BONARESnewsletter

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Grassland provides valuable ecosystem services.
Photo: Ralf Kiese (KIT)

Editorial

Alpine and pre-Alpine grassland soils in times of climate and land use change

Lush green, sometimes even colorful meadows and pastures are the trademark of the Alps and pre-Alps. This cultural landscape is not only beautiful to look at and thus a tourist magnet, these meadows and pastures are extremely diverse and fulfill a whole range of functions with great importance for our ecosystems.

While the other BonaRes projects explore different aspects of arable land use on our soils in the rather flat agricultural landscapes, SUSALPS scientists are moving into the more mountainous regions up to the mountain pastures to develop strategies for sustainable, site-adapted grassland management under changing climatic and socio-economic conditions. They report on their research work and previous results in this BonaRes newsletter.

In developing such startegies it is not sufficient to understand the natural processes at the ineterface between soil and plant communities. In adition, we need to consider the socio-economic impact chains to predict what will happen if the climate or legal regulations change. This is necessary because the changes to be expected lie outside our experience horizon.

In close cooperation with the agricultural practice, SUSALPS faces the challenge of acquiring the necessary knowledge for predictive models. These should ultimately be able to tell us where and how grassland management will provide enough feed for livestock and ensure a good livelihood for farmers, while at the same time keeping nutrients in the desired cycles to counter climate change rather than continuing to fuel it.

I wish you an exciting read

Hans-Jörg Vogel

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Hans-Jörg Vogel coordinates the **BonaRes Centre for Soil Research**. He studied agricultural sciences at the University of Hohenheim. Since 2005 he is head of the **Departmentof Soil System Science** at the **Helmholtz Centre for Environmental Research** - **UFZ** in Halle-Leipzig. His work focuses on the modelling of soils as complex systems and the influence of agricultural land use on soil functions.

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Grassland in the alpine foreland. Photo: Anne Schucknecht (KIT)

In focus

Grassland - more than just grass and feed supplier

Grassland ecosystems cover about one third of the ice-free land surface. They are important habitats for plants and animals and, by storing carbon, they are relevant for climate protection. In order to maintain or even strengthen these important functions, it is necessary to develop land use strategies for grassland ecosystems that are adapted to the climate, but also meet the changing legal and economic conditions.

In Central Europe, the first things that come to mind when hearing the word grassland are probably (intensively) used agricultural meadows and pastures. However, there are very different forms of grassland worldwide, such as savannahs or steppes. They extend over different climate zones, from warm and humid to temperate, semi-dry or cool regions. Depending on climate, soil and land use, these ecosystems differ in their appearance and properties - for example, in terms of plant and animal communities, water and matter fluxes, and the storage and turnover of nutrients. The use of grassland varies due to these different natural conditions and ranges from extensive grazing to intensive feed production.

Grassland - important for food security and economy

Grassland ecosystems perform a variety of functions and ecosystem services, such as carbon and nitrogen storage (especially in soil), water purification, erosion control and recreation. In addition, grasslands provide food for animal livestock farming, for example in form of pasture or mowing meadows. They play an important role for food security and economy globally. Livestock farming contributes directly to the livelihood and food security of almost one billion people worldwide ranging from small farms that cover their own needs or sell on local markets to highly specialized, intensively managed farms.

Grassland protection is climate protection

The preservation of grassland systems is very important for global climate protection measures. Their importance as carbon sinks has long been underestimated. However, grassland soils store an estimate of 20 percent of global soil carbon stocks.

In the southern German Alpine and pre-Alpine region, grassland is widely spread. These grassland soils store between 135 and 163 tons of carbon per hectare. Thus, carbon storage in grassland soils is comparable to that in forest soils. Rising temperatures as well as changes in precipitation and seasonality affect biogeochemical processes in grassland ecosystems. This may affect, for example, the conversion and storage of carbon and nitrogen, the composition of plant species (such as loss or immigration of species), the quality of food, microorganisms in the soil, and evaporation and seepage.

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Impairment due to effects of land use change

In addition to climate change, adjustments of socio-economic conditions also influence the processes in grassland. In some regions, the pressure to use grassland is, for example, increasing. Possible consequences are that grassland ecosystems degrade, are converted into arable land or are completely lost through sealing. In unfavorable locations, apart from that, grassland areas are partly no longer cultivated, which can also lead to an impairment or loss of ecosystem services.

Climate change as a driving factor

In the Alps, the effects of climate change are stronger than the global average: observations and predictions for the 21st century show that the temperature increase in the Alps is approximately twice as high as the global average.

Further, the distribution of precipitation is expected to shift (more precipitation in winter and less precipitation in summer). Precipitation variability will increase, which means greater differences in precipitation between years and a more frequent occurrence of dry periods or heavy precipitation. The extent to which these changes will affect various functions of grassland ecosystems is not yet fully understood and needs further investigation.

How does climate change affect microbial activity and species composition in soil? How will use efficiency of manure nitrogen and the conversion processes of nitrogen in soil be affected? What does climate change imply for water and carbon storage and nutrient leaching? How will the diversity of plant species change? Answers to these and similar questions are investigated by scientists in BonaRes' collaborative project "Sustainable use of alpine and pre-Alpine grassland soils in a changing climate – SUSALPS".

The changing climate also poses new challenges to farmers. An earlier start and a longer duration of growing seasons, longer periods of drought or a change in the distribution of precipitation are just a few examples that require management adjustments.

Difficult implementation of fertilization ordinance in the Alpine region

Political and economic conditions also play a central role in agricultural practice. One example is the new and currently heavily discussed fertilization ordinance. The regulation aims to reduce nitrate pollution of water bodies and groundwater. Among other things, it limits the amount of liquid manure that is allowed to be spread on agricultural land. Furthermore, the fertilization ordinance defines the way in which liquid manure may be spread. In the Alpine and pre-Alpine region, the size of fields and farms are generally smaller and the land is more difficult to manage than in lowland regions due to the slopes. These conditions make it more difficult to implement the required manure spreading techniques.

The interaction between natural factors such as soil, altitude and microclimate and socio-economic factors like legal requirements and business management aspects is rather complex. On the one hand, the use of previously favored locations can be constrained - for example, if biomass production and feed quality decline due to periods of heat and drought. On the other hand, rising temperatures with sufficient water supply might stimulate biomass production and make new areas at higher altitudes economically more attractive.

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Our goal: site-specific strategies

In order to manage the cultural landscape of the alpine and pre-Alpine grasslands in an ecologically and economically sustainable way, strategies adapting to the site conditions are required.Economic aspects such as farm size or competitiveness have to be taken into account, as well as natural conditions and expected climate changes. This is the only way to preserve valuable soil functions and ecosystem services and, at the same time, to meet the increasing need to adopt new management strategies in agriculture.

Anne Schucknecht and Katrin Schneider (KIT)

Anne Schucknecht studied geoecology and has worked on global change topics and the sustainable use of natural resources since her doctorate. She has specialised in methods of vegetation remote sensing and applies them primarily to agricultural issues. Since 2017 she has worked in the **BonaRes** joint project **SUSALPS** at the **Campus Alpin** of the **Karlsruhe Institute of Technology**, **Institute of Meteorology and Climate Research (IMK-IFU)**. Here she develops models for the estimation of grassland parameters from drone and satellite images and supports the project management.

Katrin Schneider has been working on the topics of land use, climate change and ecohydrology since her studies of physical geography at the Ludwig-Maximilians-University Munich. She is particularly interested in the possible effects of land use and climate change on the water balance, water quality and the water-bound export of carbon and nitrogen. Since 2017, she has worked at the **Karlsruhe Institute of Technology**, **Institute of Meteorology and Climate Research (IMK-IFU) Campus Alpin**, contributing her research interests to the **SUSALPS** project and supporting the project management.

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Ralf Kiese (left, photo: Amadeus Bramsiepe/KIT) and Michael Dannenmann (right, photo: private).

Talk

Subalpine and alpine grassland - a special research topic

Ralf Kiese and Michael Dannenmann are both scientists in the BonaRes joint project SUSALPS. In this double interview, they explain what fascinates them about grassland research and what makes alpine and subalpine grassland so special. They also report on the important exchange with farmers when developing sustainable management strategies.

Mr. Kiese and Mr. Dannenmann, both of you study biogeochemical processes in different ecosystems and agricultural landscapes. What do you find particularly fascinating about grassland?

RK: There is no such thing as THE grassland. Grassland is extremely diverse and ranges from alpine meadows or pastures to intensively-used and cut meadows – all of which are adjacent in the landscape context. These grassland types fulfill different soil functions and ecosystem services up to various degrees – hence, not all of these functions can be reached at the same time within the same area. For example, intensively used areas generally produce a higher yield, but have a significantly lower biodiversity.

MD: Agronomic needs such as productivity as well as the production of feed, meat and milk often conflict with high biodiversity, carbon storage and groundwater protection – so is plant diversity , for example, reduced by very intensive farming. However, with adapted management that takes site characteristics into account, a remarkable balance between these different requirements can be achieved, especially for grassland.

The SUSALPS project focuses on grassland in the Alps and Alpine foothills. What are the special features of grassland in these areas?

MD: Grassland is, together with forest, the predominant land use in the Alpine foothills and has shaped the landscape of the Alps and pre-Alpine region for thousands of years. This ancient cultural landscape still characterizes the regional identity today. It often guarantees a high level of biodiversity and is also a magnet for tourists. The already mentioned soil functions and ecosystem services strongly depend on the climate and management. Both have changed considerably in recent years, making the pre-Alpine region a hotspot for climatic, social and economic changes.

Which research results of the SUSALPS project surprised you and which are of particular significance for agricultural practice?

RK: The grassland yields of our study area are increasing independent from the intensity of cultivation. The reason for this is a temperature rise caused by climate change. Longer periods of drought are, of course,

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excluded from this development. In dry years, we can see that less frequently cut grasslands with higher biodiversity can produce the same, if not higher yields than intensively used grasslands.

MD: But our results also show that plant nutrition is massively supported by the mineralization of soil organic matter. This means that an increase of yields related to climate change can only be explained by the depletion of carbon and nitrogen stocks in grassland soils.

RK: Especially with regard to climate change, this means that we need adapted fertilization and adjusted management measures to promote humus formation and ensure that grassland soils can store large amounts of water and nutrients in the future.

With your project you intend to contribute to a development of sustainable solutions for grassland management which is also in the interest of farmers. How is the exchange with various interest groups currently going?

MD: The exchange with farmers is of fundamental interest to us. Without this exchange, and also without considering the socio-economic situation of farmers, an acceptance of new, sustainable management solutions is unlikely. The exchange ranges from joint field trials to the joint re-grazing of an abandoned mountain pasture. It became clear to us as scientists that we can benefit enormously from the practical knowledge and experience of farmers.

RK: The SUSALPS approach integrates results of field research into different models. With these models we can also simulate how a change in cultivation affects yield and various flows of substance like greenhouse gas emissions or nitrate leaching. We are currently developing an app from these models to support farmers in their management decisions. To give an example of the app: farmers can get yield estimates for their farmland based on the weather forecast, plus adjusted fertilization dates and quantities. With farmers, consultants and representatives of the authorities, it was discussed which functions such an application should offer in order to be relevant for users. Unfortunately, a first major test run with farmers from Upper Bavaria had to be postponed due to the Corona situation.

In which areas do you still see research gaps?

MD: Our understanding of how plants, animals and microorganisms interact during long periods of drought or extreme climate events needs to be improved. It is necessary to be able to estimate carbon and nitrogen fluxes in a changing climate. With such knowledge, management can, then again, be optimized and thus reduce greenhouse nitrogen emissions.

RK: Reliable input data, e.g. on soil properties, vegetation and management, are a prerequisite for well-functioning simulation models and decision support systems. However, these data are often not comprehensively available. We see great potential for the application of remote sensing data – i.e. planar information from satellites and drones and their integration into the models. This will help to find the most sustainable management method for different sites and regions.

The interview was conducted by Anne Schucknecht und Katrin Schneider (KIT).

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Ralf Kiese has coordinated the joint **BonaRes** project **SUSALPS** at **Karlsruhe Institute of Technology**, **Institute of Meteorology and Climate Research (IMK-IFU) Campus Alpin** in Garmisch-Partenkirchen since 2015. He studied hydrology at the University of Freiburg. Since 2011 he has been head of the working group Ecosystemic Material Flows at KIT, IMK-IFU. He is also coordinator of the **TERENO Observatory pre-Alps**. His research focuses on measurement and modelling of biogeochemical nutrient turnover and associated fluxes of nitrogen, carbon and water in natural and managed ecosystems on site specific and landscape level.

Michael Dannenmann has coordinated field experiments within the joint **BonaRes** project **SUSALPS** at **Karlsruhe Institute of Technology**, **Institute of Meteorology and Climate Research (IMK-IFU) Campus Alpin** in Garmisch-Partenkirchen since 2015. Since 2017, he has been head of the working group Stable Isotope Biogeochemistry and the Center for Stable Isotope Analysis at KIT, IMK-IFU. His research focuses on the effects of global change on soil functions of semi-natural, agricultural and forest ecosystems in Europe, Africa and Asia. After his studies in geosciences at the University of Regensburg, he received his doctorate and habilitation in soil biogeochemistry at the University of Freiburg, where he also teaches in the field carbon and nitrogen cycles in ecosystems.

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Sophie Reinermann at field work. Photo: A. Schucknecht (KIT)

Portrait

Sophie Reinermann - Grassland research from space

Since 2019, Sophie is investigating the management and yields of grassland areas in the BonaRes joint project SUSALPS. For her research she analyses satellite image data that regularly map our earth from space. In this portrait she introduces herself and her work and reports on why she became a scientist and what motivates her in her work.

I am a PhD student at the University of Würzburg, which cooperates closely with the German Aerospace Center (DLR). Therefore, I have the opportunity to do my research at the German Remote Sensing Data Center of DLR, in the Land Surface Dynamics Department in Oberpfaffenhofen near Munich.

Field studies are essential

For my PhD thesis I am investigating the usage intensity and yield patterns of grassland areas in Germany, especially in southern Bavaria. For this purpose I use satellite image data, for example to identify the number of grassland cuttings or to estimate the biomass production of the grassland. In addition to the satellite image data, field measurements for validation are necessary. The measured values of the grassland biomass are then linked to the satellite data by a statistical model to obtain area-wide information about the grassland biomass. An advantage of my PhD is that I can be active in field campaigns as well as on the computer.

Satellite image analysis - an exciting and diverse field of work

During my master studies in "Global Change Ecology" at the University of Bayreuth I worked with satellite images for the first time and immediately found the methods and possibilities involved fascinating. Earth observation satellites have been providing regular images of the earth's surface since the 1970s. The technology behind this has improved enormously over the past decades. Today, these image data can be used, for example, to obtain detailed information on the condition, vitality or structure of vegetation. Furthermore, the fields of application are much more diversified, which means that in my area of research you always learn something new.

Another thing that fascinates me about working with satellite images is that you are not spatially bound to specific study areas, but can conduct worldwide and large-scale investigations. In addition, time series of satellite data can be used to observe developments and trends over many years, which makes research of

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high social importance possible, especially against the background of global change. For example, satellite data can be used to investigate how an increase in temperature or extreme events affect yields.

I am interested in the role of agriculture in global change

Already during my studies, I increasingly focused on the topic of agriculture, because it plays an important role in global change. The impact of agriculture on ecosystem functions is enormous and anthropogenic activities are the biggest influencing factor. Grassland covers about one third of the agricultural land in Germany and is of great importance, for example for the nitrogen balance, biodiversity and as a carbon sink.

With a holistic approach to sustainable grassland use

However, grassland is in part underrepresented in science and has only received more attention in recent years. The SUSALPS project is investigating many different aspects of grassland ecosystems, such as material flows and diversity, and the effects of different farming practices and climate change. Area-wide information on management and grassland characteristics, such as intensity of use and biomass, are extracted from satellite data and then linked to the results of other partners in the project. Especially the holistic view of ecosystems and the focus on grassland areas make this project very exciting for me. I feel very comfortable in the project as well as among the scientists at DLR and I am looking forward to working on interesting, socially relevant topics in my research.

Sophie Reinermann (University of Würzburg/DLR)

Sophie Reinermann is a PhD student at the **Remote Sensing Department** of the **University of Würzburg** and works as a scientist at the **German Aerospace Center (DLR)**. She has been a member of the **SUSALPS** team since 2019.

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Andrea Kaim. Photo: private

Portrait

Supporting environmental protection with mathematics

Andrea Kaim is a business mathematician and studies how climate change and political measures, but also the personal esteem of farmers, affect the use of grassland in the (pre-)alpine region of Bavaria in the BonaRes joint project SUSALPS. In this portrait she gives an insight into her work, explains how she became a scientist and what inspires her about her work.

My goal is to model management decisions of farmers and their effects on the environment and to derive decision-making support tools for sustainable grassland farming.

Sustainable grassland management in times of climate change

Bavaria has a particularly high proportion of grassland and grassland is thus an important part of the cultural landscape. Grassland areas such as meadows and pastures provide important ecosystem services, in other words, services that nature and landscape provide to mankind. In grassland, for example, these include the production of fodder, protection against soil erosion and flooding, carbon storage, but also local recreation. Furthermore, grassland provides a habitat for many animal and plant species. Sustainable management of these areas is therefore essential in order to preserve these numerous services.

This is particularly true in view of climate change. On the one hand, intensive grassland use or the conversion of grassland into arable land is releasing an increasing amount of greenhouse gases, while on the other hand rising temperatures are leading to a shift in vegetation zones. The latter in turn leads to a threat to regional animal and plant species. Furthermore, extreme weather events such as droughts and heavy rainfall, which are becoming more frequent as a result of climate change, are causing major losses in agricultural production.

Farmers are affected in many ways in their management decisions

My main task in the project is to model farmers' management decisions and how they are influenced by local conditions such as soil quality or slope inclination, economic and political factors such as livestock numbers, fertilisation regulations or protected areas, and personal attitudes towards participation in agri-environmental measures or the appreciation of various ecosystem services.

The focus is mainly on grassland fertilisation and its effects on biomass production, greenhouse gas emissions or nitrate pollution, which in turn serve as indicators for provided ecosystem services. For example, high livestock numbers on a conventional farm in lowland areas indicate a rather intensive use of

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grassland with frequent mowing and fertiliser application. While this offers economic benefits to the farmer, it can lead to higher greenhouse gas and nitrate emissions and reduce biodiversity.

Finding practical solutions

In the context of climate change, the areas in the lowlands could become less productive, so that previously extensively used grassland with less frequent mowing and less or no fertilisation could possibly require more intensive cultivation or even abandonment of cultivation - both with negative consequences for nature and landscape. The aim of the project is therefore to develop practical solutions for grassland management under climate change. To this end, my colleagues and I are engaged in a lively exchange with farmers and experts, for example in the form of surveys and personal discussions.

Solving practical problems with mathematics

Even as a child I loved to be out in nature and learned how important it is for people. After school I studied business mathematics in Leipzig and specialized in the fields of environmental economics and mathematical optimization. I particularly liked the idea that a tutor once expressed: to see mathematics as a "toolbox for solving practical problems". I was especially interested in the practical problems of environmental research, because when it comes to the sustainable use of natural resources and ecosystem services, practical approaches are needed.

From Leipzig to Australia and back

During my studies I attended conferences and programs dealing with mathematics in biodiversity and environmental research. For example, I got to know a professor at the University of Queensland in Australia who, among other things, dealt with the problem, which areas of a country or region should be protected in order to conserve a minimum number of certain species - at the lowest possible cost. During my stay abroad in Australia he gave me the opportunity to write my diploma thesis on this topic at his department.

At a modelling conference in Australia I met my future PhD supervisor from the Helmholtz Centre for Environmental Research (UFZ) in Leipzig. Back in Leipzig I got a PhD position where I worked on the optimization of land use in agricultural areas with respect to biodiversity and ecosystem services.

Sustainable agriculture through practice-oriented research

Even now, after the end of the project, I still enjoy working on this topic and have nearly completed my dissertation on it. By now I work in Bayreuth in the SUSALPS project. The combination of biophysical and socio-economic modelling, but also the strong relation to agriculture and the cooperation with farmers is very exciting for me. Above all, I appreciate the practical relevance of our research, the results of which will contribute to sustainable agriculture.

Andrea Kaim (University of Bayreuth)

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Andrea Kaim works as a research assistant at the **Professorship for Ecological Services** at the **University of Bayreuth** and has been part of the **SUSALPS** team since 2019.

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Murnau-Werdenfelser are robust, lightweight, sure-footed and undemanding. Photo: Anne Schucknecht (KIT)

News from the field

Murnau-Werdenfelser cattle - the somewhat different employees in the SUSALPS project

For centuries, Murnau-Werdenfelser cattle was valued as a robust "three-fold cattle" for high-quality meat, unique milk and high work performance. How could it happen that these frugal cattle, which hardly need a veterinarian in their long lives, became an endangered species that has only recently become fashionable again - among others in the SUSALPS project?

The fate of the Murnau-Werdenfelser cattle was and is closely linked to that of the mountain pastures. Mountain pastures, i.e. seasonal pastures with a high biodiversity, have shaped the Alps for thousands of years. Since the middle of the 20th century, however, the management of many steep and remote mountain pastures has been abandoned.

Land use change harms biodiversity

In the course of intensified agriculture in the valley areas, the skills of the Murnau-Werdenfels cattle were no longer required and replaced by specialized high-performance cattle breeds. The abandonment of mountain pastures is the biggest land-use change in the Alpine region since the Second World War. The abandoned mountain pastures are gradually becoming overgrown with bushes and the subsequent reforestation is being enhanced by climate change. As a consequence, biodiversity is decreasing and valuable regional cultural landscape is being lost.

Re-grazing experiment on the Brunnenkopfalm

Against this background, a long-term re-grazing experiment was started in 2018 in the BonaRes project SUSALPS. On the Brunnenkopfalm, which was abandoned in 1954 and whose steep terrain is too demanding for heavy, high-performance cattle, Murnau-Werdenfelser are now being used again. We are investigating the effects of re-grazing on the soil and its functions. The most important soil functions include erosion control, carbon and nitrogen storage or water filtering, productivity and feed quality, as well as the diversity of plants, microorganisms, insects and birds. Our goal is to derive recommendations for the re-grazing of mountain pastures. First results show that re-grazing does not lead to short-term deterioration of soil functions, biodiversity and water quality if trampled areas are limited to a few percent of the grazed area by extensive grazing with locally adapted cattle breeds.

Citizens welcome the project

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We also investigate the social significance of ecosystem services provided by the Brunnenkopfalm through surveys with hikers on site. A large majority of the visitors prefer to re-graze mountain pastures and therefore prefer a structurally rich landscape with forest and open land. The survey also showed the willingness of the citizens to support the mountain pasture management financially with state subsidies or the purchase of high-quality animal products. The results of the first years of research on the Brunnenkopfalm thus show that re-grazing is a practicable way to preserve abandoned mountain pastures with their outstanding function for biodiversity and tourism. In this way, valuable traditional cattle breeds such as the Murnau-Werdenfelser could be used and spread again.

The re-grazing project has met great public interest - the **Garmisch-Partenkirchener Tagblatt/ Münchner Merkur** (in German), Spiegel and **Bayerischer Rundfunk** (in German), among others, have reported on it.

Michael Dannenmann and Anne Schucknecht (KIT)

Besides the SUSALPS team, the re-grazing experiment is supported by the following partners: **Bavarian State Office for the Environment** (**Ornithological Institute** & **Bavarian Center for the Protection of Species**), **State Association for the Protection of Birds**, **Bavarian Botanical Society**, **Weihenstephan-Triesdorf University of Applied Sciences**, **Bavarian State Collection of Zoology**, **State Office for Agriculture** (Institute for Animal Nutrition and Forage Management), Lower Nature Conservation Authority, **Bavarian State Forests** and local farmers.

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Pupils investigating the Brunnenkopfalm. Bild: Anke Jentsch (Universität Bayreuth)

Science and Education

The value of diversity: Sustainable land use of mountain meadows in climate change

In June 2019, Bayreuth schoolchildren took part in the SUSALPS project days with mountain hiking and explored the effects of re-grazing an abandoned alpine pasture in the Bavarian Alps.

Within the framework of school project days on the topic of "Climate Change and Biodiversity", 24 sixth-graders took part in the BONARES joint project "Sustainable Use of Grassland Soils in the Alps and the Alpine Foreland in Climate Change" (SUSALPS) in June 2019. The young people learned about scientific experiments carried out by ecologists on the Brunnenkopfalm to investigate the effects of re-grazing on the biodiversity and forage quality of the mountain meadows. It was particularly exciting to experience the experimental research activities carried out by the ecologists at the Brunnenkopfalm for themselves and to put into practice the theoretical knowledge about climate and land use change in the mountains, which had been acquired in the classroom beforehand, and to experience biodiversity with eyes and ears by walking through rain showers, counting flowers, visiting abysses, meeting cattle and climbing over rocks.

Enthusiastic young experts

The children formed enthusiastic teams of experts on various alpine-ecological topics such as "Adaptation of plants in the mountains", "Dwarf growth and crowning due to snow pressure", "Alpine pastures yesterday and today", "Root architecture and slope stability", "Cattle breeds for nature conservation" or "Hill topping of insects (mountain flight during mating season) " and were able to give short reports on-site on the mountain and present their topic in more detail to their classmates.

Pupils' plant guide remains on the mountain for visitors

In addition, a small "Field guide to the plants of the Brunnenkopfalm in the Ammergebirge nature reserve" was produced, which was used intensively by the pupils to identify different flowering plants in the terrain and to exchange information about their characteristics and properties. The handy plant guide remained on the alpine pasture and will in future delight many hikers and open their eyes to the unique diversity of this "biodiversity hotspot", which is the testimony of an old, extensively used, Alpine cultural landscape.

Back in the classroom, wonderful plant-art works were created on the basis of photos and drawings, which testified to the intensive experiences for a long time and could be seen in the classroom.

Impressed by the mountains, nature and the work of scientists

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The children were impressed not only by the enormously steep meadow slopes of the Brunnenkopfalm, the last remnants of snow on the brook and the rocky summit ridge with its wide panoramic view, but also by the rustic get-together at the old mountain cabin, the commitment of the cabin host and the so exciting life of the scientists. "What do I have to learn at school to become something like that" and "When do we go to the mountains next time?" were the questions of the children, who all wanted to go out again even on misty afternoons. The scientists were also pleased about the lively interest of the young people. They want to inspire enthusiasm for their research and perhaps recruit potential young scientists even among the youngest ones.

The aim of the scientists: to arouse interest and encourage young researchers

The three-day hiking excursion in Ammergebirge was organised and led by Anke Jentsch from Bayreuth University. She would like to promote the idea of enabling such active and intensive contact between scientists and young people at specific research sites in the field, to convey this personally and to make scientific content accessible to a highly receptive and enthusiastic section of the population. The next step will be a glacier hike with slightly older schoolchildren, in order to communicate further SUSALPS research topics on climate change.

Anke Jentsch (University of Bayreuth)

Prof. Dr. Anke Jentsch holds the professorship for **Disturbance Ecology and Vegetation Dynamics** at the **University of Bayreuth**. She conducts research on pulse dynamics and biodiversity, natural risks and climate change. Her scientific interest focuses on understanding the dynamics of ecosystems and the resilience of biotic communities. Her work includes extensive field experiments and field studies in Central Europe on the effects of weather extremes on biodiversity and ecosystem functions. The focus is on functional resilience and ecosystem services as well as on dynamics in protected areas.

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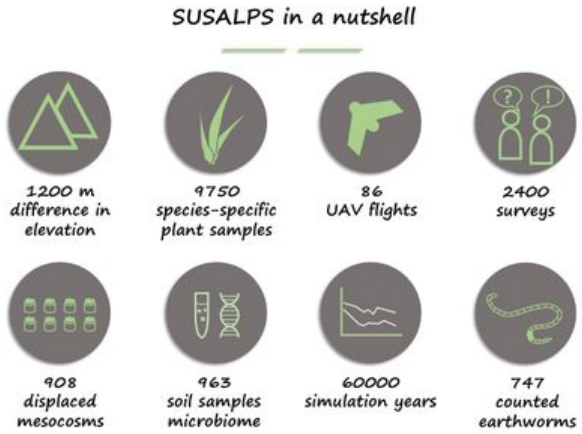

SUSALPS in a nutshell - some facts and figures about the previous work in the project. Image: K. Schneider, A. Schucknecht (KIT)

Infographic

SUSALPS in a nutshell

The SUSALPS team has collected a large amount of data in recent years. The infographic shows the scope and scale of these investigations. Some of the examined parameters are very measurement-intensive like the plant and soil samples. Other figures, such as the number of drone flights, appear low at first sight. However, behind these figures complex measurement campaigns to verify the data and large amounts of data that have to be post-processed are hidden.

For information on previous results of the SUSALPS research please visit the **project website**.

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