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The Tyrolean Alps LTSER platform – providing scientific insights for better management of protected areas

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Abstract

In a fast-changing world, Long-Term Socio-Ecological Research (LTSER) promises to provide new understanding of society-nature interactions. Management of protected areas (PAs) relies heavily on such scientific knowledge to address complex issues. Since large areas within the Tyrolean Alps are under protection, close collaboration between scientists working in LTSER within the Tyrolean Alps and the managers of PAs would be very beneficial for appropriate area management.

Introduction

In the context of global change, contemporary environmental problems such as loss of biodiversity, climate change and resource depletion require advanced scientific approaches in order to grasp the complexity behind and describe lasting ecological phenomena. Through long-term ecological research (longer than the usual project duration of 3–5 years), how ecosystems respond to these changes can be identified, and valid information can be provided on issues that can span vast geographic areas and may last decades (LTER 2016). With this in mind, the first Long-Term Ecological Research (LTER) network was established back in the 1970s in the United States in order to provide scientific expertise and long-term datasets (LTER 2016) for the modelling of future scenarios and the development of management strategies. Such modelling, and the management strategies which may result from it, are of particular interest when it comes to the management of protected areas (PAs), for which long-term data records are necessary in order to address complex ecological issues, such as biodiversity loss or invasive species. Science can, moreover, help legitimate PAs through the provision of evidence-based information for appropriate management (Arpin et al. 2016).

After the creation of the first LTER network, it soon became evident that there was a growing need for global communication and collaboration among long-term scientific researchers. Comparable methods and long-term data covering ecosystem diversity were needed across the globe. US LTER became a trigger for the formation of ILTER (International Long-Term Ecological Research) (https://www.ilternet.edu/), which has multiple divisions, including LTER-Europe, which was formally launched in 2007. Austria has been involved in the global LTER network since 2001, and in 2002 the Austrian Society for Long-Term Ecological Research was founded.

Within the classical LTER approach, mainly unaffected ecosystems, with clearly defined spatial boundaries, have been studied, the focus being primarily on ecological patterns and processes. However, when

Figure 1 – The Stubaital site. © University of Innsbruck / Georg Leitinger

the LTER idea was transferred to Europe, challenges emerged. Since, compared to the US, Europe has a higher population density as well as a long history in land-use in which ecosystems and human activities interact strongly, the initial approach had to be adapted. Moreover, human activities such as industrialization, agricultural revolutions and urbanization are now a force of global importance (Foley et al. 2005) with a high impact on habitat destruction and species loss, requiring trade-offs between current human needs and maintaining the capacity of the biosphere to provide ecosystem services in the long term (Lambin et al. 2001; Foley et al. 2005). Hence, there is an emerging need to study society-nature interactions in a more comprehensive way (Singh et al. 2013). In response to these concerns, the human / social dimension became incorporated in the LTER concept, leading to the next-generation network, which consists of traditional LTER sites at the local level combined with LTSER (Long-Term Socio-Ecological Research) platforms covering sub-regional and landscape levels (Mirtl et al. 2010).

The LTSER concept thus combines social, economic and historical usage aspects with classical long-term ecological research. Entire landscapes with their diverse interactions between society and the natural environment are the object of study. In order to achieve the best possible results, the aim of LTSER is that scientists from different disciplines as well as lo-

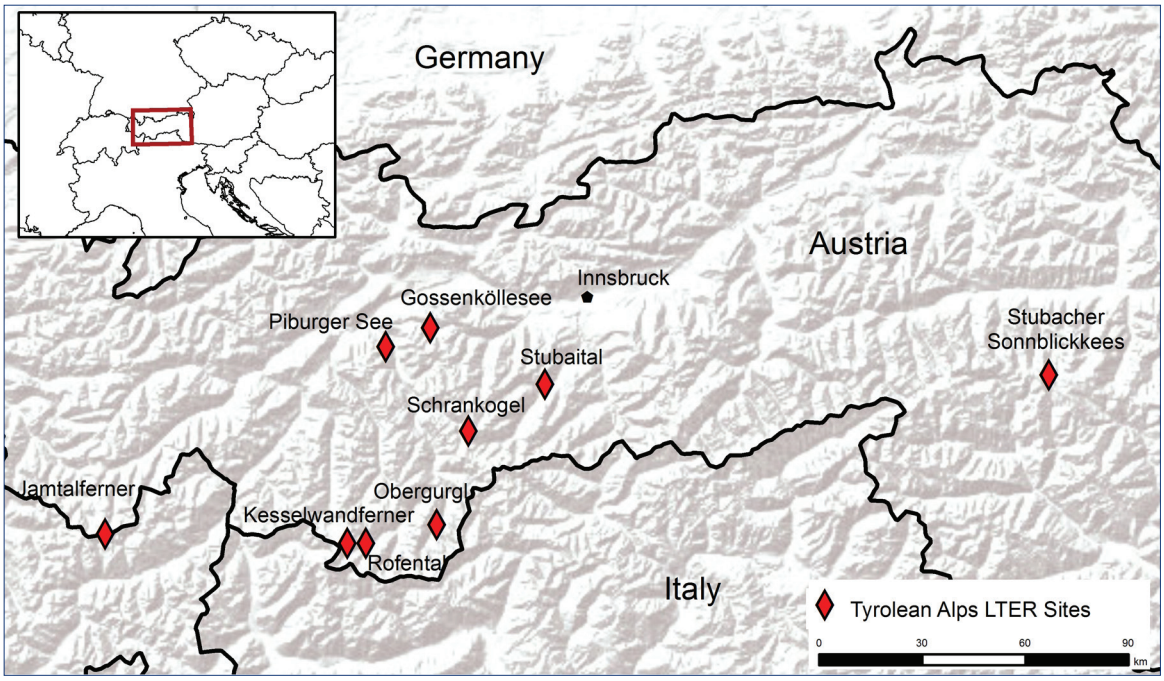

Figure 2 – Map for the Tyrolean Alps LTSER platform, showing research sites. Source: LTSER & ESRI, USGS, NOAA. Map design: Johannes Rüdisser. For more information on protection status of the sites see Figure 5. For more information on the sites in general see http://www.lter-austria.at/ta-tyrolean-alps/

cal stakeholders should work closely together in order to jointly develop issues of regional relevance. Hence, LTSER contributes significantly to integrated sustainability research. In this study, we apply a comprehensive, inter- and transdisciplinary approach to optimize the management of PAs using the (Austrian) Tyrolean Alps LTSER platform (Figure 2).

The Tyrolean Alps Long-Term Socio-Ecological platform and protected areas

Mountain habitats are particularly sensitive to global changes such as changes in land use and climate and recover only slowly if disturbed (e.g. EEA 2004). At the same time, they belong to regions that are most affected by global changes (Schroter 2005; Beniston 2006). Due to the complex structure and the extreme living conditions of mountain habitats, the Tyrolean Alps (TA) feature highly diverse ecosystems and landscapes, and provide various ecosystem services to people, such as water, fresh air, timber, carbon storage, protection from natural hazards, energy and recreation. However, the region also suffers from severe direct impacts of socio-economic activities, such as winter and summer tourism, hydropower generation, agriculture, changes in land use, transport, settlement etc., all of which challenge those ecosystems and their ability to provide services for human livelihood (see Figure 1).

Within the TA platform, a total of 9 LTER sites are embedded, some of which comprise several habitat types. The LTER sites include two lakes, grasslands at different altitudes (Figure 3), a treeline site, a gla-

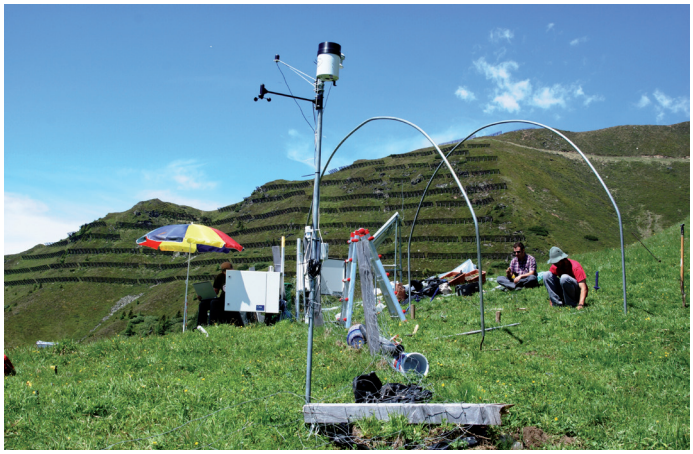

Figure 3 – Measurement area at the Stubaital site . © University of Innsbruck / Romed Ruggenthaler

Figure 4 – The Rofental site: Hintereisferner with Weißkugel. © University of Innsbruck

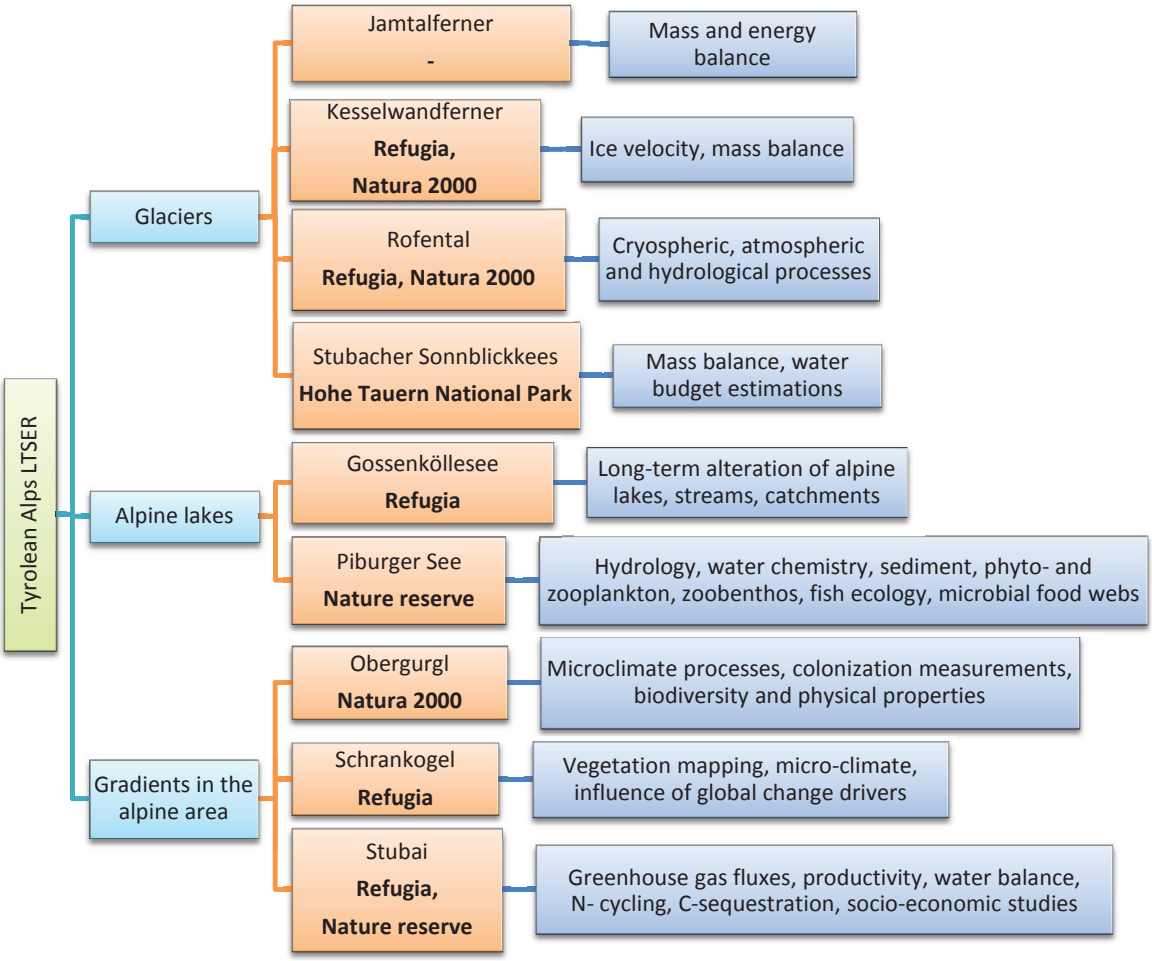

Figure 5 – Hierarchical structure of the Tyrolean Alps Long-Term Socio-Ecological (TA LTSER) research platform, including the protection status of the sites and their main research focus.

cier foreland, and several glaciers (Figure 4). Based on interacting environmental factors and habitat types, these 9 sites have been pooled into 3 clusters *Glaciers*, *Alpine lakes* and *Gradients in the alpine area* (Figure 5).

Besides offering diverse and sensitive ecosystems with extraordinary flora and fauna, the Tyrolean Alps also have a unique cultural heritage. Therefore, it is only reasonable that large parts of the area are under protection. The IUCN describes a protected area as: "*A clearly defined geographic space, recognized, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values*" (Dudley 2008). The history of PAs dates back to the creation of the first national park, the Yellowstone National Park in America, in 1872; other countries soon followed suit. The 1960s saw a broadening of concerns relating to resource planning and management. A systematic approach was needed and scientific activities became more and more integral to the management of PAs. This is also reflected in the IUCN (1994) classification system for PAs, for which biodiversity conservation forms the basis.

In 2002, at the World Summit on Sustainable Development, 190 countries agreed to "*achieving by 2010 a significant reduction of the current rate of biodiversity loss at the global, regional, and national level*" (UNEP 2002). As PAs often host great biodiversity, they are central to biodiversity conservation. Biodiversity is a prerequisite for ecosystems to provide the ecosystem services that humanity vitally depends on. Only if it is well understood how ecosystem services are generated, how they interact with each other and what influences them can management practices be adapted in a sustainable way. In order to achieve conservation objectives in PAs, a good monitoring system is essential (Braun 2005).

Within Tyrol, there are 8 different protection categories (Hohe Tauern National Park, individual elements within a Protected Landscape, Nature reserves, Conservation areas, Refugia, Natura 2000 areas, Special Protected areas, Ramsar-Protected areas), and most sites of the TA research platform are located within at least one protection area category.

An example would be the Ötz valley, which includes several sites and is a key research area within the TA. All the Ötz valley sites are situated within the Stubai Alps refugia and some belong to the Natura 2000 network, for which, according to a recent paper by Orlikowska et al. (2016) revealing key research gaps

within the Natura 2000 network, monitoring data of alpine habitats are missing.

One of the main research sites within the Ötz valley is the site Obergurgl (Figure 6), which has been in operation since 1952 and is managed by the Obergurgl Alpine Research Centre (http://www.uibk.ac.at/afo/), a branch office of the University of Innsbruck. Parameters observed are mainly grazing measures, atmospheric conditions, radiation, weather, wind, conductivity, and water measurements (e.g. Erschbamer 2007; Marcante et al. 2009).

Two lake sites are also located within the Ötz valley. One of them is Piburgersee, which has been protected since 1929 and is part of a Nature reserve. Research topics here cover the lake's hydrology, water chemistry, zoo- and phytoplankton, zoobenthos, fish ecology and microbial food webs. The other LTER lake site is Gossenköllesee (Figure 7), situated at 2 413 m. Until 2014, Gossenköllesee was the smallest UNESCO biosphere reserve in the world, but due to new and complex requirements to qualify for the status of a UNESCO biosphere reserve, it was removed from the list. Nevertheless, Gossenköllesee is a very important research site as this is a largely intact, natural environment characteristic of high alpine regions. The main research focus is the long-term alteration of alpine lakes, streams and catchments, and important parameters have been surveyed over three decades (e.g. Cuperova et al. 2013; Sommaruga 1999).

For the TA LTSER platform as a whole, databases exist on biodiversity, greenhouse gas fluxes, climate, glacial balances, hydrology, permafrost, demography, tourism, agro-economy and historical land-use changes. The data gathered from all LTER sites are fed into the DEIMS (Drupal Ecological Information Management System), a central platform for networks dealing with long-term ecological observations and experimentation. The DEIMS is especially valuable as freely available data from PA sites is scarce (Bertzky & Stoll-Kleemann 2009), while being at the same time a prerequisite for effective area management.

Figure 6 – The Obergurgl site. © University of Innsbruck / AFO

Figure 7 – The Gossenköllesee site. University of Innsbruck / Birgit Sattler

Conclusio

Having long-term ecological research sites within PAs is a win-win situation for both scientists and PA managers. Mountain PAs especially are ideally suited for global change research and will be increasingly important in illustrating biodiversity conservation (Becker et al. 2007). Researchers need to observe environmental parameters over a long period of time in an area where severe direct human impact is prohibited, as in the case of PAs, while at the same time external forces such as atmospheric change also interact with biota and ecosystems. Managers of PAs, meanwhile, are able to use scientific outcomes for legitimacy and appropriate management.

Communication between scientists and PA managers should therefore be further encouraged and strengthened (Müller 2010). LTSER platforms could act as interdisciplinary and multi-institutional entities, providing the means for knowledge exchange between the scientific community and PA managers (Arpin et al. 2016). Close collaboration between TA LTSER scientists and Tyrolean PA managers could therefore be a fruitful way to develop further appropriate and adaptive management strategies within Tyrolean Protected Areas applicable beyond their boundaries in a world that is changing ever faster.

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