BOOK OF ABSTRACTS

Geoecological problems: Changing climate in the Krkonoše/Karkonosze Mountain

Špindlerův Mlýn, 21–23 September 2026

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Interreg

Co-funded by the European Union

Czechia – Poland

“Strategická a koordinovaná správa KRNAP – KPN”
(CZ.11. 04.01/00/24_017/0000184)

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Kick off Meeting of the Project
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The abstracts were published as submitted,
without additional language editing or proofreading.

Issued by the Krkonoše Mountains National Park Administration in 2026.

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The Aim

The aim is to present current research results on the natural environment of the Krkonoše Mountains for application within the strategic planning of the administrations of the Krkonoše Mountains National Park and the Karkonosze National Park. The central theme is the ongoing climate change as a major challenge for nature conservation in both national parks.

Topics

- Climate change impacts on mountain ecosystems of the Krkonoše/Karkonosze Mountains – long-term monitoring of climate, vegetation, hydrology, geomorphological processes, and ecosystem responses to ongoing environmental change.
- Research, monitoring and innovative technologies for biodiversity conservation – application of UAVs, satellite remote sensing, LiDAR, machine learning, AI, long-term ecological monitoring, and advanced modelling for species and habitat conservation.
- Conservation, restoration and adaptive management of mountain habitats – practical approaches to the restoration and management of mountain grasslands, peatlands, forests, tundra, wetlands and invasive species.
- Biodiversity dynamics and ecological processes in mountain environments – recent research on flora, fauna, fungi, soils, ecosystem functioning, historical changes, and the effects of climate change on species and communities.
- Sustainable management of protected areas under environmental and societal pressures – visitor monitoring, tourism impacts, environmental quality assessment, historical landscape change, and the integration of scientific knowledge into protected area management and decision-making.

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Invited talks

Long-Term Environmental Monitoring in the Krkonoše Mountains:
Climate Change, Permanent Grasslands, and Treeline Dynamics

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Vegetation Responses to Climate Change and Innovative Monitoring

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Organizing Committee

- **Radek Drahný**
- **Přemysl Janata**
- **Irena Kholová**
- **David Krause**
- **Jan Pačák**
- **Lidia Przewoznik**
- **Lucie Šimurdová**
- **Josef Taláb**

ABSTRACTS

Oral presentations

Invited talks

14:00–14:30 *Krzysztof Migała**

Some Notes on Present Climate Change in the Karkonosze Mountains

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The results of meteorological measurements carried out continuously on Mount Śnieżka in the Karkonosze Mountains since 1880 well document the warming observed on a global scale. The lowest annual mean temperature of −1.2 °C was noted in 1941; the highest value of +2.9 °C was recorded in 2014.

Data analysis indicates warming expressed by an increase in the mean annual air temperature of 0.8 °C/100 years. A much higher temperature increase was recorded in the last two decades of the twenty-first century with mean air temperatures exceeding +1.5 °C and 2.2 °C.

The mean annual air temperature at Mount Śnieżka in the entire130-year period is +0.5 °C. Taking into account the 50-year period (1971–2020), the average annual air temperature on Śnieżka was +1.3 °C. Over the past fifty years, there were an average of 167 frost-free days per year (days with $T_{min} > 0$ °C), 125 ice days (days with $T_{max} \leq 0$ °C) and 73 days with a freeze-thaw cycle (days with $T_{min} \leq 0$ °C and $T_{max} > 0$ °C).

According to the 1991–2020 climate normal and the Köppen-Geiger climate classification, Mount Śnieżka represents conditions on the border of two climate zones, i.e., the subarctic snow climate *Dfc* and the polar climate *ET* (annual temperature +1.7 °C and July temperature +10.1 °C).

The progressing warming leads to shorter winters with a decreasing tendency of −16 days / 100 years, earlier spring thaw and longer periods with above-zero temperatures (Migała et al. 2016, 2026). The increase in temperature, decrease in spring precipitation and a greater share of anticyclonic circulation at this time of year are particularly unfavorable for vegetation (Ojrzyńska et al. 2026).

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14:30–15:00 *František Krahulec*, Hana Skálová, Tomáš Herben, Věroslava Hadincová & Sylvie Pecháčková*

What We Learned from Forty Years of Monitoring Permanent Grassland Areas

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In 1985, we established a series of permanent plots in mountain grasslands to study fine-scale processes and species interactions. We counted morphological modules, the number of flowering individuals and biomass for individual species. Their yearly census has been repeated until the present day.

1. The dynamics of individual species are high even on a fine scale. The responsible factor seems to be their type of clonal growth.

2. Long-term dynamics of some species seems uncorrelated even between individual plots.

3. For legumes (especially *Trifolium*) we have found cycles of about nine years. These cycles would not be uncovered without a long-term study.

4. We observed decline of acidophilous species such as *Nardus* and *Avenella*, which probably a decrease in acid immissions and the buffering of soil reaction (the bedrock and soil skeleton is formed by erlan, a lime-silicate rock).

5. There are some other trends, which seem to be related to climate change: an increase in the proportion of species with higher demands for Ellenberg's values for temperature and lower demands for soil moisture; however, these trends have been decreasing during the last years. We speculate that the changes in the trends could be caused by the absence of snow cover protecting against frost during the spring months.

It is evident that several different processes are taking place at the same time. It is difficult to separate them using a single set of observations; better coverage over the whole region, potentially combined with manipulative experiments, would be necessary to identify the role of their individual drivers.

15:00–15:30 *Václav Treml**

Recent Dynamics of Treeline Ecotone Stands of *Picea abies* in the Krkonoše Mountains

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Many of the nature protection and landscape values of the Krkonoše Mountains are bound to forest-free summits. Forest-free patches surrounding the highest summits and glacial cirques have persisted since the Late Glacial period, providing space for alpine and arctic species. The extent of alpine patches fluctuated during the Holocene and has been substantially enlarged by mountain farming starting from medieval ages. In the 20th and 21st centuries, the extent of the forest-free area shrank again in response to land abandonment and warming. Focusing on the last four decades, the development of the treeline ecotone can be divided into two phases. In the first phase, from the 1990s until the early 2010s, we recorded an unambiguously advancing treeline with accelerating growth rates (relaxation from acid deposition, warming, nitrogen fertilization) and gradual stand densification. This process was slower at wind-exposed ridges. At the end of this phase in the 2010s, we could delineate only very limited areas without formally defined trees (height > 2 m). Even these topmost trees were found substantially below the treeline isotherm. In the second phase since the 2010s, we have observed a stabilization of the growth trend and a gradual shift in growth phenology. Stem growth of treeline *Picea abies* tends to start earlier, the period with the highest growth rates shrinks, and the main growth period ceases earlier due to drought stress. We still document the densification of the upper part of the treeline ecotone, but variable stand density trends are observed in the lower part, with some plots exhibiting thinning due to various disturbances. The main environmental factors that should be considered to explain the trends mentioned above are temperature increase, carbon and nitrogen fertilization, and gradual wind stilling. The recent observations suggest that the dynamics of the treeline ecotone will probably be more complex than expected.

15:30–16:00 *Bronisław Wojtuń**

How Does Climate Change Affect Vegetation in the Karkonosze?

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In 2002, Walther et al. published a paper in the prestigious scientific journal *Nature*, titled "Ecological responses to recent climate change". This paper demonstrated that the impact of climate change on organisms and ecosystems is already evident. The authors grouped biological responses into four main categories: (1) phenology and physiology, (2) species ranges and distributions, (3) community composition and species interactions, and (4) ecosystem structure and dynamics. There is now evidence that climate change has affected a wide range of organisms with diverse geographical distributions.

Climate change profoundly affects high mountain vegetation by altering temperature and precipitation regimes and accelerating snowmelt. High-mountain ecosystems are warming faster than lower elevations. The following are the most significant climate-driven changes in high-mountain vegetation: 1) thermophilization of plant communities, 2) shrub encroachment (shrubification), 3) upslope shift of the treeline, 4) summer soil droughts, 5) phenological shifts, and 6) biodiversity loss.

The majority of these processes have been documented in the Karkonosze. Community thermophilization is the process in which vegetation becomes dominated by heat-tolerant species as cold-adapted species decline. In the alpine summit vegetation of the Karkonosze, this process is realised due to the decline of cold-adapted species rather than the influx of new heat-adapted ones. Shrub encroachment is a global phenomenon in which woody shrubs expand into alpine grasslands; this is the most pronounced climate-driven change in the Karkonosze. The subalpine forest limit – particularly stands of Norway spruce (*Picea abies*) and dwarf pine (*Pinus mugo*) – is moving upslope as temperatures rise. Summer soil drying, driven by warming and earlier snowmelt, limits the growth and persistence of alpine vegetation.

Session I

Tuesday, 22 September 2026

Vegetation Responses to Global Change and Innovative Monitoring

8:15–8:30 *Lucie Kupková*, Markéta Potůčková, Lucie Červená, Jakub Lysák, Záboj Hrázský, Alex Šrollerů, Mojmír Polák, Michaela Vítková, Jan Čuda, Jiří Sádlo, Marie Černá, Eliška Hlaváčová, Lukáš Kysela, Vojtěch Vítek & Petr Pyšek*

UAV and Deep Learning for Plant Invasions Monitoring

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Invasive and expansive plant species threaten valuable mountain habitats by reducing native biodiversity and complicating conservation management. Effective control requires precise and repeatedly updated information on species distribution and management success.

This contribution presents a project focused on monitoring invasive and expansive plants in the Krkonoše and Orlické Mountains using botanical field mapping, high-resolution UAV data and deep-learning detection. Target species include *Rumex alpinus*, *Lupinus polyphyllus*, *Telekia speciosa*, *Veratrum album*, and *Senecio nemorensis* agg. Field campaigns combined repeated botanical mapping, phytosociological relevés and the recording of target species and control vegetation on permanent plots before, during and after management.

RGB UAV imagery was acquired several times during the growing season to capture phenological stages and test species detectability. Training and validation datasets were prepared from botanical GPS mapping, field observations and image interpretation. Detection workflows were developed for individual plants and vegetation patches, with an emphasis on training data quality, field validation and practical use.

Deep-learning models were tested on high-resolution UAV RGB orthomosaics. For *Veratrum album*, detection from 1 cm RGB imagery using U-Net with a ResNet-34 backbone achieved an F1-score of 0.90 and 89% detection success when validated against botanical field data. Further analyses focused on improving detection accuracy and evaluating reliability using accuracy metrics.

The results show that UAV imagery combined with deep learning and robust botanical validation can support detailed mapping of plant invasions. The outputs provide practical information for planning, targeting and evaluating management measures such as grazing, mowing, mulching, herbicide application and manual removal, and support the development of operational monitoring technology for nature conservation.

8:30–8:45 *Michaela Vítková*, Jan Čuda, Jiří Sádlo, Martin Hejda, Pavel Pipek, Klára Pyšková, Eliška Hlaváčová, Vojtěch Vítek, Lukáš Kysela, Marie Černá, Zdeňka Konopová, Magdalena Lučanová, Lucie Kupková, Markéta Potůčková, Lucie Červená, Záboj Hrázský, Alex Šrollerů, Mojmír Polák & Petr Pyšek*

Hotspots and Drivers of Alien Plant Species Upward Spread to the Arctic-Alpine Tundra

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Mountain ecosystems harbour exceptional biodiversity but are increasingly threatened by climate warming, overtourism, and land-use change, i.e., processes that facilitate biological invasions. In the Krkonoše/Karkonosze Mountains, key invasion hotspots include settlements and mountain chalets, which serve as sources of propagules for alien species, whereas roads and hiking trails act as the main dispersal corridors for the upslope spread of invasive, native expansive, and native extralimital plant species.

Surveys of ornamental plantings recorded 3,156 occurrences of 446 cultivated taxa, with 44 % escaping cultivation and 21 species posing a potential threat to native biodiversity. Long-term microclimatic measurements and soil analyses show that roads create warmer, more nutrient-rich, and less acidic conditions, thereby facilitating plant establishment beyond natural elevational limits. A unique vegetation monitoring program initiated in 1976 documented 708 plant taxa along 300 roadside and trail sections, of which 307 reached tundra communities. Roadside vegetation exhibited a pronounced shift along the elevational gradient, ranging from cultivated alien species and lowland ruderal and meadow species at lower elevations to tundra communities containing 13 % lowland meadow and ruderal species and 25 % species typical of forest margins, clearings, and trampled habitats.

These long-term ecological datasets form the basis of the ongoing TA CR project (SQ02010073), which integrates conventional botanical surveys with a vehicle-mounted CamAlien system, multispectral UAV imagery, and machine-learning approaches for automated plant detection. The project will develop an integrative methodology that will enable early detection and quantification of plant invasion and expansion risks, and provide a robust basis for effective management and conservation of mountain ecosystems.

8:45–9:00 *Jana Müllerová* & Erik Šiffel*

Krkonoše Vegetation Patterns: Satellite Insights into Environmental Drivers under Climate Change

*Jan Evangelista Purkyně University in Ústí nad Labem, jana.mullerova@ujep.cz

Mountain ecosystems are highly sensitive to climate change due to their extreme environmental conditions and specific flora and fauna. Within the GEOTUNDRA project ("Analysis of spatial data as a practical tool to protect species and habitats of alpine and subalpine zone under global change", TA CR, 2025–2028), we aim to identify the key environmental drivers of species and habitat distribution above the treeline of the Krkonoše and Jeseníky Mountains. We reconstruct the past state and predict future shifts using remote sensing, machine learning, and climate change scenarios. Specifically, we derive a suite of variables hypothesized to drive species distribution within the extreme environments of mountain ridges, exploring the dynamics, changes, and trends in snow cover, growing season phenology, and land surface temperature. To do this, we utilize long-term time series of satellite data (Landsat, Sentinel), and parameters derived and modeled from digital terrain models and climatic data, such as wind exposure, solar insolation, and snow deposition. The results will advance our understanding of mountain ecosystem dynamics and their response to global change by uncovering the drivers behind the current occurrence of endangered species, explaining the expansive behavior of certain native species, and forecasting future shifts.

9:00–9:15 *Wojciech Pusz* & Katarzyna Patejuk*

Plant health as part of the environmental monitoring on the example of the Karkonosze Mountains

*Uniwersytet Przyrodniczy we Wrocławiu, Katedra Ochrony Roślin, wojciech.pusz@upwr.edu.pl

The aim of phytopathological monitoring is to check healthiness of plants and observe the changes that occur in their populations. In the vast majority, these types of observations are conducted in agriculture and forestry. An interesting aspect of phytopathological monitoring is the assessment of the origin of plant species. The research on fungal communities (including pathogens) on plants may, for example, indicate the relic nature of the host plant species. A reduction in the occurrence or the disappearance of fungal species associated with a host plant can indicate a slow decline of their habitats. This applies mainly to arctic-alpine fungal species. On the other hand, for some plant hosts, the colonization of their organs by polyphagous fungi is being recorded. One such example is the downy willow, on which six species of fungi were found in the Karkonosze Mountains. In 2014, no fungi were found on this plant. However, comparing the species composition of fungi associated with the downy willow reported by Schroeter (1908) to the contemporary one and to the study results of other researchers, a decrease in the number of fungal species is clearly visible. This may be related to environmental pollution, which took place in the Sudetes during the second half of the 20th century. For instance, species of the genus *Rhytisma*, which colonize the leaves of trees and shrubs and are particularly sensitive to SO_2 concentration in the air, were nowhere to be found previously. However, presently, *Rhytisma* fungi have been found in the Karkonosze Mountains. Phytopathological monitoring was conducted during 2014–2015 and 2026 in the sub-alpine zone of the Karkonosze (Giant) Mountains. It has been shown that, compared to similar studies conducted in the 1990s, the species composition has changed.

9:15–9:30 *Stanislav Březina**

Changes in Vegetation of the Krkonoše Tundra on the Czech Side of the Krkonoše Mountains

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The Krkonoše tundra is one of the most valuable natural resources of the Czech mountains. Plants and animals that are adapted to cold, wind, long winters, and poor soils survive on the summit plains, in the glacial cirques, and on the ridge peatlands (for a review, see Vaněk, Materna, and Flousek 2013). This is why these biotopes are extremely sensitive to climate change and human intervention.

In recent decades, it has become clear that the tundra is not changing dramatically in a sudden leap, but slowly and steadily – and most often towards overgrowth. The most visible change is the retreat of open treeless areas. In places where low grasslands, lichen tundra, or a small mosaic of cold-loving herbs used to prevail, today there is a growing presence of dwarf pine, scattered spruces, blueberries, lingonberries, and heather. The tundra is thus gradually "closing".

There are several reasons behind these changes at once. Warming extends the growing season and increases the chance that competitively stronger species will survive in the highlands. Some of the processes that used to naturally open up the tundra are also receding – such as long-term snow cover or increased avalanche activity. The disappearance of some traditional farming practices after World War II, which had previously kept some stands more open, also plays a role.

The changes clearly show that climate change is not only manifested in higher temperatures in the Krkonoše tundra. In practice, we perceive it mainly as the overgrowth of vegetation. The most endangered are not common and adaptable species, but small plants tied to extreme conditions. It is these that give the Krkonoše tundra its special face. Monitoring from recent years shows that blueberries, cranberries, or heather are increasing on some peaks, while species typical of cold, windy, and poorly connected grasslands are decreasing. In other words: generalists are winning, while specialists are losing space.

This is also reflected in specific rare plants. For example, species tied to blown alpine grasslands, the edges of peat bogs, or small springs are endangered. Expert data shows that some endemic species of hawkweed are among the sensitive species. They pay the price as the vegetation thickens, the population increases, and the water regime changes in some locations.

The KRNAP Administration cannot respond to global climate change by stopping it. However, it can mitigate its local consequences. This is where simple management interventions make sense: removing old biomass, mowing and clearing vegetation, digging up old vegetation, restoring disturbed water regimes, or replacing unsuitable material in road structures. Where appropriate, even small interventions in the vegetation surrounding the most valuable populations of rare species can help.

9:30–9:45 *Martina Fabšičová*, Marie Vymazalová, Přemysl Bobek & Radim Hédl*

Subalpine Grasslands as Climate Change Refugia for Endangered Species? Insights from the Krkonoše and Jeseníky Mountains

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Subalpine grassland habitats in Central Europe are highly vulnerable to global climate change due to their isolation and specific microclimatic conditions. Global warming accelerates shifts in snowmelt patterns, moisture availability, and nutrient cycling leading to vegetation compositional changes. Our study assessed the drivers of grassland community composition above 1,300 m a.s.l. in the Jeseníky and in the Krkonoše Mountains. Direct ordination (dbRDA) revealed that species composition is primarily driven by soil nitrogen content (19.5 %), soil pH (19.4 %), and the C:N nutrient turnover gradient (5.1%).

Based on our field data, generalized linear models (GLMs) analysing present-day niches show that *Anemonastrum narcissiflorum* tolerates higher litter cover but strictly occupies sites with low C:N ratios (fast litter decomposition) and low moss cover, and increases its abundance with rising soil pH. *Hieracium alpinum* agg. shows high tolerance to elevated C:N ratios. *Campanula barbata* indicates nitrogen-poor sites and prefers species-rich grasslands; its abundance significantly decreases with increasing soil nitrogen.

Comparison of current data with 51 historical plots (1949–1974) using PCoA revealed a complete compositional shift. Historical plots exhibited significantly higher Ellenberg-type indicator values for moisture compared to current plots. *C. barbata* has apparently completely vanished from *Calamagrostion villosae* tall-grass communities but still persists at lower elevations. Instead, its current subalpine occurrences are restricted to anthropogenically disturbed microhabitats around tourist chalets and roadsides. These findings underscore the limited importance of subalpine grasslands as refuges for endangered species from sites disturbed by human activities.

9:45–10:00 *Marie Vymazalová*, Martina Fabšičová, Martin Brtnický, Radim Hédl & Marie Mrázková*

Plant-Soil Decoupling in Subalpine Grasslands Microbial Nutrient Trapping Drives Plant Community Regeneration Following Climate Change-Induced Dieback

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Extreme climatic events are rapidly altering alpine ecosystems, yet the cascading feedback loops between vegetation shifts and soil microbial processes remain poorly understood. This study investigates the ecological consequences of three severe and extensive grassland dieback events in the Jeseníky Mountains, Central Europe. Using variance partitioning, distance-based redundancy analysis (dbRDA) and structural equation modelling (SEM), we explored the causal links between regenerating plant species composition after vegetation dieback, soil stoichiometry, and microbial functional responses.

Our results revealed a distinct, diagonal ecological shift following the dieback event. Soil stoichiometry emerged as the primary driver, with an increased C:N ratio indicating severe nitrogen limitation that directed the broad trajectory of vegetation change. Crucially, variance partitioning demonstrated a strong functional coupling (2.4% shared variance) between the high C:N ratio and phosphodiesterase activity (Pho), rather than a purely independent enzymatic effect. This tight coordination indicates that microbes engage in intensive phosphorus mining specifically to balance the stoichiometric disruption.

Crucially, this channelled energy is trapped directly within the increasing microbial biomass. This biological 'nutrient trap' sequesters vital resources within the soil microbiota, creating a competitive bottleneck that halts nutrient turnover and hampers the re-establishment of typical subalpine plant communities. Despite environmental differences among peaks, this internal regulatory mechanism operates universally across the mountain range, providing a unified ecological signature of climate-driven subalpine grassland disruption.

Session II

Tuesday, 22 September 2026

The Past, Present and Future of the Krkonoše Mountains Landscape

10:30–10:45 *Josef Halda* & Ema Kestřánková*

Current Changes in the Krkonoše Tundra from a Lichenologist's Perspective

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Over the course of two decades, vegetation changes in the tundra area of the Krkonoše Mountains have been monitored. Climate change has affected the species composition of lichens. The main reason is the unexpected expansion of woody plants, particularly heather (*Calluna vulgaris*) and mountain pine (*Pinus mugo*). This process is still ongoing and will be difficult to stop or even slow down.

10:45–11:00 *Jakub Hruška* & Tomáš Chuman*

Critical Loads of Sulfur and Nutrient Nitrogen for Terrestrial Ecosystems and Their Exceedance by Current Atmospheric Deposition

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The Krkonoše Mountains have historically been known as a region with very high sulfur and nitrogen deposition, which resulted in severe damage to mountain forests and terrestrial biodiversity. Since the early 1990s, atmospheric deposition has declined substantially, and forest health has improved markedly. Critical loads (CLs) for sulfur, as well as for nutrient nitrogen, were both exceeded by atmospheric deposition during the 1990s. Since approximately 2010, however, critical loads for sulfur and acidity have no longer been exceeded. In contrast, critical loads for nutrient nitrogen remained substantially exceeded across the entire Krkonoše National Park (KRNAP) until 2016. Although nitrogen deposition has also declined over recent decades, in 2023 the critical load for nutrient nitrogen was still exceeded in approximately 70% of the KRNAP area, predominantly in its western part. Such exceedance has numerous implications for biodiversity, including a reduction in plant community richness and enhanced growth, followed by increased instability, of spruce plantations.

11:00–11:15 *Helena Svitavská**

Regarding the Past: Mountain Tundra and the Upper Forest Limit History in the Krkonoše Mountains

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The presentation reviews interwar and post-war paleobotanical and paleoecological research conducted in the summit cryo-vegetation zone of the Krkonoše Mountains, focusing on key subarctic-subalpine raised bogs and forest history. Pollen, macrofossil, and vegetation analyses from Pančavská louka, Pláň pod Sněžkou, Labská louka, Úpské rašeliniště, and Černá hora were synthesized.

The oldest reliable data come from Pančavská louka, which began to develop during the Boreal period from wet sedge and tall-herb communities later colonized by pine stands. During the Atlantic period, climatic warming caused the retreat of tundra vegetation and the upslope expansion of dwarf pine, hazel, spruce, and mixed oak forests to an elevation of 1,300 m a.s.l. In the Late Atlantic, spruce remained dominant while beech and fir gradually spread into the alpine zone.

The transition to Subboreal in 3700 BC, brought climatic deterioration and major vegetation shifts. Spruce and fir expanded across the eastern Krkonoše. Ridge areas retained open herbaceous and shrub vegetation. Fir became dominant earlier in the eastern than in the western part. During the Late Subboreal, fir expanded to the ridge elevations in two phases. Colder oscillations in 850 BC temporarily halted fir and promoted beech and dwarf pine.

In the Early Subatlantic, fir once again became dominant in mountain forests, even near peatlands. The Late Subatlantic was marked by increasing human impact, reflected by a decline in arboreal pollen. Colonization of the high mountains from the 13th century onward, associated with glassmaking, mining, and mountain pastoralism, caused long-term extensive degradation of natural montane forests. This disturbance enabled the spread of pioneer species such as birch and hazel, while the modern reintroduction of dwarf pine is also reflected in pollen records.

The reviewed paleoecological evidence demonstrates that Holocene climatic oscillations and centuries of human activity fundamentally transformed the original montane mixed-forest ecosystem of the Krkonoše.

11:15–11:30 *Michal Skalka**

How Do We Count Visitors in the Krkonoše Mountains and Why?

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The Krkonoše Mountains National Park (KRNAP) ranks among the most visited national parks in the world. But how do we actually count all those visitors? Where do they come from, how long do they stay here, and – perhaps most importantly – is all this expensive data actually worth it?

This presentation introduces our methodology of data collection via SIM cards. While almost every adult in the Czech Republic carries a mobile phone, this method has its limits, particularly when monitoring smaller areas. To get a truly comprehensive picture of visitor behavior, we must combine these digital footprints with other methods.

Our analysis, covering the period from November 2024 to August 2025, interprets the movement of SIM cards to distinguish between day-trippers, tourists, commuters, and local residents. We even attempted to track "cross-visits" – for example, whether the opening of the Treetop Walkway has helped ease the pressure on the summit of Sněžka. As it turns out, the relationship between different tourist destinations is a complex puzzle with no simple solution. However, the data did reveal one surprising fact: the average daily visitor numbers on Sněžka in February are nearly the same as in August.

The overall trends show that while visitor numbers in the Krkonoše Mountains continue to grow slightly, the length of their stay is shortening. Roughly one-fifth of all visitors come from abroad, primarily from Poland, Germany, and the Netherlands.

Ultimately, these findings are vital for the KRNAP Administration. They help us plan budgets, maintain trails, prepare multilingual materials, and organize our ranger services. Above all, they serve as a crucial tool for building and maintaining positive relationships with our local communities.

11:30–11:45 *Mateusz Rogowski*, Martin Erlebach**, Monika Rusztecka & Veronika Květoňová*

Does Climate Variability Reshape Visitor Intensity in Protected Areas? A Case Study from the Krkonoše Mountains

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**
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In the modern tourism discourse, climate is increasingly framed not merely as a background condition but as a key resource shaping sustainable development strategies. Empirical studies confirm that elements such as temperature regimes, precipitation patterns, and weather variability significantly influence destination competitiveness and tourist satisfaction. However, ongoing climate change is disrupting these relationships, reshaping global tourism flows through environmental degradation, rising operational costs, and increasing uncertainty. Mountain areas, characterized by sensitive ecosystems and distinct climatic conditions, face heightened risks. Traditionally valued as cooler refuges, these regions are gradually losing this role as warming progresses, with impacts already noticeable in lower-elevation zones and expanding upwards (Gössling et al. 2023; Peeters et al. 2024). Mountain areas of the European mid-altitude ranges, exemplified by the Karkonosze Mountains, are particularly sensitive to climate change. The aim of this study is to attempt to determine the impact of changing weather conditions, in the context of ongoing climate change, on the daily number of visitors to the most popular attractions in the Karkonosze Mountains. To achieve this, daily Eco-counter data were compared with meteorological data from the years 2012–2025, and the consistency of changes was assessed using correlation coefficients and nonlinear regression for meteorological seasons and tourist seasons. The results indicate gradual transformations in both the volume and variability of tourist traffic.

11:45–12:00 *Jiří Bašta**

Visual Documents on Climate Change in the Collections of the Krkonoše Museum

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The collections of the Krkonoše Museum of the Krkonoše Mountains National Park (KRNAP) Administration contain thousands of documents – including photographs, works of art, and maps – that make it possible to compare changes in vegetation cover, geological and geomorphological features, and the human transformation of the mountain environment over more than 200 years. The longest time series can be compiled for major tourist destinations, particularly in the central parts of the mountain range.

Session III

Wednesday, 23 September 2026

Mountain Fauna, Forests and Ecosystem Health

8:45–9:00 *Sebastian Salata*, Dominik Zięcina, Beata Czyż, Jacinto N. Flores Llerena, Diego I. Ordoñez Mazier, Archana Santhosh, Jacob A. Wilkerson & Magdalena Zagalska-Neubauer*

Survivor or Returnee? *Formica lugubris* in the Changing Climate of the Karkonosze Mountains

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Formica lugubris Zetterstedt, 1838 is a boreo-montane wood ant associated predominantly with cool coniferous forests of northern and alpine regions of Europe. In Poland, the species has long been considered extinct, as the last confirmed records date back more than 60 years. Despite extensive myrmecological surveys conducted in recent decades, no contemporary populations have been documented.

During field investigations in Karkonosze National Park, we discovered a previously unknown population of *F. lugubris*. This finding represents the first record of the species from the Karkonosze Mountains and the first confirmed occurrence in Poland in over half a century. The discovery not only extends the known current distribution of the species but also raises important questions regarding its origin and persistence.

The presence of *F. lugubris* in the Karkonosze Mountains may reflect the survival of a relict population that remained undetected in a climatic refugium, or alternatively, a recent recolonisation event facilitated by environmental change. We discuss these hypotheses in the context of the species' ecology, historical distribution, and habitat conditions.

The rediscovery of *F. lugubris* highlights the importance of continued biodiversity monitoring in mountain regions and demonstrates that even well-studied faunas may still contain unexpected elements. This finding provides a valuable basis for future phylogeographic and conservation studies aimed at understanding the status and history of one of Poland's rarest wood ants.

9:00–9:15 *Jakub Šimurda* & Roman Fuchs*

Forestry Plans as the Source of Environmental Data for the Analysis of Bird Community Composition

*The Krkonoše Mountains National Park Administration, jsimurda@krnap.cz

Forest management plans offer valuable data on forest species composition and structure, useful for large-scale bird conservation. We examined the relationship between bird community diversity and five vegetation characteristics from management plans in the Krkonoše Mountains National Park.

Bird communities were surveyed from 2012 to 2014 using the point method on 285 plots (radius 100 m). We analyzed songbirds, woodpeckers, and pigeons. Vegetation characteristics were divided into composition (tree species proportion, soil-based phytocoenosis, and target vegetation type) and structure (vertical tree layering, remotely sensed heights).

Bird species richness was used as a diversity measure. Redundancy analysis (RDA) tested the impact of vegetation characteristics on bird community composition. Higher bird diversity was linked to deciduous forests, particularly beech forest, in multi-layered stands (20–40 m height) on rich soils. In contrast, lower diversity occurred in spruce-dominated stands with Scots pine, waterlogged soils, and low vegetation (< 0.5 m).

All vegetation characteristics correlated significantly with bird community diversity and composition. Our findings demonstrate that forest management data can help identify key variability sources in bird communities, aiding in large-scale monitoring and landscape planning. Beyond tree composition and structure, phytocoenological characteristics provide useful insights for conservation.

9:15–9:30 *Jan Materna* & Karolina Mikslová*

How Are the Birds of the Krkonoše Tundra Faring in the Face of Ongoing Climate Change?

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The area above the upper treeline represents the most valuable part of the Krkonoše Mountains. With ongoing climate change, there is not only a rise in temperature and changes in precipitation patterns, but also the encroachment of shrubs, dwarf pine, and other woody plants into the tundra. The aim of this study is to summarize, based on literature data on the distribution and abundance of individual bird species associated with the tundra, the prospects for their future occurrence in the Krkonoše Mountains.

The Bluethroat, the Eurasian Dotterel (both with their core ranges in the northern tundra), the Water Pipit, and the Alpine Accentor (both with their centers of distribution in European mountain ranges, with the exception of the Scandinavian and British ranges) show an exclusive association with the Krkonoše tundra. The dotterel nests here very irregularly; while the other three species nest here regularly, their population sizes have shown a negative trend in recent decades, with the Bluethroat and Water Pipit experiencing a sharp decline. Furthermore, their occurrence in the Krkonoše Mountains is satellite, outside their core range, which increases their vulnerability. For the Ring Ouzel, the Peregrine Falcon, and the Black Grouse, a significant portion of their Krkonoše populations is found in the tundra. The population of the Peregrine Falcon is stable, in the case of the Ring Ouzel it is growing. The population of the Black Grouse is declining overall, although it appears to be relatively stable above the upper treeline.

Due to the complexity of the needs of individual bird species (food, nesting, shelter, climate) as well as other significant factors (intra- and interspecific competition, predation) and the size of their territories, it is difficult to imagine that we will be able to implement targeted management measures to maintain or improve their populations. It is clear that certain general measures, such as improving water management or maintaining a mosaic of dwarf pine and alpine grasslands, can also have a positive impact on the Ring Ouzel or the Black Grouse. The natural dynamics of ecological processes in forest stands at the upper forest boundary – including their natural thinning and dieback – can also contribute to improving conditions for these species.

9:30–9:45 *Paweł Sienkiewicz**

Ground Beetles (*Coleoptera Carabidae*) in the Polish Part of the Karkonosze National Park – Current Status, Conservation Issues

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Ground beetles (Coleoptera: Carabidae) belong to a family of beetles frequently used as indicators of the condition of the natural environment. This paper presents the current state of knowledge regarding ground beetles in the Polish part of the Karkonosze National Park, together with an analysis of the changes that have occurred since previous studies of this area.

Based on an analysis of the available scientific literature, archival materials, and the results of the latest research, the presence of 80 species of Carabidae has been confirmed. This indicates a low level of knowledge regarding this group of insects within the Karkonosze National Park. This is due to the fact that research has focused on selected habitats, mainly forest habitats. Earlier reports from the study area also listed species whose presence is unlikely given their ecological requirements. Such Carabidae have been removed from the list, and species requiring confirmation by more recent studies have also been identified.

Attention was also drawn to the appearance of species characteristic of open habitats, which may indicate changes taking place in the environment as a result of human pressure and climate change. Ground beetles constitute a valuable bioindicator group; therefore, monitoring them can provide information on the condition of mountain ecosystems and the effectiveness of conservation measures. However, this first and foremost requires comprehensive research into the Carabidae of the Karkonosze National Park, focusing on the most valuable ecosystems that are sensitive to climate change.

In summary, the current state of knowledge regarding the ground beetle fauna of the Polish part of the Karkonosze National Park remains incomplete. Comprehensive studies covering all habitat types found within the park are necessary to gain a more accurate understanding of the species composition of this insect family and to monitor changes occurring in the ecosystems of the Karkonosze Mountains.

9:45–10:00 *Radek Novotný*, Věra Fadrhonsová & Petr Fišer*

Soil Chemistry, Tree Nutrition, and Crown Condition in Mountain Spruce Stands during the 1996–2025 Period

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In response to the gradual decline in air pollution levels observed during the 1990s, monitoring plots were established in young mountain spruce stands to assess and evaluate long-term changes in crown condition (crown defoliation), soil chemistry (the FH humus layer and mineral topsoil to a depth of 30 cm), and needle nutrient status (main nutrients, selected trace elements, potentially toxic elements). In the Krkonoše Mountains, a total of 17 permanent plots have been monitored continuously since the mid-1990s. This contribution presents a synthesis of 30 years of monitoring data from these plots, providing insights into the long-term trends in site conditions, stand nutrition, and health status.

10:00–10:15 *Wojciech Kowalkowski*, Piotr Robakowski, Marlena Baranowska, Monika Dering, Maria Hauke-Kowalska, Bartosz Bułaj, Radosław Jagiełło, Robert Korzeniewicz, Adrian Łukowski*, Marcin Zadworny & Władysław Barzdajn*

Restitution of Silver Fir in Sudety Mountains

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Silver fir (*Abies alba* Mill.) is one of the most important forest tree species in the mountainous and upland regions of Poland. Its presence enhances the biodiversity of forest ecosystems and increases their resistance to wind, snowfall, and biotic threats. Deforestation, clear-cut forest management, the widespread establishment of Norway spruce monocultures, and the species' sensitivity to air and soil pollution have reduced the area occupied by silver fir and limited its natural regeneration.

In the late 1990s, on the initiative and under the scientific supervision of the Department of Silviculture at the Poznań University of Life Sciences, the State Forests National Forest Holding in Poland launched a programme to restore valuable and unique silver fir genetic resources in the Sudetes, including in the Karkonosze National Park. The programme encompasses a wide range of both practical and scientific activities.

Over a period of 27 years, the proportion of silver fir has increased from 0.36% to 2.5%. Nine conservation plantations have been established in the State Forests, together with three conservation archives in the Karkonosze National Park. These are intended to provide a particularly valuable supplement to the currently insufficient seed base.

The research focuses on methods of managing forest stands containing silver fir, the associated fungal communities, and different approaches to seedling production. Unfortunately, climate change is giving rise to numerous previously unknown threats. The most significant of these include aphids attacking silver fir and fir mistletoe, which is spreading throughout many forest stands.

Despite numerous challenges, the silver fir restoration programme is continuing and is ultimately expected to result in the full restoration of this unique population of the species. The presentation will provide details of the activities undertaken to date and the results of the research conducted.

Session IV

Wednesday, 23 September 2026

Climate Change, Hydrology and Landscape Processes

10:45–11:00 *Paula Przygoda-Kuś* & Aleksandra M. Mirończuk*

Are Protected Areas Really Protected? Microplastics Concentrations in Soils within Natura 2000 Sites and the Karkonosze National Park Relative to Other Types of Land-Use

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To date, research on microplastics accumulation has mainly focused on the aquatic environment. Despite growing recognition of soils as a major sink for microplastics, current understanding of their environmental distribution remains limited. Most studies have focused on agricultural soils, which is why other types of soil environments are less well understood.

The aim of this study is to determine whether the concentration and polymer composition of microplastics in soils vary depending on land-use type, with particular emphasis on protected areas. Soil samples were collected from sites representing contrasting land-use types, including Natura 2000 areas, the Karkonosze National Park, agricultural lands, and areas near factories. By comparing microplastics abundance and polymer diversity across these environments, the study seeks to evaluate whether legally protected areas are effectively shielded from microplastics contamination or whether they remain vulnerable to tourism and other indirect anthropogenic pressures.

The results are expected to provide new insights into the spatial distribution of microplastics in terrestrial ecosystems and contribute to understanding the relationship between land-use and soil contamination. Furthermore, the study will help determine whether protected areas can serve as reliable reference sites for environmental quality or if microplastics pollution has become pervasive even in ecosystems under formal conservation management.

11:00–11:15 *Julie Schmidtová**

Winter Transformations: A Testimony of Highlanders about Climate Change

*Nature Conservation Agency of the Czech Republic, juli.schmidtova@gmail.com

One of the main challenges of current anthropogenic climate change is its speed – so rapid that it becomes observable and tangible within the lifetime of an ordinary individual. This very aspect makes oral history a particularly suitable method for conducting social science research on climate change.

The aim of this study was to document the stories and observations of people living in mountainous regions and to analyze how they perceive climate change in the landscapes of their homes. What changes do they notice? How do changing winter conditions affect their lives? What adaptations are necessary, and how do they manage them? The data were collected primarily through narrative interviews with individuals over the age of 70, who have spent the majority of their lives in the Krkonoše, or Jizera Mountains, at elevations above 600 meters above sea level.

In total, I conducted interviews with ten highlanders, resulting in more than 20 hours of audio recordings, along with numerous handwritten notes. Analysis of these interviews reveals that winters are indeed changing – significantly. Locals speak of the acceleration of natural cycles, a decline in snow levels, a loss of stability, and the growth of unpredictability.

The interviews also show that, over time, changes in the natural environment and winter conditions have led to shifts in local culture and lifestyle. Over the past century, many mountain villages have become depopulated; cottages are often rented out, and the number of permanent residents has decreased, which has had a direct impact on the social life of the locals.

However, it is not easy to distinguish which factors – whether natural, technological, or social – have had the strongest influence on these cultural changes.

The study gathered a wealth of memories and photographs. Ultimately, this work brings the otherwise complex issue of climate change closer to the public and illustrates the scale and urgency of the problem more effectively.

11:15–11:30 *Libor Kukačka**

Microclimatic Measurements in the Arctic-Alpine Tundra

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Microclimatic conditions (ground-level temperatures, soil temperatures, and snow cover) were studied at three localities within the arctic-alpine tundra of the Giant Mountains (Jestřábí Boudy, Studniční hora, and Klínové Boudy) between 2022–2025. The study focused primarily on comparing daily temperature extremes at ground and soil levels across different microenvironments: within dwarf pine polycormons, under trees at the tree line, and in open tundra communities such as alpine meadows and heaths. The results were compared with measurements from 1999–2001. The study confirmed the determining effect of snow cover on the amplitude of ground-level and soil temperatures. Daily temperature amplitudes exceeding 25°C were measured in the open tundra during the summer months, whereas those inside dwarf pine polycormons or under trees tended to be lower. The intensity of frost processes (e.g., regelation) was evaluated and compared with historical data from the 1999–2001 period.

11:30–11:45 *Adam Jaczewski*, Natalia Pilguj, Joanna Wieczorek, Tomasz Strzyżewski & Bartłomiej Sobczyk*

Applications of Weather and Climate Modelling to Improve Preparedness for Climate Change

*Institute of Meteorology and Water Management – National Research Institute, adam.jaczewski@imgw.pl

Currently, the primary tools for climate modelling are numerical climate models. These are computer programs that represent equations describing the physical processes occurring within the components of the climate system and their interactions. The results of these models provide the scientific basis for political and social decisions necessary for taking adaptive actions in response to climate change.

The increasingly pressing need for climate information at regional scales means that the demand for accurate model output is greater than ever. Furthermore, the low resolution of current global models limits their ability to provide reliable regional-scale information for stakeholders. The CORDEX initiative provides regional climate projections downscaled with Regional Climate Models (RCMs) for continents at a 12 km resolution, and these are beginning to be further dynamically downscaled to a 3–4 km resolution. While dynamical downscaling uses physical principles to project future changes at a local scale, gridded observations provide the real-world baseline and are used to calibrate the models.

The Sudetes and Carpathians are among the most climate-sensitive landscapes in Central Europe. Observed trends, including rapid warming, shorter snow seasons, more extreme precipitation events, and altered hydrological regimes, already affect biodiversity, tourism, and infrastructure safety in transboundary mountain areas, such as the Karkonosze massif.

The "Carpathian – Sudeten Transboundary Climate Assessment" (CaSuT) project, implemented and led by the Institute of Environmental Protection – National Research Institute in partnership with the Institute of Meteorology and Water Management – National Research Institute (NRI), the Czech Hydrometeorological Institute, and the Slovak Hydrometeorological Institute, addresses this need by developing a common high-resolution climate dataset and a dedicated downscaling methodology for the Sudeten and Carpathian regions using Copernicus Climate Change Service data.

11:45–12:00 *Milada Matoušková*, Adam Bartůšek*, Miroslav Šobr, Václava Šimandlová & Matyáš Štregl*

Dynamics of Surface Water Biogeochemistry in Relation to Hydrological Extremes

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In recent decades, changes in baseline climatic and hydrological conditions have become increasingly apparent, affecting even the headwater areas of mountain watersheds. These changes, in conjunction with other environmental factors, have a significant impact on surface water quality. The aim of our research is to analyse the dynamics of surface water biogeochemistry in the context of climate change and related hydrological extremes. The study area comprises the upper reaches of the Úpa and Bílé Labe rivers. Attention is focused on comparing individual sub-basins with varying occurrences of peatlands. The analysis includes an assessment of temperature, precipitation, and snow characteristics, as well as runoff variability and the biogeochemical composition of water at several sites. The following parameters were monitored: physicochemical parameters (water temperature, pH, specific electrical conductivity), concentrations of major cations, forms of selected macronutrients with a focus on nitrogen compounds, organic carbon content (TOC/DOC), selected metals, and, additionally, other ions. Data analysis was performed using standard statistical methods, including the Mann – Kendall trend test, correlation analysis, and linear regression. The results indicate significant changes in certain hydroclimatic variables – particularly a rising trend in air temperature, a shortening of the duration of snow cover, and a decline in summer flows. For most of the monitored parameters, a significant dependence on discharge was confirmed, with the direction of this dependence reflecting the specific transport mechanism of individual substances into the watercourse. The significant influence of the peatlands was evident primarily in relation to basic physicochemical parameters and concentrations of organic substances. Regarding geochemical parameters, only limited trends were identified due to the shorter length of the time series; however, a decrease in the concentrations of certain major cations and in specific conductivity was observed, while aluminium concentrations, conversely, showed an increase. Progressing climate change and the associated hydrological extremes could potentially have a significant negative impact on the condition of mountain peatlands in the headwaters of watercourses.

Keywords: climate change, surface water biogeochemistry, physicochemical parameters, DOC, nitrogen compounds, hydrological extremes, peatlands

12:00–12:15 *Lukáš Vlček*, Jiří Kocum, Kristýna Falátková & Václav Šípek*

Water Balance of Peatlands

*Czech Academy of Sciences, Institute of Hydrology, vlcek@ih.cas.cz

The ecological condition of peatlands depends on their hydrological regime, which is primarily characterized by a high groundwater table. However, this apparent stability is a bit misleading, as peatlands are dynamic systems in which water is continuously moving. Groundwater levels reflect a balance between water inputs and outputs, including precipitation, evapotranspiration, and surface or subsurface inflows and outflows. Therefore, groundwater dynamics are controlled not only by climate but also by the hydraulic properties of soils and the underlying geological substrate.

Climate change is extending the growing season and increasing evapotranspiration, which may result in more frequent and prolonged periods of low groundwater levels. The impact on peatland ecosystems may be immediate, through changes in precipitation, or delayed due to water transport through soil and bedrock over timescales ranging from days to years. The contributions of different water sources may also reinforce or mitigate one another.

Peatlands consist of several soil types that, together with the geological substrate, form a layered system with contrasting hydraulic properties. Individual horizons may affect groundwater table fluctuations differently. A groundwater decline can be slowed or accelerated depending on hydraulic conductivity and flow gradients. The water table recession rate is important because it determines the duration of low-water conditions and the associated stress experienced by indicator plant species.

This study presents a detailed assessment of groundwater table dynamics in selected peatlands of the Krkonoše Mountains. By combining groundwater monitoring with information on climate, soil properties, and geological conditions, the study aims to improve our understanding of the factors controlling groundwater fluctuations and to provide a better basis for assessing the impacts of climate change, drainage, and peatland restoration measures.

Invited Lecture

15:20-18:20 *Anastasiia Kolomiiets, Oleksandr Bren, Eva Hejduková, Pavel Přibyl, Jana Kvíderová, Lenka Procházková, Ekaterina Pushkareva, Jaromír Lukavský, Linda Nedbalová, Jiří Liška, Vojtěch Bělohlav, Tomáš Jirout, Jan Tříska, Karel Hořejší, Burkhard Becker & Josef Elster**

Global climate crisis in the Arctic; Impacts of winter thaws, Urbanization – medium-sized microalgae farm

*University of South Bohemia, České Budějovice, Czech Republic

Human society on planet Earth is under pressure from the climate crisis. Long-term monitoring of global climate at all levels provides evidence that climate change is linked to human activity. One very important task of Czech science is to provide information related to climate change, to understand these changes as much as possible, and to propose solutions on how to adapt to climate change and how to modify the behaviour of our society at all levels.

The Arctic is warming three to four times faster compared to the rest of our planet. The Norwegian archipelago of Svalbard, where the Czech Republic has its scientific base, Josef Svoboda,‘ is an Arctic area where extensive international research is conducted (every year 3 to 5 thousand scientific projects are carried out here), mostly aimed at studying how the Arctic ecosystem responds to climate change.

A group of Czech and German algologists focused on studying how cyanobacteria and algae in biological soil crusts respond to winter thaws. We‘re showing evidence of the changes in diversity and metabolic activity that happen throughout the different seasons (winter ecology) in relation to winter thaws.

In connection with the necessary preparation for the urbanization of the Arctic, we are developing biotechnology for cultivating cold-loving cyanobacteria and algae. We are testing cultivation technology during the winter period in Central Europe, while also modifying cultivation techniques and selecting potentially advantageous strains that could be used in the Arctic during the summer. Cyanobacteria and algae adapted to low temperatures are a source of biomass and can potentially be used in the production of biotechnologically valuable substances, and they are also a potential component for wastewater treatment. Using cyanobacteria and algae in industrial areas of the Arctic with the help of waste energy would allow year-round operation, essentially reconfiguring human impact on the Arctic environment.

ABSTRACTS

Posters

Poster Session I

Biodiversity Monitoring and Species Conservation

*Dominik Zięcina**, *Beata Czyż*, *Jacinto Nicolas Flores Llerena*, *Diego Ivan Ordoñez Mazier*, *Archana Santhosh*, *Jacob Andrew Wilkerson*, *Magdalena Zagalska-Neubauer* & *Sebastian Salata*

Continuity or Decline? Formica (*Hymenoptera Formicidae*) Populations in Karkonosze National Park after 50 Years

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Red wood ants (RWA), members of the *Formica rufa* species group, play a keystone role in forest ecosystems. They provide various ecosystem services, such as regulating the populations of other arthropods, serving as a food source for vertebrates, contributing to the soil nutrient cycle, and dispersing seeds. Furthermore, their mounds provide habitat for many myrmecophilous organisms.

Five species from this group occur in the Karkonosze Mountains, namely: *Formica lugubris* Zetterstedt, 1838, *F. polyctena* Foerster, 1850, *F. pratensis* Retzius, 1783, *F. rufa* Linnaeus, 1761, and *F. truncorum* Fabricius, 1804, all of which are protected species in Poland and the Czech Republic. These species are known to be highly responsive to environmental and climatic changes and are therefore commonly used as key indicators to examine the restoration process or the stability of montane habitats.

The aim of the study was to compare the results of the 1975 inventory conducted in Karkonosze National Park with the situation in 2025 and to determine whether Formica populations had undergone any changes in response to environmental and climate change. The results indicated substantial changes in the species diversity and population levels. Compared with 50 years ago, all ant species now nest at higher altitudes. Additionally, the most recent survey revealed the presence of one species that was undetected 50 years ago (*F. lugubris*), and one species (*F. pratensis*) present in the national park in 1975 was not recorded in the current survey.

*Magdalena Stanek**

Acoustic Monitoring of Bats in the Karkonosze Mountains: A Conceptual Framework

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No abstract was submitted.

*Jan Materna** & *Přemysl Janata*

Results of the Dipper Breeding Census in the Czech Part of the Krkonoše Mountains

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The white-throated dipper (*Cinclus cinclus*) is a bird species found along fast-flowing streams and rivers. It forages for food – primarily various invertebrates – on the rocky riverbed. In 2024, under the coordination of the Czech Agency for Nature Conservation, a nationwide survey of the dipper's breeding range was conducted using a standardized methodology (https://portal.nature.cz/documents/20121/5809527/Ptaci.zip). As part of this survey, its breeding range was mapped along sections of the Jizera, Jizerka, and Úpa rivers that flow through the Krkonoše NP and its buffer zone. In the following two years, the breeding range was also mapped on other significant river sections in the region – the Mumlava, Labe, Klínový potok / Malé Labe, Čistá, and Malá Úpa. A total of 121 km of watercourses were surveyed, and 89 presumed dipper pairs were recorded, representing 40–52% of its estimated population in the Krkonoše Mountains based on the results of the local breeding atlas from 2012–2014. Its abundance ranged from 5 to 11 pairs per 10 km of watercourse, which corresponds to the upper half of the range of values commonly recorded in Central Europe (1 to 10 pairs per 10 km). The highest values were recorded on the Úpa (11 pairs / 10 km), Bílé Labe, and the Labe (8 pairs / 10 km) rivers. On all other watercourses, the numbers consistently ranged from 5 to 6 pairs per 10 km. All data were stored in the Nature Conservation Findings Database. According to the local breeding atlas, the population of the dipper in the Krkonoše Mountains is rising, and this trend is primarily linked to the declining acidification of watercourses and their subsequent recovery. On the other hand, fluctuations in flow rates and reduced water volume can have a negative impact on their density, as observed in diverted sections near small hydroelectric power plants on smaller watercourses. During the surveys, the abundance of the grey wagtail (*Motacilla cinerea*) was also monitored, ranging from 10 to 26 pairs per 10 km; the highest densities were recorded on the Bílé Labe and Mumlava rivers – 26 and 25 pairs per 10 km, respectively – followed by the Jizera and Labe rivers (17 and 16 pairs per 10 km, respectively). On other streams, its abundance ranged from 10 to 13 pairs per 10 km. However, the grey wagtail is not limited to the stream itself for its food but relies on the wider surrounding area.

*Jakub Šimurda**

Spring Arrival of Birds in the Foothill of the Krkonoše Mountains in 1997–2026

*The Krkonoše Mountains National Park Administration, jsimurda@krnap.cz

Using faunistic data published in print and in online databases, this study examined trends in the timing of the first spring sightings of common migratory bird species over the study period and investigated the relationship between their arrival and certain meteorological indicators.

Karolina Mikslová & Jitka Feřtová*

The Krkonoše – Jizera Mountains Population of the Black Grouse over Time

*The Krkonoše Mountains National Park Administration, kmikslova@krnap.cz

The Krkonoše – Jizera Mountains population of the black grouse (*Lyrurus tetrix*) is, alongside those of the Ore Mountains and the Šumava – Boletice region, one of the last promising populations on which the survival of this species in the Czech Republic depends. In both mountain ranges, the black grouse is found mainly on peat bogs, in meadow enclaves, on plateaus above the upper forest line, and in forest clearings outside them.

During the 20th and 21st centuries, the black grouse population in both mountain ranges underwent dramatic changes. The state of the population is mainly influenced by natural events and phenomena caused directly or indirectly by human activity, which fundamentally change the quality of habitats. The open habitats of the foothills, which the black grouse inhabited in the first half of the 20th century, were abandoned due to the onset of intensive agriculture. On the contrary, between 1917–1921, the population temporarily benefited in places from the consequences of the nun moth outbreak. In the 1970s, 113 males were found in the Krkonoše Mountains and 30 in the Jizera Mountains. In the 1980s, the creation of extensive immission clearings in mountain areas contributed to a significant increase in numbers. Open areas with slowly growing vegetation provided suitable conditions and plenty of food. However, in the 1990s, these clearings were mostly forested. Since 2001, the number of black grouse has been steadily decreasing, and a more significant decrease began to appear during the second decade of the 21st century in connection with the regrowth and canopy closure of spruce stands. The total estimate of the Czech Krkonoše – Jizera Mountains population in 2026 is 73 males (20 in the Jizera Mountains, 53 in the Krkonoše Mountains).

The black grouse is retreating from the western part of the Jizera Mountains and the eastern Krkonoše Mountains. In the mountainous areas of both mountain ranges, there is still a sufficient supply of suitable habitats, and a number of active management measures are being implemented to support them. However, the increasingly isolated grouse population faces a number of problems, in particular the heavy pressure of tourism in both areas. Survival depends on maintaining the connectivity of their habitats, especially through the Polish part of the Jizera Mountains.

*Anna Josefovičová**

Otter Population in KRNAP

*The Krkonoše Mountains National Park Administration, ajosefovicova@krnap.cz

The poster presents an overview of current knowledge regarding the Eurasian otter (*Lutra lutra*) population on the Czech side of the Krkonoše Mountains. The monitoring methods employed and the results obtained will be detailed and discussed.

*Maja Grendel**

Microscopic Invertebrates on the Snow Fields in the Karkonosze National Park

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Snow microfauna of the Karkonosze National Park (KPN)

Microinvertebrates are a ubiquitous and diverse faunal group worldwide. However, knowledge of the microfauna on snow is still limited to a few sites worldwide, thus anticipating the impact of climate change on snow biota is impossible. In this study, I focused on two groups of invertebrates: Bdelloidea, a class within the phylum Rotifera, and Tardigrada, a phylum also known as water bears, which inhabit ephemeral snow patches and snowfields. The aim of the study was to characterise their diversity in the Karkonosze National Park (KPN) and compare their species composition between different habitats in KPN and previously described species from snow and ice in the Pyrenees, the Alps, Scandinavia, and Svalbard. I collected samples of snow, mosses, and water from five different localities in KPN. The species found in mosses and water were compared to snow ecosystems as a reference.

The findings may outline new strategies that could be implemented for the environmental protection of the Karkonosze National Park with a special focus on snow patches and snowfields.

The project was conducted within the ID-UB programme “Mikrofauna naśnieżna w Karkonoskim Parku Narodowym. Karkonoskie endemity czy europejscy oportuniści?” nr 202/39/UAM/0010, at the Faculty of Biology, Adam Mickiewicz University in Poznań, with supervisor Krzysztof Zawierucha, DSc.

Daniela Gluzová & Lucie Procházková*

Native Seed Multiplication Plot for Krkonoše Meadow Plant Species in the Monastery Garden, Vrchlabí

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As part of the "Management of semi-natural grasslands in the Krkonoše National Park" project (CZ.05. 01.06/01/22_029/0002269), the first native seed multiplication plot for Krkonoše meadow species was established. The project aims to evaluate the feasibility of ex situ cultivation of selected native plant species and to develop a long-term source of regional seed for the management and restoration of valuable semi-natural grasslands.

During 2024–2025, seeds were collected from representative meadow enclaves within the Krkonoše National Park and its buffer zone. After cleaning, the seeds were used to produce seedlings, which were subsequently planted in an experimental native seed multiplication plot established in the Monastery Garden in Vrchlabí. The project primarily focuses on species characteristic of mesic *Arrhenatherum* meadows, montane *Trisetum* meadows, and subalpine *Nardus* grasslands. Species selection was based on their ecological requirements, life-history traits, and suitability for long-term cultivation. Protected species and species with a low potential for ex situ cultivation were intentionally excluded.

The seed produced will be used for the restoration and enrichment of degraded mountain meadows, the establishment of additional seed multiplication plots, and the production of seedlings for direct planting at restoration sites.

This project represents one of the first attempts to produce regional seed of native Krkonoše meadow species and may contribute to the development of ecological restoration methods for species-rich mountain grasslands in the Krkonoše Mountains.

*Ludmila Harčariková**

Seed Bank – Hope for Rare Species?

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The study deals with the long-term storage of seeds of endangered plant species associated with the Krkonoše Mountains and evaluates their germination after 10 or more years of storage. Seeds were stored within a seed bank under two temperature regimes (5 °C and −18 °C), and the germination of fresh and long-term stored samples was subsequently compared. The study includes a wide range of species typical of the Krkonoše flora, particularly alpine and subalpine species, species of peat bogs, and species-rich mountain grasslands, including several endemics and regionally important taxa. The results show that most of the studied species retain high germination even after ten years of storage at −18 °C, and in a number of cases, germination rates at this temperature were higher than at 5 °C. The results confirm the importance of seed banks as a key tool for the ex situ conservation of plants, not only for the most endangered species of the Krkonoše flora. Long-term seed storage at low temperatures therefore represents a real safeguard for the preservation of populations and species, even under continuing environmental change.

Maria Malicka, Weronika Kozłowska, Marek Malicki, Adam Matkowski & Sylwia Zielińska*

In vitro propagation of *Rhododendron ferrugineum* – supporting ex situ conservation under climate change

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Rhododendron ferrugineum L. is a characteristic species of alpine and subalpine habitats and may be particularly vulnerable to the impacts of ongoing climate change. Rising temperatures, changes in water availability, and shifts in habitat conditions may affect the distribution and population dynamics of this species. Therefore, the development of effective propagation and conservation methods under ex situ conditions may represent an important component of future conservation strategies. The aim of this study was to develop suitable conditions for the in vitro micropropagation of *R. ferrugineum* and to evaluate the potential of tissue culture techniques as a tool for supporting the ex situ conservation of this species. Shoot cultures were initiated from surface-sterilized, germinated seeds. Plant material was maintained under controlled phytotron conditions at 25 °C, with an 18 h photoperiod and 6 h of darkness, under white LED illumination. Anderson's Rhododendron Medium (Anderson, 1984) was supplemented with the cytokinin 6-(γ,γ-dimethylallylamino) purine (2iP) and the auxin indole-3-acetic acid (IAA) at different concentrations. The effects of the applied plant growth regulator treatments on culture establishment and development were assessed, with particular emphasis on shoot regeneration, multiplication, elongation, and subsequent root development. In vitro propagation enables the production of genetically valuable plant material from a limited number of donor plants and provides a means of maintaining plant material under controlled conditions outside its natural habitat. The development of a reproducible micropropagation protocol for *R. ferrugineum* may contribute to the establishment and maintenance of ex situ collections and provide plant material for future conservation and population reinforcement efforts. The study demonstrates the potential of tissue culture techniques as a complementary tool for the conservation of *R. ferrugineum*, particularly in the context of environmental changes affecting high-mountain ecosystems. Further optimization of culture conditions and assessment of the genetic stability of regenerated plants will be important for the practical application of in vitro propagation in long-term ex situ conservation programs.

Poster Session II

Remote Sensing, Monitoring Technologies and Restoration

*Vojtěch Vítek**, *Pavel Pipek*, *Michaela Vítková*, *Jan Čuda*, *Jiří Sádlo*, *Martin Hejda*, *Klára Pyšková*, *Eliška Hlaváčová*, *Lukáš Kysela*, *Marie Černá*, *Zdeňka Konopová*, *Anna Lučanová*, *Lucie Kupková*, *Markéta Potůčková*, *Lucie Červená*, *Jakub Lysák*, *Záboj Hrázský*, *Alex Šrollerů*, *Mojmír Polák* & *Petr Pyšek*

CamAlien – Innovative Technology for Mapping Non-Native Species in Rugged Mountain Terrain

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Mountain ecosystems in the Krkonoše/Karkonosze National Parks harbor exceptionally high biodiversity and unique arctic-alpine tundra, making them both highly valuable and increasingly vulnerable to the invasion of non-native plant species. Due to the rugged mountain terrain, traditional botanical surveys are highly time-consuming and often struggle to effectively detect spreading species in hard-to-reach areas. For efficient ecosystem management, early detection and continuous monitoring of management effectiveness are crucial, goals that traditional methods alone cannot reliably ensure.

To address this challenge, the autonomous camera system CamAlien was developed to monitor the spread of plant species along highways and motorways. The device is able to obtain precisely geotagged high-resolution (4,096 × 3,000 pixels) images at speeds of up to 110–130 km/h, with an adaptive recording frame rate of up to 5 images per second. The system performs real-time, GDPR-compliant image anonymization before saving data to an on-board SSD drive. As part of a new project (TAČR SQ02010073), and as the focus of my bachelor's thesis, we will test this innovative system over three vegetation seasons across the Czech and Polish parts of the Krkonoše Mountains, including their foothills.

We will comprehensively test the performance of this camera system across varying environmental parameters, including different surface materials (such as asphalt and gravel), different road widths, light intensities, and GPS signal qualities. The primary output of this work will be a detailed distribution map of selected non-native plant species. Ultimately, these results will be compared with standard ground botanical surveys to evaluate the system's accuracy, reliability, and time efficiency.

Adam Kulich, *Lucie Kupková**, *Lucie Červená*, *Jakub Lysák*, *Záboj Hrázský* & *Viera Horáková*

Monitoring Ramsar Peatbogs Vegetation Using UAV and Machine Learning – Lucie Kupková

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Alpine peat bogs are highly valuable and heterogeneous wetland ecosystems that host specialised and often rare plant species. Their vegetation composition reflects fine-scale hydrological and ecological gradients and can therefore serve as an indicator of ecosystem condition and ongoing environmental change. Reliable high-resolution monitoring is essential for detecting vegetation shifts and supporting the long-term conservation of these vulnerable habitats.

This study evaluates the potential of UAV-based multispectral imagery, botanical field data, and machine learning for detailed vegetation mapping of Ramsar peat bogs in the Krkonoše/Karkonosze Mountains. The work is carried out within the Interreg Czechia – Poland project "Importance, Change and Practical Protection of Peatlands" (CZ.11. 01.0 2/00/23_011/0000161). The project focuses on the Úpské Peat Bog, Pančavské Peat Bog, and Hraniční Meadow.

High-resolution UAV multispectral imagery was acquired together with detailed botanical reference data collected in the field. These data were used to train and validate machine-learning models for the classification of 14 vegetation classes. Several classifiers, including Random Forest, Gradient Boosting, XGBoost, and Multi-Layer Perceptron, were compared. To assess transferability to other peat bog sites, we also tested SegFormer, a deep-learning model that classifies vegetation directly in the image while considering the spatial context of surrounding pixels.

The best results were achieved using XGBoost, with F1-scores reaching approximately 94% when multi-temporal UAV data were used. The transferability evaluation brought very promising results, showing that the integration of botanical field surveys, UAV imagery, and machine learning enables detailed mapping of peatland vegetation at the species or vegetation-class level. This approach can support the detection of vegetation changes and provide valuable information for the practical conservation and management of mountain peat bogs.

*Tereza Kaliská**

LiDAR-Based Quantification of Anthropogenic Impacts on the Mountain Relief

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Historical agricultural landforms represent an important component of the cultural landscape and constitute a valuable geoheritage of the Krkonoše Mountains. Despite their significance, these anthropogenic geomorphological features are increasingly threatened by natural degradation processes, vegetation succession, and insufficient documentation. Accurate identification and quantification of such landforms are therefore essential for their inventory, conservation, and management.

This study focuses on the application of LiDAR-based approaches for the detection and morphometric characterization of historical agricultural landforms in the Krkonoše Mountains (Czechia). While airborne laser scanning has become a standard tool for mapping these features, the potential of terrestrial laser scanning remains less explored. The research compares airborne and terrestrial LiDAR datasets acquired under contrasting environmental conditions, including forested and non-forested areas as well as different relief settings. Particular attention is devoted to evaluating the effectiveness of individual methods for landform detection, parameterization, and volume estimation.

Preliminary observations indicate that the results obtained using different LiDAR approaches may vary according to landscape characteristics and data acquisition methods. The study contributes to the development of detailed geomorphological inventories and provides methodological insights relevant to nature conservation and landscape management in protected mountain environments.

Irena Kholová & Pavel Blažek*

Preservation and Restoration of the Gene Pool of Presumably Autochthonous Silver Fir (Abies alba Mill.) in the Krkonoše Mountains

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The silver fir (*Abies alba* Mill.) was formerly one of the most important tree species in the forests of the Krkonoše Mountains, where it nearly disappeared despite its high historical abundance. This decline has been caused by a combination of factors, particularly historical human activities and gradual changes in environmental and climatic conditions. Increasing the proportion of silver fir while preserving the genetic diversity of autochthonous populations represents one of the main priorities of forest management in this area.

The most effective approach for conserving the genetic diversity of this species is the establishment of the first silver fir seed orchard on the Czech side of the mountains. The orchard will be estabilished using heterovegetative propagation through the grafting of selected scions from high-quality mother trees. Scions were collected from 49 clones of the Krkonoše population during the 2024/2025 dormancy period and immediately grafted onto suitable rootstocks in a specialized forest nursery. A total of 2,352 grafts were established.

The survival rate of the grafted plants immediately after grafting was very good, with first-year mortality reaching 13%. Overall vitality is also good, with 35% of individuals classified as category A (excellent quality) and 40% as category B (slightly reduced quality). The grafted plants will be grown until September 2027 and subsequently planted on a prepared site according to a pre-defined layout. Appropriate subsequent management of the seed orchard will be crucial, as clones typically begin to produce cones within a few years. Regular pruning will be applied to support reproductive output.

*Viera Horáková**

Restoration of Drained Forests Localities in the Krkonoše Mountains National Park

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Wetlands and their significance in the landscape have recently gained increased urgency, particularly in connection with global climate change. This type of ecosystem can significantly support the structured nature of the natural environment. New areas are being formed, inhabited by a range of specialized species of flora and fauna, which contributes to increasing the overall biodiversity in the region. The Krkonoše National Park Administration has set the preservation or restoration of the natural regime of wetland habitats as one of its goals within its management principles.

To achieve this goal, the project "Revitalization of Wetlands in Selected Areas of the KRNAP Territory, Phases I and II" was implemented within KRNAP. The project, funded by the OPŽP II (Operational Programme Environment) program (CZ.05. 4.27/0.0/0.0/17_078/0005869; CZ.05. 4.27/0.0/0.0/20_142/0014092), took place between 2017 and 2023. Interventions were carried out to revitalize these ecosystems in locations previously affected by pollution-induced dieback, unsuitable tree planting, or land reclamation. Concurrently, long-term monitoring was established.

In the initial phase of the project, a study was prepared containing current data on the active occurrence and status of wetland communities in the forests of the Krkonoše Mountains. Based on this study, specific areas suitable for revitalization through the damming of drainage channels were selected. Out of all the revitalized areas, ten were chosen for long-term monitoring. This monitoring includes the establishment of permanent plots and transects to track vegetation changes, as well as the installation of dataloggers to monitor groundwater levels, pH, and temperature. Water samples are also taken at these locations for chemical analysis. As part of the project, more than 40 km of drainage channels were removed across 35 locations.

Markéta Potůčková, Alex Šrollerů, Lucie Kupková, Micha Silver & Arnon Karnieli*

Soil Moisture Retrieval in Mountainous Grasslands Using Optical and SAR Satellite Data Combined with In Situ Measurements

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Grasslands provide essential ecosystem and production functions. Their conservation and appropriate management are therefore critical, with substantial economic and environmental implications. Vegetation growth strongly depends on soil moisture. Copernicus Sentinel-1 and Sentinel-2 observations enable the retrieval of surface soil moisture (SSM) in the uppermost soil layer (0–5 cm). This study examines the challenges associated with using these observations for SSM estimation in mountainous grasslands. The study area comprises a transect of four permanent grasslands in the Krkonoše Mountains.

We employed two models for SSM retrieval. The Optical Trapezoid Model (OPTRAM) relates SSM to a selected vegetation index (VI) and to transformed reflectance in the shortwave infrared band (STR). The upper and lower bounds of the trapezoid are defined by the relationships between VI and STR observed during dry and wet conditions. The second model is based on a time series of Sentinel-1 C-band SAR observations, using changes in the backscatter coefficient between successive acquisitions. Variations in vegetation are accounted for using a VI. Both models are being evaluated against in situ measurements of soil volumetric water content (SVWC) using Time Domain Transmission (TDT) sensors.

Preliminary results indicate that grasslands with continuous biomass cover present challenges for both models. In the case of the OPTRAM model, it is necessary to capture early-season vegetation conditions under both low and high soil moisture levels, which may be difficult in temperate grasslands. A potential solution for constructing a robust model is to collect data across multiple seasons. For SAR data, it will be necessary to focus on the L-band (e.g., PALSAR-2, NISAR), which has a better ability to penetrate vegetation, allowing the backscatter signal to include contributions from both the vegetation layer and the underlying soil.

*Olha Kachalova**, *Michael Matějka*, *Jan Řehoř*, *Kamil Láska*, *Marie Novotná*, *David Tichopád* & *Jana Müllerová*

Reconstruction of Long-Term Soil Moisture Dynamics in Subalpine Grasslands in the Jeseníky and Krkonoše Mountains Using Deep Learning with In Situ Validation

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Subalpine grasslands are vulnerable ecosystems sensitive to drought [1], snowpack variability and freeze-thaw dynamics, yet their soil-water regime remains poorly resolved. We present a deep-learning framework for reconstructing daily soil moisture (SM) in the Jeseníky and in the Krkonoše Mountains over five years.

The model combines in situ observations from 86 TOMST TMS-4 sensors in Jeseníky (2–5-year records) and 25 in Krkonoše (1-year records). Sensors measure SM at −10 cm, soil, ground and near-surface air temperature. Climatic layers are taken from SOILCLIM daily grids of precipitation, air temperature, humidity, radiation, sunshine, wind, ETref/ETa, snow water equivalent, heat/thermal indices, SPEI 1/3/6/12, and soil saturation and water deficit. Selected variables, mainly above-ground temperature and precipitation, were downscaled to 10 m using local/new project meteorological stations. Static geomorphometric and hydrographic predictors are derived from GeoHydroMorphoCZ_10m.

Reconstruction is performed at 10 m resolution and daily time step using an attention-aware LSTM architecture inspired by Li et al. [2]. LSTM layers generate multi-feature vectors from sequential predictor windows, and three attention mechanisms summarize them for SM prediction. This captures delayed responses to rainfall, snow accumulation and melt, evaporative demand and antecedent drought, while highlighting influential predictors and time lags across seasons, elevations and hillslope positions.

The model was cross-validated with withheld periods and sensors to test temporal gap filling and transfer to ungauged grassland pixels. Independent validation will use new 2025–2026 sensor measurements from both areas. The maps will identify drought-prone patches, snowmelt-buffered wet refugia and exceptional water-balance deficits, supporting hydrological vulnerability assessment and providing training data for longer-term reconstruction and future prediction.

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Poster Session III

Climate Change, Forest Dynamics and Mountain Processes

*Ondřej Biemann**

Climate Anomalies Predict Overwintering Losses of Honey Bees in Czechia

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Overwintering losses of honey bee colonies represent a major challenge for beekeeping and pollination services. Although colony mortality is strongly influenced by parasites, pathogens and management, climatic conditions may also affect winter survival by altering colony thermoregulation, brood phenology and seasonal parasite dynamics. We analysed whether monthly climatic anomalies are associated with honey bee colony losses in Czechia.

We combined 11 years of Czech COLOSS monitoring data from 142 postcode areas with high-resolution monthly meteorological data from the Czech Hydrometeorological Institute. Monthly climate anomalies were calculated relative to the 1991–2020 climatological normal and linked to winter colony loss rates for each postcode area and year. We focused on maximum air temperature anomalies and applied beta-regression generalised linear mixed models with random intercepts for postcode area and year. Additional analyses included a February–July response surface, colony-number weighted sensitivity models and a Mundlak within-between decomposition.

February maximum temperature anomalies showed the strongest association with subsequent overwintering losses. The relationship was non-linear, with predicted losses increasing most strongly under large positive February anomalies. July anomalies showed a weaker negative association, suggesting a context-dependent seasonal effect within the observed Czech climatic range. The February signal remained robust in weighted sensitivity analyses and was supported by both within-area year-to-year variation and between-area climatic differences.

Our results suggest that late-winter warming represents an important climatic risk factor for honey bee colony survival in Central Europe. Unusually warm February conditions may disturb overwintering physiology, stimulate earlier brood rearing and increase opportunities for Varroa destructor reproduction before spring. The study highlights the value of long-term monitoring for identifying climate-sensitive periods and supports the development of early-warning approaches for adaptive beekeeping under climate change.

Marek Błaś, Bartosz Jasiński, Elżbieta Myśkow, Aleksandra Słupianek, Hanna Ojrzyńska, Piotr Owczarek & Magdalena Opała-Owczarek*

The Influence of Topoclimatic Variability and Contemporary Climate Change on the Intra-annual Growth Dynamics of Norway Spruce in the Western Sudetes

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For three consecutive growing seasons (2022–2024), the intra-annual growth rate of Norway spruce (*Picea abies*) was investigated at several monitoring sites representing diverse topoclimatic conditions across the Western Sudetes. In addition to standard meteorological observations, soil moisture, stem circumference variations (band dendrometers), and cambial dynamics (following the methodology using a Trephor tool) were continuously monitored. The primary objective of the study was to explain the spatial variability of annual spruce growth dynamics in relation to both intra-annual and spatial variations in weather conditions.

The spatial variability of topoclimatic conditions in the Western Sudetes is most pronounced within the lower montane forest zone, at elevations between approximately 800 and 900 m a.s.l. In this altitudinal belt, the average date of the last spring frost ranges from late April on slopes to late June within flat-bottomed mountain depressions. These enclosed landforms provide optimal conditions for the development of nocturnal radiation inversions (cold-air pooling), resulting in both a high frequency and considerable intensity of frost events. Such frosts may occur even during the climatological summer optimum, causing substantial forest damage. Correspondingly, dendrometric measurements and microcore analyses revealed significant differences in intra-annual tree growth rates among the study sites.

The effects of topoclimatic variability were further amplified by the distinct weather conditions observed during the three consecutive growing seasons. All studied seasons were characterized by positive temperature anomalies, ranging from +0.8 to +2.3 °C, and precipitation deficits corresponding to 7–23% below the long-term average. During periods of spring and summer drought, spruce trees exhibited premature growth cessation or a marked reduction in growth rates, particularly at lower elevations. Under warm and dry growing-season conditions, the lowest radial increment was recorded within the foothill zone, whereas the highest growth rates occurred near the upper timberline.

In summary, climate-growth relationships revealed a pronounced inter-seasonal influence of climatic conditions, particularly precipitation deficits and reduced soil moisture availability, on short-term tree growth responses. Given the projected increase in drought frequency, forest ecosystems of the Western Sudetes are expected to exhibit progressively weaker growth responses, potentially leading to the decline and eventual disintegration of monoculture forest stands-a process that has already been observed in some areas.

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Climatic Influence on Spruce Forest Conditions in the Western Sudetes in the Era of Climate Change

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The forest stand of the Western Sudetes, dominated by the introduced Norway spruce (*P. abies*), revived after the ecological catastrophe of the 1980s, now exhibits distinct variation in condition. The diverse morphology of the Sudetes once influenced the extent and intensity of acid precipitation, translating into spatial variation in annual growth reduction, with the highest intensity in the upper montane zone at the treeline. The current spatial variation is largely a reversal of the relationships observed in those years. After a period of markedly intensive growth in each altitudinal zone, renewed intensive reductions are now observed, particularly in trees at the foot of slopes and on south-facing lower montane slopes. The aim of this study is to explain the dynamics of annual growth of spruce in the context of changing climatic conditions. The analysis is based on dendrochronology of growth cores from 42 locations in the Polish and Czech parts of the Western Sudetes, representing various altitudinal zones, landforms, and their exposures. Mean annual growth values were compared with regional averages of air temperature, total precipitation, and the SPEI drought index from 1961–2022.

Over the past six decades, the Sudetes have seen an upward trend in temperature, and in the last two decades, droughts have become more frequent during the growing season. Warming has caused a varied response in spruce growth depending on water availability: from optimal to a decline of up to –40% at the foothills. The temperature increases before 2000, combined with higher than usual rainfall, contributed to dynamic tree growth. This was observed particularly at lower elevations, but also, with a certain delay, in upper montane forests and at the treeline. After 2000, the positive regional temperature anomaly from the long-term average exceeded 15%. This, in the absence of additional precipitation, resulted in a reversal of the statistically significant relationship between temperature and tree growth and a clear correlation with the SPEI drought index. The strongest negative impact of temperature increases and precipitation deficiency is particularly noticeable in the foothills and concave forms in the lower montane zone. Pearson correlation coefficients for these zones reach –0.7 and –0.8 for temperature, and 0.7 and 0.5 for SPEI, respectively.

*Natalia Pilguj**, *Adam Jaczewski*, *Joanna Wieczorek*, *Tomasz Strzyżewski*, *Bartłomiej Sobczyk* & *Mariusz Figurski*

Application of Numerical Weather Prediction Models for the Sudetes Region

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Numerical weather prediction models are commonly used in operational weather forecasting and atmospheric research. Areas with complex orography, such as mountainous regions, are characterized by high spatiotemporal variability of meteorological elements. For this reason, it is common to apply dynamical downscaling methods and use high-resolution numerical models to provide the most accurate representation of meteorological conditions over such areas. In this work, we present selected examples of the application of the numerical weather prediction models for the Sudetes region. The simulations presented were performed under the EURO-CORDEX initiative, in which the Institute of Meteorology and Water Management-National Research Institute (Poland) is involved. A set of prepared simulations includes reconstruction of weather conditions (1950–2015), and climate projections (2015–2100). Therefore, the modelling results allow presenting the current state and possible future changes under various scenarios.

Numerical modelling results could be applied in various ways. They can be used to perform basic climatologies of meteorological elements (e.g., trends in air temperature and precipitation), or analyses of vertical profiles and specific atmospheric processes. High-resolution numerical models are also widely used to analyze the occurrence of weather hazards, such as severe thunderstorms, or heavy rainfall. Importantly, numerical modelling results can also be used to calculate indices useful from the perspective of societies and economies. With this poster, we want to present several examples of weather prediction model applications to demonstrate the feasibility of using gridded databases across various areas of interest. Presented modelling results and post-processing methods will be used in the "Carpathian-Sudeten Transboundary Climate Assessment" (CaSuT) project (2026–2030), where it is planned to develop databases with higher horizontal resolutions.

*Marek Błaś**, *Hanna Ojrzyńska* & *Marta Rauk*

Thermal Differentiation in the Western Sudetes within the 800–900 m a.s.l. Altitudinal Zone

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The Western Sudetes are characterized by exceptionally high variability in topoclimatic conditions. This study is based on air temperature measurements conducted between 2022 and 2025. The monitoring network consisted of 13 measurement sites located within the 800–900 m a.s.l. elevation belt in the Izera Mountains and the Karkonosze Mountains. The primary objective of the study was to identify and explain the factors and circumstances responsible for the occurrence of pronounced thermal contrasts within this altitudinal zone.

The central part of the Izera Mountains is occupied by an extensive plateau featuring numerous flat-bottomed basins situated in summit positions. These landforms provide optimal conditions for the development of nocturnal radiation inversions and cold-air pools, resulting in a high frequency and intensity of frost events. In contrast, the Karkonosze Mountains, which form a relatively long and compact mountain range, exhibit a warm-slope belt at the same elevation. The mean annual air temperature in Karpacz (872 m a.s.l.) is 3–4 °C higher than at Hala Izerska (845 m a.s.l.), while the mean annual minimum temperature is nearly 6 °C higher. During anticyclonic (high-pressure) weather conditions, air temperature differences between these locations may reach several degrees Celsius, with extreme cases exceeding 20 °C.

The magnitude of thermal contrasts may become even greater during foehn events. The highest temperatures are typically recorded on convex slope sections, lateral ridges, and particularly in the uppermost parts of the Karkonosze Foothills, where the influence of the foehn wind is strongest. Its impact is less pronounced within valleys incising the northern slope of the Karkonosze Mountains, with the degree of influence depending largely on valley depth. Consequently, the thermal conditions in the Kozacka Valley more closely resemble those found within the flat-bottomed interior basins of the Izera Mountains than those characteristic of the northern Karkonosze slope. As a result, during the anticyclonic phase of a foehn event, temperature differences between sites located at the same elevation in the Karkonosze Mountains may reach as much as 15 °C. During the cyclonic phase, however, these differences are considerably smaller, typically not exceeding 5–6 °C.

Martin Erlebach, Veronika Květoňová*, Milan Viktořík & Pavel Klapka*

Avalanche Activity as an Indicator of Climate Change: Evidence from the Krkonoše Mountains

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Avalanche activity is a significant geomorphological and ecological process affecting the functioning of the mountain ecosystems of the Krkonoše Mountains. Although a number of studies document changes in the frequency and nature of avalanches in connection with climate change, less attention is paid to the changes in the relationships between meteorological factors that determine avalanche activity. The aim of this study was to analyze the long-term development of avalanche activity in the Czech part of the Krkonoše Mountains between 1979 and 2020 and to identify changes in the significance and mutual interaction of climatic variables affecting the formation of spontaneous avalanches. The analysis is based on a database of 822 avalanche events supplemented with meteorological data from Luční and Labská bouda. The development of mutual relationships of selected meteorological variables was evaluated separately for four decades using principal component analysis (PCA) and factor analysis (FA). The results confirm the long-term decrease in avalanche size and frequency in the last monitored period, together with the expected changes in climatic conditions, in particular the decrease in snow cover and wind speed, and an increase in temperature characteristics and sunshine. The key finding is the change in the structure of climatic links affecting avalanche activity. While in the first three decades the importance of new snow, wind and temperature conditions dominated, in the period after 2010 the importance of sunshine, temperature gradient and air humidity increased. At the same time, the number of resulting factors decreased, which indicates a higher integration of the climate system and more complex links between individual variables. Moreover, these changes do not manifest themselves spatially homogeneously, but differ between individual types of avalanche paths, with the most pronounced changes observed in the main glacial cirques. The study shows that climate change modifies not only the intensity of avalanche activity, but also the mechanisms of its formation. The analysis of changing relationships between meteorological variables provides new insights into the long-term evolution of the avalanche regime and can contribute to a better understanding of future changes in mountain ecosystems and key phenomena such as anemoorographic systems.

*Marek Kasprzak**

COLDSPOTS – Low Ground Temperatures in the Karkonosze Mountains

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Climate change is transforming ecosystems worldwide, with the strongest impacts observed in polar and mountain regions. One of the least-understood environmental characteristics is the thermal regime of near-surface ground layers, which is strongly influenced by external factors. This knowledge gap also applies to the Bohemian Massif. Until recently, no continuous borehole temperature monitoring comparable to that conducted in the Scandinavian Mountains had been carried out in this region. Such data are essential for assessing whether conditions favourable for persistently low ground temperatures or even microclimatic permafrost still exist in the Karkonosze Mountains, which is the main objective of the monitoring programme presented here. The author refers to such locations as "COLDSPOTS".

The study is based on temperature data from a 15-m-deep borehole (OBSz1) installed at the meteorological station on Mount Szrenica (1,325 m a.s.l.) and from sensors located at sites considered favourable for low ground temperatures. These include the Mały Śnieżny Kocioł cirque, near a long-lasting snow patch, and block fields on Mount Szrenica, Mount Wielki Szyszak and Mount Śnieżka. Preliminary results indicate that ground temperature at a depth of 14–15 m in weathered granite covered by grass vegetation remains stable at approximately 4 °C. Shallower layers show fluctuations controlled by air temperature, snow cover, and intense summer precipitation. Within the voids of block fields, low temperatures persist as long as snow remains present. At the same time, snow insulation may prevent deep ground freezing, as demonstrated at the Mały Śnieżny Kocioł site. Owing to its specific shading conditions, this location remains a promising candidate for microclimatic permafrost, as previously investigated using geophysical methods.

The research was funded by the Polish National Science Centre (NCN) under the OPUS project No. 2021/43/B/ST10/00297 "COLDSPOTS – Low Ground Temperatures in the Sudetes".

Andrzej Traczyk, Krzysztof Migała & Marek Kasprzak*

Long-Term Variability and Projected Frost Conditions in the Karkonosze Mountains and Their Potential Geoenvironmental Impacts

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The authors analysed temperature data from 30 weather stations located in the Arctic and mid-latitude mountain ranges for the period 1971–2020 (Migała et al., 2026: https://doi.org/10.1007/s10584–025–04092–2). Based on these data, trends in contemporary changes in freeze-thaw days (FTD), ice days (ID), and frost-free days (FFD) were identified.

For the Karkonosze Mountains, represented by the station on Śnieżka, a 1 °C increase in the annual mean temperature will result in an increase in FTD from 85 to 87 days, a decrease in ID from 122 to 113 days, and an increase in the number of FFD from 150 to 165 days. Paradoxically, therefore, the projected temperature changes may lead to an increase in the frequency or number of frost cycles in the subalpine and alpine zones of the Karkonosze Mountains.

This may be primarily linked to a shortening of the period during which snow cover remains on the ground, as it acts as an insulator protecting the soil from deeper freezing and stabilising the temperature of its near-surface layers. A thin snow cover and/or its rapid disappearance exposes the ground being exposed to significant diurnal temperature fluctuations (FTD), even during the winter months. During this period, under normal conditions, there is usually a long-lasting, thick snow cover. This may also apply to the altitudinal zone encompassing the upper forest limit. The absence or rapid disappearance of snow cover will have an adverse effect on this ecosystem. The dieback of forest and subalpine vegetation will result in greater exposure of the ground surface, thereby increasing the potential for frost penetration.

The effects of these frost-related processes will include enhanced degradation of subalpine peatlands and soil cover. This will result from the synergy of frost-related processes (frost heave, needle ice), surface runoff caused by the rapid disappearance of snow cover, and wind erosion during periods of soil desiccation.

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Monitoring the Development of Natural Spruce Forests in the Krkonoše Mountains over the Past 30 Years

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During the years 1992 to 1994, five permanent research plots (PRP) were established by the staff of the Institute of Landscape Ecology of the ČSAV (now CzechGlobe) throughout the territory of the Krkonoše National Park. At each of the five monitored sites (Mumlavská hora, Alžbětinka, Modrý důl, Slunečné údolí, Pašerácký chodníček) a PRP measuring 50 × 50 m was established and further subdivided. Geodatabases were created for each PRP at a scale of 5 × 5 cm for soil maps, dead wood, the position of living trees and their projections. From 1994 to the present, these PRPs have been periodically monitored for the condition of Norway spruce crowns (assessing both defoliation and crown transformation), natural rejuvenation, herbaceous vegetation, the occurrence of mushrooms, signs of red deer presence, and twice a year, litter has been collected using five litter frames.

In 2018, within each 10 x 10 m subsections, the community of ectomycorrhizal (ECM) fungi (fruiting bodies, survey of ECM tips, mycelia in the soil) and soil samples were collected at three selected PRPs (Alžbětinka, Modrý důl, and Pašerácký chodníček) in order to determine the connection between the occurrence of ECM fungi, crown damage, and soil properties.

To monitor the shift of forest ecosystems above the upper forest line, a total of 30 circular PRPs of 500 m2 were established in 2014–2016 on two altitudinal transects, in the altitude range of 1,210 to 1,390 m a.s.l. In 2016 and 2017, six meteorological stations were installed on the lower and upper PRPs, which are still in operation today. An assessment of the state of crowns, natural rejuvenation, vegetation diversity and a survey of ECM symbioses were carried out all 30 plots.

Overall, the five PRPs have undergone an asynchronous alternation of degradation and regeneration phases over the past 30 years, with most plots currently in the regeneration phase. Selected results are demonstrated and discussed on a poster.

Grzegorz Urban, Ondřej Fatka, Stanislava Kliegrová, Michał K. Kowalewski, Henryk Marszałek, Dáša Richterová, Michał Rysiukiewicz, Jana Solánská & Ilona Zusková*

Groundwater in the Karkonosze and Jizera Mountains in the context of contemporary climate change

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Observed long-term changes in meteorological elements, such as increasing air temperature, negative trends in precipitation sums, increased frequency of liquid precipitation in the winter season, decreased snow cover depth and duration, as well as snow water equivalent, are causing changes in groundwater resources.

From 1974 to 2024, a decline in groundwater levels and reduced spring yields were observed in the Czech part of the Western Sudetes (no data from a comparable period is available on the Polish side). The largest significant negative correlations were observed during the warm season of 1995–2004. This decade, as well as the years preceding it, was characterized by frequent occurrences of atmospheric and hydrological droughts. In the decade 2015–2024, at measurement points previously characterized by a long-term decreasing trend, a reversal in groundwater trends was observed – from negative to positive. This period also saw a change in the trend direction, from negative to positive, and a strong increase in precipitation sums. The clear increased trend in precipitation sums over the last decade is crucial for shaping groundwater resources; it offsets the impact of the successive increase in air temperature. This process is facilitated by the strong sealing of the Karkonosze-Izera Massif and the considerable thickness of the weathered sediments.

With climate warming, the groundwater trend has reversed over the past dozen or so years – from negative to positive, or the downward trend has slowed, as precipitation sums are increasing and their structure is changing. Groundwater monitoring should continue to correctly interpret changes in the groundwater balance.

Poster Session IV

Landscape Evolution, Geodiversity and Human Impacts

*Andrzej Traczyk** & *David Krause*

Geomorphological Controls on the Genesis of Proto-Cirques in the Karkonosze Mountains

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Based on an analysis of an ALS LiDAR DEM and field surveys, the authors identified 16 initial forms of so-called proto-cirques (a term used by Grove in 1961) in the Karkonosze Mountains. The presence of such forms in the Karkonosze Mountains has been noted, among others, by Vitásek (1924), Šebesta and Treml (1976), and Pilous (2019).

The analysed features are distributed within an altitudinal range of 970–1,360 m a.s.l. Most of them (Type 1) are situated on the eastern side of broad, rounded mountain ridges, whereas the remainder (Type 2) are found in the upper reaches of deeply incised river valleys. GIS analysis has shown that the decisive factors in the formation of proto-cirques may have been snow-drift conditions (Type 1 – the presence, behind the proto-cirques, of extensive gently sloping hillslopes) and/or turbulent conditions (Type 2 – snow accumulation in turbulent zones below sharp slope edges delimiting river valleys). In addition to snow-drift conditions, insolation also played a significant role, as it favoured the preservation of snow deposits and enabled their transformation into firn or glacial ice. This, in turn, controlled the development of erosion (exaration), transport, and glacial accumulation (moraine ridges).

Forms of proto-cirques are also known from other mountainous and upland areas which remained within the glacial – periglacial Pleistocene/Holocene zone (Roth 1944, Gams 2008, Fezer 1957, Rapp 1984, Galabala 1997). Reports of proto-cirques from other regions of the Northern Hemisphere suggest a broader palaeogeographical significance of these landforms. In areas where local mountain glaciation occurred during the Pleistocene, such features indicate the presence of a transitional zone in which glacial landforms could have developed well below the regional snowline. In other areas, where topography favoured snow-drift processes and locally enhanced snow accumulation, these forms constituted an equivalent of mountain glaciation ("embryonic glaciation" – Grigor'ev 1930).

*Krzysztof Parzóch**

Monitoring of High-Energy Geomorphological Processes in the Area of KPN

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The Karkonosze Mountains, often classified as medium-high mountains, are a place where various catastrophic phenomena (high-energy processes) frequently occur. Knowing how often these processes happen and how intense they are is essential for a proper and complete description of the morphogenetic system of the Karkonosze. Additionally, in the era of climate change and increasing instability of weather events, such occurrences are expected to become more frequently in these mountains. The goal of the activities launched in 2024 is to monitor the processes currently shaping the landscape. Field observations include (1) the degradation of slope covers along tourist trails (including those protected against erosion), (2) assessing the effectiveness of anti-erosion measures in erosion gutters formed after logging, and (3) inventorying episodes of mass movements and other high-energy processes. The research will be interventionist in nature: activating the process will trigger fieldwork. This work will aim to provide a detailed description of the phenomenon: morphometric parameters, determining the cause of movement, etc.

The activities carried out in collaboration with the Karkonosze National Park aim to fully document catastrophic (high-energy) geomorphological events in the KPN area. The main goal is to coordinate actions between the Park services and the staff of the Department of Geomorphology at the Institute of Geography and Regional Development. Direct field observations, conducted from various aspects and continuously by the Park services using ArcGIS Field Maps, will be uploaded to the ArcGIS Enterprise system, which will be accessible to designated Institute staff.

*Jiří Bašta**

The Paradox of Berger's Death (1865)

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Assistant forester Vinzenz Berger died completely unexpectedly. Even in the 19th century, an avalanche on one of the Krkonoše spurs, at an elevation of just over 900 metres, was a tragic rarity, and today the conditions required for such an event practically no longer exist. The cause of the accident is revealed by forest management records held in the collections of the Krkonoše Museum and by the KRNAP Administration's inventory of geomorphological features.

*Petra Šťastná**

Strážné Quarry – an Inconspicuous Gem of the Krkonoše Mountains

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Strážné Quarry, also known as Hříběcí Quarry, is an exceptionally valuable natural history site located in a former limestone quarry where natural succession has been taking place since extraction ceased in 1974. Owing to its limestone bedrock and the diverse mosaic of habitats – including dry calcareous grasslands, rock faces, wetlands, woodland edges, and early-successional forest communities – the site supports a high diversity of plant and animal species.

The locality is particularly important for its population of the common spotted orchid (*Dactylorhiza fuchsii*) and other rare plants, including early coralroot (*Corallorhiza trifida*), one-flowered wintergreen (*Moneses uniflora*), and grass-of-Parnassus (*Parnassia palustris*). It also provides habitat for protected amphibian and reptile species and serves as a hibernation site for several bat species.

Entomological surveys have confirmed the presence of numerous rare and threatened invertebrates, including the bee beetle (*Trichius fasciatus*), the green click beetle (*Ctenicera virens*), the leaf beetle *Sclerophaedon carniolicus*, the weevil *Trachodes hispidus*, and the high brown fritillary (*Argynnis adippe*).

The significance of the site also lies in the preservation of geological and karst features associated with the crystalline limestone deposit and in the existence of a unique mosaic of successional habitats that creates favourable conditions for the long-term maintenance of high biodiversity. To preserve these conditions, management measures have been carried out at the site since 2015, including the removal of woody vegetation and the mowing of the wetland areas on the quarry floor.

Paula Przygoda-Kuś, *Mateusz Szczepańczyk**, *Aneta Urbanek* & *Aleksandra M. Mirończuk*

The Impact of Land-Use on Microplastics Concentrations in the Soil, with Particular Focus on Natura 2000 Sites and the Karkonosze National Park

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Microplastics are plastic fragments ranging in size from 5 mm to 1 µm. To date, most studies on microplastics have focused on their presence in aquatic environments, such as rivers, lakes, and oceans. Considerably less is known about their occurrence in soils, even though soils may be one of the main places where they accumulate.

The aim of the project is to explore whether if there is a link between land-use and the concentration of microplastics and dominant synthetic polymers in soil. Soils samples were collected from six different types of land-use: agricultural soils (1) fertilized or (2) not fertilized with sewage sludge, (3) areas near traffic routes, (4) areas near factories, (5) urban greenery, and (6) areas with limited antropopression.

Due to the lack of standardized methodologies for the sampling, isolation, identification, and quantification of microplastics in soils, the project will also focus on optimizing analytical procedures. The optimization process will focus on improving the efficiency of organic matter removal, enhancing density separation efficiency and increasing the reliability of polymer identification. Preliminary visualization and quantification of microplastics were carried out using fluorescent staining techniques, including Nile Red and Rose Bengal staining. Rose Bengal reduces false positives by staining only natural fragments, leaving microplastics unstained.

The results of this study will contribute to a better understanding of the occurrence and distribution of microplastics in soil across different land-uses.

*Michal Skalka**

How Do We Count Visitors in the Krkonoše Mountains and Why?

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The Krkonoše Mountains National Park (KRNAP) ranks among the most visited national parks in the world. But how do we actually count all those visitors? Where do they come from, how long do they stay in the park, and – perhaps most importantly – is all this expensive data actually worth it?

This presentation introduces our methodology for collecting data via SIM cards. While almost every adult in the Czech Republic carries a mobile phone, this method has its limits, particularly when monitoring smaller areas. To get a truly comprehensive picture of visitor behavior, we must combine these digital footprints with other methods.

Our analysis, covering the period from November 2024 to August 2025, interprets the movement of SIM cards to distinguish between day trippers, tourists, commuters, and local residents. We even attempted to track "cross-visits" – for example, whether the opening of the Treetop Walkway has helped ease the pressure on the summit of Sněžka. As it turns out, the relationship between different tourist destinations is a complex puzzle with no simple solution. However, the data revealed one surprising fact: the average daily visitor numbers on Sněžka in February are nearly the same as in August.

The overall trends show that while visitor numbers in the Krkonoše Mountains continue to grow slightly, the length of visitors' stay is shortening. Roughly one-fifth of all visitors come from abroad, primarily from Poland, Germany, and the Netherlands.

Ultimately, these findings are vital for the KRNAP Administration. They help us plan budgets, maintain trails, prepare multilingual materials, and organize our ranger services. Above all, they serve as a crucial tool for building and maintaining positive relationships with our local communities.

*René Jirmus** & *Adam Stražovec*

Footprints in the Dark: Spatiotemporal Patterns of Nighttime Hikers

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The increasing popularity of outdoor recreation has led to a significant temporal shift, with hiking activities increasingly extending into the night. This emerging trend poses unique challenges for protected area management, particularly in highly vulnerable alpine environments. This study investigates the spatiotemporal dynamics of nocturnal hiking within the Krkonoše National Park (KRNAP), the most heavily visited national park in the Czech Republic.

To analyze these patterns, we utilize long-term continuous data collected from a comprehensive network of automatic trail counters deployed across key tourist routes, ranging from mountain valleys to subalpine ridges. Human presence data were temporally filtered to isolate traffic occurring between local sunset and sunrise, allowing for a detailed evaluation of hourly, weekly, and seasonal variations.

The results reveal distinct spatiotemporal clustering of nighttime hikers. Nocturnal traffic is not uniformly distributed across the park but is highly concentrated along specific high-altitude corridors, most notably on the routes leading to Sněžka Mountain. Temporally, nighttime activity exhibits sharp spikes during summer weekends, under clear weather conditions, and during full moon phases, largely driven by the popular phenomenon of chasing the sunrise from mountain summits. Conversely, lower-elevation forest trails display negligible nighttime traffic, indicating that nocturnal hikers are highly destination-oriented.

These findings highlight critical intersections where intense nighttime recreation overlaps with strictly protected core zones, potentially disrupting vulnerable local wildlife during sensitive nocturnal hours. By providing a clear, data-driven visualization of where and when nighttime activity occurs, this study offers essential insights for national park authorities to design targeted visitor-guidance strategies, optimize conservation measures, and balance recreational demands with ecological preservation.

Marta Pyziołek & Marek Kasprzak*

Pleistocene Glaciation of the Łomnica Valley: Identification of Glacial and Periglacial Landforms and Palaeoglacier Reconstruction

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The Łomnica Valley in the Karkonosze Mountains preserves clear evidence of past glacial activity accompanied by numerous landforms associated with periglacial processes. It is one of the best-preserved glacial landscapes in the Sudetes. Despite extensive geomorphological investigations, numerous environmental studies, and the widespread availability of digital datasets, a comprehensive and unambiguous synthesis of the extent and thickness of the former glaciation remains lacking. In this study, the existing literature was reassessed, and a detailed analysis of a high-resolution Digital Terrain Model (DTM) was conducted using GIS-based methods to reconstruct the palaeoglacier of the Łomnica Valley. Glacial and periglacial landforms were identified and mapped, and their spatial distribution and morphological characteristics were used to delineate the former glacier's boundaries. The glacier surface reconstruction was carried out using the PalaeoIce toolbox available in the ArcGIS Pro environment. The results indicate that at its maximum extent, the glacier covered an area of approximately 2,497,188 m^2, with an estimated ice volume of about 105,532,276 m^3, corresponding to approximately 96,795,100 m^3 of meltwater. Based on geophysical measurements using the electrical resistivity method, we also reconstrructed the shape of a smaller glacial lake near the Hunter's Lodge, now filled with mineral and organic sediments. Based on the measurements, we can also identify the rocky outcrop that once enclosed the lake. Further research is needed to establish a detailed chronology of glaciations in the Karkonosze Mountains and to integrate the available datasets.

*Milan Viktořík**

Connectivity Models as a Key to the Preservation of Grassland Areas

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Mountain grasslands form an important component of the cultural and ecological landscape of the Krkonoše Mountains. Their ongoing decline and spatial fragmentation may reduce landscape connectivity and complicate the long-term conservation of these semi-natural habitats.

This study applies graph theory and resistance-based connectivity modelling to propose a potential ecological network for mountain grasslands in the Krkonoše Mountains. Structural characteristics and the identification of core areas of grasslands were assessed using landscape pattern and fragmentation analyses in the GUIDOS Toolbox. Grassland core areas were represented as nodes, while their potential connections were evaluated using least-cost-path and circuit theory approaches implemented in Linkage Mapper and Circuitscape.

The resulting models identified core grassland patches, stepping-stone areas, potential corridors, and locations where connectivity is constrained by settlement, transport infrastructure, forest cover, and other landscape barriers. The comparison of modelling approaches also revealed alternative connections that would remain overlooked when considering only Euclidean distance or a single least-cost route.

The proposed network provides a spatial framework for identifying priority areas for maintaining or restoring grassland connectivity. The results demonstrate how graph-based and circuit-theory models can support landscape planning and the conservation management of fragmented mountain grasslands in the Krkonoše Mountains.

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Co-funded by
the European Union

Czechia – Poland