying attention to the source, noting both its strengths and weaknesses for answering each question, researchers can address the post-modernist critique that former landscapes can never be described precisely.

Why Study the History of Landscapes

Landscape changes are traditionally studied in a descriptive way (e.g., Ewald 1978). Despite today's more analytical approach in research, such descriptive studies are still relevant. They satisfy the public's general interest in landscape history, which is shown by the success of many popular publications (e.g., Schama 1995; Tanner 1999), or in the relevance of traditional cultural landscapes for tourism, such as in the popularity of hiking along historic traffic routes or irrigation conduits (e.g., Crook and Jones 1999). Thus, descriptive studies of landscape history enables to locate society and individuals in time and space.

In planning processes, information about past landscape states is relevant on three different levels. First, a thorough analysis of the driving forces of landscape change in the past (e.g., Bürgi and Turner 2002; Bürgi *et al.* 2004) results in a deeper understanding of the changing relationship between societies and landscapes and it enables us to analyze the legacy of past land uses in present-day landscapes. Therefore, landscape history has explicitly been proposed as a tool for landscape and conservation planning (Marcucci 2000; Foster 2000). Second, studying landscape history in a municipality can be a good starting point for participatory planning processes, as public discussions about where the landscape is coming from provide a baseline for reasoning about where it might be heading (e.g., HSR Rapperswil 2002). Third, the development of new policy goals clearly requires information about long-term changes in the targeted system. This is especially true for land-use planning, including the development of urban areas, agriculture, forestry, infrastructure, but also topics such as sustainable development and biodiversity.

Why Study the History of Ecosystems

Not only landscapes, but also ecosystems with a history of human impacts can only be properly understood if the changing history of these impacts is considered (e.g., McDonnell and Pickett 1993; Vitousek *et al.* 1997). Several international long-term research programs, such as the MAB-Program (http://www.unesco.org/mab/), LTER (http://lternet.edu/) or PAGES (http://www.pages.unibe.ch/), especially with its focus 5 "Past Ecosystems Processes and Human-Environment Interactions" and the therein located activity "Human impacts on terrestrial ecosystems" (HITE, http://www.liv.ac.uk/geography/hite), have implemented this history oriented approach on the ecosystem level. The integration of history into ecologically oriented studies is especially crucial for systems characterized by slow changes and long time lags between impacts and effects, such as forests (e. g., Magnuson 1990; Foster and Aber 2004), or in other ecosystems dominated by human impacts, such as anthropogenic grasslands (Cousins *et al.* 2002; Foster and Motzkin 2003).

Ecological studies that include historical aspects also find a growing application in the field of restoration ecology, the science of assisting in the recovery of damaged ecosystems (Society for Ecological Restoration International 2004). With damaged and abandoned land being the world's fastest growing land type (Wali 1992), restoration ecologists are utilising historical landscape studies to provide descriptions of former conditions to be restored (Hall 2001). Landscape historians therefore find restoration ecologists to be an eager audience seeking available information about past natural systems (Egan and Howell 2001).

Restoration, furthermore, is not limited to efforts at bringing back relatively untouched, 'pristine' systems (such as wild forests or wetlands), but is also concerned with bringing back desirable historic anthropogenic ecosystems (such as managed forests, pastureland or gardens). Indeed, research about former natural ecological processes (e.g., fire frequency, flooding events, predator-prey interaction) or about former human land use and management

(e.g., grazing pressure, forestry practices, wildlife harvest) may be more useful to restoration practitioners than static descriptions of past landscape states. The rise of the concept of historical variability (Landres *et al.* 1999) reflects a growing need for precise information about historical changes in disturbance regimes (e.g., Hellberg 2004).

Using Landscape History

We surveyed the various pitfalls of working with historical sources for landscape history, and how they can be accounted for in a source-critical approach. Generally, information about the past does not automatically provide answers about how to manage such ecosystems today or in the future (e.g., Hellberg 2004). The decisions about which historical questions we pursue must be based on our current needs and value systems. While certain restoration projects may require very specific descriptions of the past (e.g., Egan and Howell 2001), in most cases, more general information about former land use and management will already help to better understand current ecosystem functions as well as landscape patterns and processes.

Modelling studies in particular may be prone to promoting unduly accurate forecasts, projections or predictions (Veldkamp and Lambin 2001). The more complex the system and the more factors involved, the more difficult or even impossible it is to make accurate predictions. Often, scenario analyses will be a good way to mitigate the tension between predictability and uncertainty (Lambin *et al.* 2000). That said, the authors also believe that retrospective analyses can reduce unexpected behaviour (Middelham 2001) to a certain extent and under specific conditions. In any case, historical research should inform but not dictate future land-use decisions (Umbricht 2003).

Outlook

The diversity of source types providing data about the forms and functions of past landscapes clearly requires an interdisciplinary dialogue in order to develop new methods and approaches for combining a wide range of information with different reliabilities. It will remain impossible to rigorously test hypotheses regarding the potential link between changes in environmental features and changes in human activities, but experimentation and modelling are valuable tools to gain additional insights into their plausibility and the dynamics of the interactions studied. In any case, landscape ecologists must incorporate circumstantial evidence and inferential reasoning in applying such integrative methods. Not including historical information in landscape ecological studies frequently leads to misinterpretation of the observed environmental change (McDonnell and Pickett 1993).

The long list of uses of information about former landscapes reflects the growing awareness of the interconnectedness of societal and environmental development. It seems likely that landscape historians, historical ecologists and environmental historians will play increasingly crucial roles in basic landscape and ecological research as well as in related practical applications such as restoration ecology, planning processes and outreach programs.

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