Conference Volume	6th Symposium for Research in Protected Areas 2 to 3 November 2017, Salzburg	pages 379 - 381

Monitoring of abiotic natural processes in the Hohe Tauern National Park, Austria: A long-term approach

Gerhard Karl Lieb & Andreas Kellerer-Pirklbauer

Institut für Geographie und Raumforschung, Universität Graz

Abstract

In connection with a long-term ecological monitoring in the Hohe Tauern National Park a set of abiotic processes will be monitored. This paper presents these processes (weather, hydrology, glaciers, permafrost, morphodynamics), discusses the question of scale and gives information on the available data. Special emphasis is given to the variations of glaciers and permafrost.

Keywords

Long-term monitoring, weather, hydrology, glaciers, permafrost, morphodynamics

Introduction

In 2017 an interdisciplinary long-term ecological monitoring program in the Hohe Tauern National Park has been started (KÖRNER 2017). The focus of it is to monitor 'life at the limit under climate change'. Because environmental conditions largely depend on abiotic processes the decision was made to monitor those, too. The aim is to provide an annual report to stakeholders on the variations of abiotic processes.

A challenge in this context is the spatial scale. The ecological monitoring itself is carried out at 3 different scales:
1. catchment of rivers covering areas of some tens of km² (Fig. 1);
2. micro-catchments; and
3. permanent plots with only a few meters in diameter.

In contrast, the abiotic monitoring considers the scales of catchments and the entire national park. Therefore the problem arises how to transfer the data from point measurements to the catchment and the national park scale. The focus is to investigate the usability of already existing monitoring activities and to avoid new installations for financial and environmental protection reasons.

Overview of relevant abiotic processes

The most important abiotic processes influencing environmental conditions in high mountains ecosystem are (APCC 2014):
- Weather and climate: interannual (including extreme events) and long-term variations (climate change) are of interest.
- Hydrology: Critical for water supply depending on precipitation, evapotranspiration and runoff.
- Glaciers play a crucial role in high mountain environments, e.g. glacier retreat reveals new unstable ground.
- Permafrost widely exists at above 2500 m in the Hohe Tauern Range. It influences ecosystems indirectly, e.g. by creeping rock-ice-mixtures (rock glaciers).
- Morphodynamics: broad term comprising many processes which determine ecosystems. The most frequent ones are rock falls, debris flows, avalanches and erosion.

Monitoring activities on abiotic processes in the Hohe Tauern National Park

This chapter gives an overview of current monitoring activities on the processes listed in the overwiew chapter. Special emphasis is given to data availability and to glaciers and permafrost.

Weather and climate

As in almost all countries, monitoring of meteorological elements is carried out by a national institution. In Austria the Central Office of Meteorology and Geodynamics (ZAMG) operates a dense network of automatic weather stations. However, most of them are situated outside high mountain areas. In the Hohe Tauern National Park the Sonnblick Observatory (Fig. 1) located at a summit (3105 m) has to be mentioned because of its long data series (since 1886) and the representativeness for the nival belt of the Hohe Tauern Range. Other institutions run further weather stations.

Hydrology

In high mountains the only hydrological parameter which can be measured accurately is the river discharge. In Austria the Hydrological Services are responsible for a dense network of gauging stations and also run meteorological stations (temperature, precipitation). Some gauging stations are situated within the national park.

Glaciers

In contrast to weather and hydrology, monitoring of glacier and permafrost variations is not carried out by state institutions. Instead the Austrian Alpine Association (ÖAV) took over this task as early as 1891 establishing annual measurements of length variations of glaciers. The data are compiled to a report which is published in the ÖAV journal 'Bergauf' and in the internet. In the Hohe Tauern Range 36 glaciers were monitored in 2015 (Fig. 1). On a limited number of glaciers not only length but also surface elevation and flow velocity changes are measured.

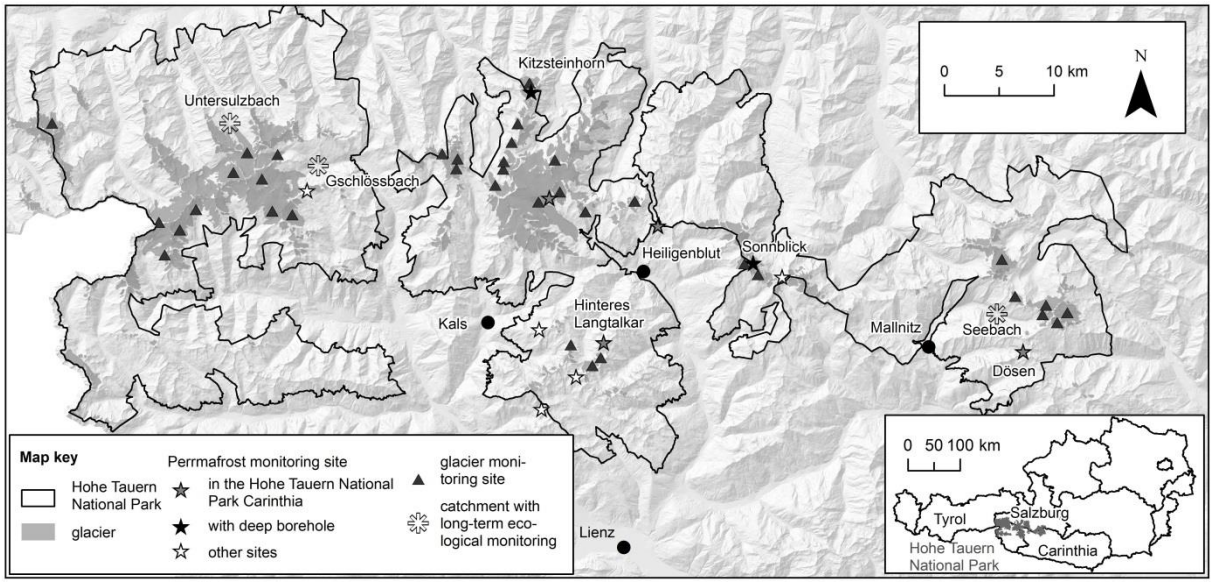

Figure 1: Overview of the Hohe Tauern National Park with locations of monitored glaciers and permafrost sites. The three catchments of the long-term ecological monitoring are indicated, inset map and major settlements for orientation. Glaciers based on FISCHER et al. (2015).

Unfortunately, mass balance measurements are not part of the ÖAV activities though are carried out at some glaciers by other institutions (WGMS 2017). However, there is sufficient information available to understand the annual glacier variations and their consequences – also with regard to the different meteorological and glaciological conditions which may occur at both sides of the Hohe Tauern central crest. This crest has a major effect on the transport of air masses as a crucial obstacle.

Permafrost

Compared to glaciers, the situation of monitoring is even worse because there is also no private organization like the ÖAV. However, since the 1990s measurement devices suitable for long-term monitoring have been installed within permafrost research. Because monitoring is commonly not part of research funding the researchers only in a few cases succeeded in maintaining their networks (KELLERER-PIRKLBAUER et al. 2015). E.g., the monitoring sites of the 'Graz permafrost monitoring network' (LIEB et al. 2016) in the Carinthian part of the Hohe Tauern National Park are supported by the National Park authority (co-financed by the ÖAV) since 2015.

Further permafrost monitoring is carried out at Sonnblick by the ZAMG (chapter weather and climate) and – slightly outside the national park – at Kitzsteinhorn (cooperation of institutions lead by AlpS, Innsbruck). The advantage of these two sites (Fig. 1) is the presence of boreholes which allow observing the long-term thermal behavior of permafrost better than surficial measurements do.

Considering the creep of permafrost, two rock glaciers in the Hohe Tauern National Park (Dösen, Hint. Langtalkar) are currently part of the Graz permafrost monitoring network (Fig. 1). Deformation rates of creeping permafrost indicate not only variations in air and ground temperature but also in seasonal snow cover.

Altogether the knowledge of permafrost variations cannot be considered sufficient until now because permafrost largely depends on substrates and topographies, the variety of which is not yet covered by the existing monitoring sites. This was an essential argument why a new monitoring site has been established in autumn 2017 in the western part of the National Park (Innerer Knorrkogel, Eastern Tyrol).

Geomorphodynamics

Until recently besides single studies morphodynamics only attracted attention when larger events caused damage. In such cases institutions like the Torrent and Avalanche Protection Service (WLV) document the events and investigate the reasons, but monitoring is started at single locations only where traffic lines or settlements are endangered. There are only few attempts of monitoring morphodynamics beyond endangered infrastructure, one of them within the Graz permafrost monitoring network (creeping permafrost and rock face denudation). An already elaborated concept for the recording of events (LIEB et al. 2016) has not yet been implemented.

Discussion

Based on existing monitoring networks there is sufficient information on the annual variations of weather, water runoff and glacier length changes available at a catchment and the entire National Park scale. Concerning permafrost, the recently established monitoring site will help to fill existing information gaps. For geomorphodynamics, however, only local scale information is available so far. Hence it is recommended to establish the already elaborated observation system soon.

In this paper only little emphasis has been given to methodological questions. This is due to the fact that the long-term monitoring discussed here had the focus on using synergies of the already existing monitoring networks. Improving methodology is of course desirable and should be kept in mind.

Conclusions and Outlook

No comprehensive report on the results of monitoring of the abiotic processes discussed above has been written yet – the first one will be published in 2018. It will comprise statements on the national park and catchment scale for weather, runoff, glacier and permafrost variations and their interactions. Areal information on geomorphodynamics should be added in the future. Hopefully this report will help the persons working on ecological monitoring to better understand their observations.

References

APCC (2014): Österreichischer Sachstandsbericht Klimawandel 2014 (AAR14). Austrian Panel on Climate Change (APCC). Verlag der Österr. Akademie d. Wissenschaften, Wien. Available at: http://hw.oeaw.ac.at/APCC_AAR2014.pdf (accessed: 7/9/2017).

FISCHER, A., SEISER, B., STOCKER WALDHUBER, M., MITTERER, C. & ABERMANN, J. 2015. Tracing glacier changes in Austria from the Little Ice Age to the present using a lidar-based high-resolution glacier inventory in Austria. The Cryosphere, 9, 753–766.

KELLERER-PIRKLBAUER, A., BARTSCH, A., GITSCHTHALER, C., REISENHOFER, S., WEYSS, G., RIEDL, C. & AVIAN, M. 2015. PermAT – Langzeitmonitoring von Permafrost und periglazialen Prozessen und ihre Bedeutung für die Prävention von Naturgefahren: Mögliche Strategien für Österreich. Endbericht von StartClim2014.F. In: StartClim2014: Beiträge zur Umsetzung der österreichischen Anpassungsstrategie, Auftraggeber: BMLFUW, BMWFW, ÖBF, Land Oberösterreich, 49 S.

KÖRNER, C. 2017. Life at the limit under climate change – long term ecological monitoring in the Hohe Tauern National Park. This volume.

LIEB, G. K., KELLERER-PIRKLBAUER, A., KAUFMANN V. & AVIAN, M. 2016. The Graz permafrost monitoring network in the Hohe Tauern National Park (Austria). In: Joannea Geol. Paläont. 12: 9-16.

WGMS (world glacier monitoring system) 2017. Latest glacier mass balance data. Available at: http://wgms.ch/latest-glacier-mass-balance-data/ (accessed 7/9/2017)

Contact

Gerhard Lieb, Andreas Kellerer-Pirklbauer
gerhard.lieb@uni-graz.at; andreas.kellerer@uni-graz.at
Universität Graz
Institut für Geographie und Raumforschung
Austria

MIT UNTERSTÜTZUNG VON BUND UND EUROPÄISCHER UNION

MINISTERIUM FÜR EIN LEBENSWERTES ÖSTERREICH

LE 14-20 Entwicklung für den Ländlichen Raum

Europäischer Landwirtschaftsfonds für die Entwicklung des ländlichen Raums: Hier investiert Europa in die ländlichen Gebiete