Annual meeting of the High-Mountain Research circle

Jahrestagung des Arbeitskreis Hochgebirge

2023

Program and Abstract Book

Marburger Haus, Kleinwalsertal, 1-4 June 2023

Organizing Committee:

Maaike Bader, Lirey Ramírez, Nishtha Prakash

Faculty of Geography, University of Marburg

Program AKH 2023

Thursday, June 1st

18:30	**Dinner**

Friday, June 2nd

07:45	**Breakfast**
08:50	Welcome and Introduction
09:00 -17:00	Excursion
18:30	**Dinner**

Saturday, June 3rd

07:45	**Breakfast**
08:45	Registration
09:00	Christian Körner: *Shades of grey: sorting out treeline concepts*
09:30	Nishtha Prakash: *Remote sensing of alpine-treeline ecotone patterns*
09:45	Lirey Ramírez: *Microsites preferences of individuals of* Larix decidua*,* Pinus uncinata *and* P. cembra *in calcareous and siliceous treeline sites in the French Alps*
10:00	Georg Miehe: *'Mind the Gap': What do we know about the reasons for the absence of forests in mountains?*
10:30	**Coffee break**
11:00	Peter Wolff: *Summarizing emerging insights of the Mountain Invasion Research Network (MIREN) and the Global Observation Research Initiative in Alpine Environments (GLORIA)*
11:30	Carolina García Lino: *Plant communities in Andean cushion peatlands mediating microbial decomposition: Consequences for carbon sequestration*
12:00	Anke Jentsch: *Response of alpine and subalpine grasslands to suddenly changing climate – evidence from a translocation experiment across the European Alps.*
12:30	**Lunch break**

14:00	Yujie Niu: *Soil cracking in the degradation of alpine Kobresia grasslands on the Tibetan plateau.*
14:30	Andrei Dörre: *Food security in the Pamirs, Tajikistan*
15:00	Marika Stutzriemer: *Ongoing paleoenvironmental research in the Fotsch Valley – first oxygen isotope records derived from hemicellulose sugars of two subalpine mires*
15:30	Lightning talks posters
16:00	**Poster session & Coffee break**
16:45	Matthias Braun: *Glaciological research in Patagonia*
17:15	AK Hochgebirge "business meeting"
18:30	**Dinner**

Sunday, June 4th

Breakfast and departure

Posters

Marta DeGiuli: *Arrested succession on fire affected slopes in the Northern Limestone Alps: Factors controlling krummholz pine dynamics and subalpine forest regeneration on the Arnspitze.*

Juliana Freitas-Santos: *Potential biogeophysical effects of vegetation changes in complex topographical areas*

Svenja Wanke: *Evaluating vegetation patterns across altitudinal gradients in the European Alps using the standardized monitoring approach of the Eurasian Dry Grassland Group (EDGG).*

Antonia Warnstedt: *The 2015 Villarrica eruption in the Southern Andes of Chile: Retracing lava flows and lahar paths*

Christian Sommer: *Regional glacier mass change measurements in the European Alps from interferometric spaceborne SAR*

ABSTRACTS

Shades of grey: sorting out treeline concepts

Christian Körner[1]

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The way science moves forward is by careful observation, pattern finding, formulating hypotheses and testing these. In long cycles that might yield a theory. In ecology, this procedure often finds limits, because neither the objects, the patterns, nor the causes are sharply defined. Treeline ecology is a classic example where the ambiguous meaning of terms und underlaying assumptions led to a 'Babylonian' confusion, that prevented the research community from moving from pattern finding to hypothesis testing, and, as a consequence, has difficulties in arriving at consolidated theory. Because there are no wrong or correct concepts, the way forward is a clearly as possible definition of terms. As pedantic this might appear, one might return to more pragmatic approaches in a second step, where the shades of grey of the reality find a solid reference to compare with. I will explain why the dual niche concept is a promising way toward hypothesis testing and for developing theory of the global treeline phenomenon. Once the position of the edge of the fundamental niche of the life form tree is known, the space between that boundary and the edge of the realized niche of actual tree distribution is defined. This opens terrain for exploring the causes of the discrepancy of the two in a defined space. A central element of that concept is separating commonness from local peculiarity, not giving weight to either, but simply clarifying the difference. This rises the issues of defining the fundamental niche. Again, there is no wrong or right, but simply a need to give an answer that holds the test across the mountains of the world. I will close by illustrating current treeline dynamics in the central Alps. These examples underpin the advantage of operating in a defined niche space.

Remote sensing of alpine-treeline ecotone patterns: Possibilities and challenges

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Alpine-treeline ecotone patterns at different scales indicate different ecological and disturbance processes. At the global scale, climate data allows for modelling the elevation of the potential treeline quite accurately, though with some regional deviations. At the hillslope scale, however, variability in demographic processes – that is, trees establishing, surviving, growing, sometimes being deformed into krummholz, and dying out of old age or due to stress or disturbance – leads to variability in spatial patterns in treelines ecotones on mountainsides globally. Although manual surveys yield excellent quality data to completely characterize treeline ecotone patterns, this approach is time-consuming, labour intensive, and not feasible for many hard-to-access mountain areas. Remote sensing enables extensive spatial coverage and global comparison of treeline ecotones. While at the landscape scale, medium to coarse resolution imagery (10-30 m spatial resolution) has been used to delineate the mountain forest from grassland, at the hillslope scale, high (<1 m spatial resolution) to very high-resolution imagery (VHRI) (<50 cm) can be used to detect and interpret structure and patterns of treeline ecotones. Using VHRI, a remote sensing-based method can be applied to a diversity of treeline sites – even those that are difficult to access – ensuring that the pattern descriptions and subsequently pattern-process relationship models are comparable. However, such data are only available for some sites, especially those in the global north, and continue to be prohibitively expensive to study treeline ecotones in less accessible and resources- and data-deficient mountain ranges. One way to fill in this data gap is to collect drone-based data, ideally shared with other mountain researchers through a database of very high-resolution aerial treeline imagery that is based on a uniform data collection protocol. I will emphasize the need for and present the current status of VHRI data availability in treeline and alpine ecosystems and suggest some potential ways forward.

Microsites preferences of individuals of Larix decidua*,* Pinus uncinata *and* P. cembra *in calcareous and siliceous treeline sites in the French Alps*

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Seedling establishment is crucial for elevational advance of trees in and above the treeline ecotone, but the characteristics and availability of safe sites for tree regeneration in alpine ecosystems are not well understood. The conditions that constitute a safe site are likely to vary between tree species, and conditions are likely to interact, e.g. in edaphically dry sites only topographically wet microsites may be “safe”. We aimed to describe the microhabitat preferences of the conifers *Larix decidua, Pinus uncinata* and *Pinus cembra* in areas with two different types of geologic origins. We selected four sites, two with calcareous and two with siliceous parent material, in the French Alps. At each site, we located the upper treeline ecotone, selected 50 individuals and compared the establishment microsites with 50 randomly-placed reference microsites in terms of their substrate, ground cover, meso- and microtopography, and nearest shelter. We also evaluated the health status of the individuals. We found that the three-tree species were established in similar microsites and usually with some shelter. Those with shelter were mostly close to rocks, since rocks are widely available, and those without shelter showed a preference for patches with low vegetation, and in the siliceous sites also with dwarf shrubs like *Vaccinium*, but avoided *Juniperus* shrubs. About two third of the individuals had a krummholz form or were bent, but only a small proportion presented signs of mechanical damage, desiccation, snow mold, and/or herbivory. Since safe-site availability in these areas is high, although even in such microsites stress and disturbance are obviously still limitations, seed availability is likely a main limitation for tree- species establishment in these alpine treeline ecotones.

Summarizing emerging insights of the Mountain Invasion Research Network (MIREN) and the Global Observation Research Initiative in Alpine Environments (GLORIA)

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We summarize and synthesize emerging insights from MIREN and GLORIA:

MIREN, i.e.: “Climate change and other global change drivers threaten plant diversity in mountains worldwide. A widely documented response to such environmental modifications is for plant species to change their elevational ranges. … Here, we present a standardized protocol developed by the Mountain Invasion Research Network (MIREN) to systematically quantify global patterns of native and non-native species distributions along elevation gradients and shifts arising from interactive effects of climate change and human disturbance.” (Haider S et al. 2022: Think globally – measure locally: The MIREN standardized protocol for monitoring plant species distributions along elevation gradients. Ecology and Evolution 12:e8590.)

GLORIA, i.e.: “Global-scale approaches to monitor climate and biotic change in high mountains … have found that species from lower elevations are colonizing habitats on mountain summits at an accelerating pace, with five times faster rates than half a century ago. Further, repeated in situ surveys in permanent plots showed a widespread transformation of alpine plant community assemblages toward more warmth-demanding and/or less cold-adapted species. Concurrently to widespread increases in overall species richness, high-elevation plant species have declined in abundance and frequency. Strongly cold-adapted plant species may directly suffer from warmer and longer growing seasons through weak abilities to adjust respiration rates to warmer conditions. Combined effects of warming and decreasing water availability will amplify detrimental effects of climatic stresses on alpine biota. Many of the dwarf and slow-growing species, however, will be affected when taller and faster-growing species from lower elevations invade and prosper with warming in alpine environments and, thus, threaten to outcompete locally established species.” (Pauli & Hallo 2019: High mountain ecosystems under climate change. In Oxford Research Encyclopedia of Climate Science, pp. 1-56. Oxford University Press.)

Plant communities in Andean cushion peatlands mediating microbial decomposition: Consequences for carbon sequestration

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Tropical Andean cushion peatlands store high amounts of carbon (C). They are highly vulnerable to climate-change-induced shifts in their hydrology caused by decreasing rainfall. This results in the reduction of belowground water capture, with strong consequences for the C sink-source balance. Besides water, vegetation also plays an important role in determining C accumulation and loss. Well-conserved Central Andean peatlands are dominated by vascular cushion plants, but other life forms, such as grasses, can also be found. In comparison to grasses, cushions are slow-growing and produce recalcitrant litter. Therefore, we expect that, under the same hydrological conditions, soils under cushion plant communities (*Distichia muscoides*, *Oxychloe andina*) lose less carbon than soils under grass-dominated plant communities. High soil microbial activity and biomass are associated with decomposition and, consequently, C loss, but also with higher turnover of microbial cells. We explore how different plant communities mediate microbial decomposition and, consequently, C loss in a high-Andean cushion peatland. Basal microbial respiration and microbial biomass decreased with soil depth. However, we did not find differences in basal respiration and microbial biomass in soil under different plant communities.

Community weighted means (cwm) of leaf trait (C/N ratio, lignin, hemicellulose) of the *D. muscoides* community were lower than the community dominated by *O. andina*. While, cwm leaf traits (percent N, tannins and phenol) of community *D. muscoides* were higher than in the *O. andina* community.

There was no relation between basal soil respiration and cwm of leaf

functional traits of plant communities. Our results highlight that cwm leaf functional traits underpin the quality and differences of litter from the study plant communities. However, microbial respiration is not the best predictor for understanding how vegetation affects C loss, but other proxies such as decomposition may be more informative, as well as direct measurement of gas fluxes.

Response of alpine and subalpine grasslands to suddenly changing climate – evidence from a translocation experiment across the European Alps

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Warming of mountain regions is projected to be three times faster than the global average. However, so far, only few studies have reported species loss in mountain regions due to warming, and even fewer have explored mechanisms facilitating the colonization of high elevation ecosystems by novel species.

Despite the apparent resistance of mountain plant communities to climate change, alpine and subalpine ecosystems are currently under close scientific observation and predicted to generate an "extinction debt". Following five years of exposure to warmer and drier downslope climates, we tracked plant community responses of alpine and subalpine species in translocated plant-soil mesocosms and studied their interactions with novel competitors at the trailing edge of their distribution range. We found increasing species turnover rates under climate warming. Gradual extinction of species from high elevation sites was followed by the colonization of lowland species, particularly after the severe European drought year in 2018.

Our downslope translocation experiment suggests 'environmental filtering' rather than 'competitive pressure' as a crucial mechanism for the facilitation of novel species colonization in mountain plant communities – highlighted by a time lag between the extinction of native species and the colonization of novel species.

Such time lags in plant community change and reassembly can be explained by interacting climate stressors, such as warming and drought, which gradually erodes the competitive balance and triggers threshold dynamics in susceptibility to colonization. Destabilized and thinned communities provide a window of opportunity for novel species colonization. Our study thus provides experimental evidence of an emerging extinction debt in mountain plant communities suggesting potential threshold dynamics in a long thought inert system.

Soil cracking in the degradation of alpine Kobresia *grasslands on the Tibetan plateau*

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Soil cracking is an important feature of degraded terrestrial ecosystems. Soil crack opens the closed, intact grassland, alters microtopography, and influences the dynamics of soil nutrients and water, further affecting plant community composition and distribution. Despite their importance, the patterns and causes of soil cracks related to grazing management on alpine grasslands of the Tibetan plateau have been rarely reported and poorly understood. We used a comprehensive cross-scale approach to investigate the distribution of cracked- soil areas in the eastern Tibetan plateau (mainly in traditionally grazed alpine steppes, meadows, and swamps), then selected the grazing-induced parameter that was related to the cracks at a small scale (i.e. 1 ha), and quantified the effects of microtopography (raised areas and healed cracks) on water infiltration at a micro scale (i.e. crack patch). Additionally, we evaluated the role of soil cracking for the degradation of alpine grasslands.

Our results suggest that cracks only form in *Kobresia*-dominated grasslands of the Tibetan Plateau, if the local carrying capacity is exceeded, as soil cracking was closely related to the increased soil compaction caused by high stocking rates. Initial and continued infiltration rates of the healed cracks were significantly higher than those in the raised areas in the center of the patch mosaics.

We propose a new model for alpine meadow degradation which incorporates the cracking phenomenon and provides easy-to-measure, early warning indicators to prevent overgrazing and cracking. We suggest that the cracking stage is the most critical turning point in the process of *Kobresia* grassland degradation and that grassland managers should pay more attention to these phenomena to prevent severe degradation on the Tibetan Plateau. Linking patch dynamics and plant functional traits to emerging disturbance theory, our future work will focus on the nonlinear responses of plant communities in *Kobresia* ecosystems facing collapse.

Food security in the Pamirs, Tajikistan

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Ensuring physical and economic access to sufficient, safe, and nutritious food for a healthy and active life for all people is an ongoing global challenge. For mountainous regions in the so-called "developing world," an increase in the number of people considered vulnerable to food insecurity has been noted since the turn of the millennium. Remoteness due to challenging topography, natural hazards, and local impacts of global environmental change, have been identified as determinants that aggravate mountain food systems, along with armed conflict, resource degradation, and limited access to markets, social services and facilities, and off-farm income opportunities. In Central Asia, development aligns with these sobering global dynamics (FAO 2015; Romeo et al. 2020). Case studies have the potential to flesh out such general findings with detailed and context-specific accounts of the complexity of the subject under study, which can then be made available to policymakers, development practitioners, and civil society activists. Against this backdrop, this paper utilizes a case study conducted in the Pamirs of Tajikistan to address the question of how the human nutrition situation plays out in the specific local context of Zong Village, a remote, rural mountain settlement in the Gorno-Badakhshan Autonomous Province. The aim is to understand and reconstruct which conditions influence the general food situation on site, the parameters upon which unequal nutrition patterns of households in the community depend, and which dynamics these patterns exhibit in concrete cases over time during the course of one year. Multiple empirical social research methods were used to generate the data of the study, including a group interview with local leaders, guided interviews with informed stakeholders, a standardized household survey, and the keeping of food diaries by representatives of selected households of Zong. Preliminary results show that a wide range of challenging conditions make food security difficult, that exceedingly close relationships exist between the socioeconomic status and dietary patterns of individual households, and that these patterns exhibit periodic and episodic fluctuations.

Ongoing paleoenvironmental research in the Fotsch Valley – first oxygen isotope records derived from hemicellulose sugars of two subalpine mires

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During the last years, our working group focused within the project “Ullafelsen” on geoarchaeological research in the Fotsch Valley (Stubai Alps, Austria) (Zech et al., 2021). Given that mire archives offer great potential for paleoenvironmental-and climate reconstructions, apart from soil profiles on the Ullafelsen itself, two subalpine mires, namely the "Potsdamer Hütte Mire" (1970 m a.s.l.) and the "Schwarzmoos" (2010 m a.s.l.) were investigated within a pilot study. Radiocarbon dating for both sites indicates that peat formation started during the Early Holocene and age-depth models were established using R Bacon. Based on first results from elemental, biomarker, palynological and stable isotope analyses carried out on the samples from the “Potsdamer Hütte Mire”, a contribution to reconstructing the landscape evolution, palaeoclimate and human impact is presented by Lerch et al. (accepted). We will present and discuss respective results and ongoing work with a focus on the oxygen isotopic composition of hemicellulose-derived sugar biomarkers ($\delta^{18}O_{sugars}$).

Glaciological research in Patagonia

Matthias Braun[1]*, Moritz Koch[1], Christian Sommer[1], Philipp Malz[1], Norbert Blindow[1], Illaria Tabone[1], Johannes Fürst[1], David Farias[2], Pedro Skvarca[3], Lucas Ruiz4, Ricardo Jana[5], Marius Schaefer[6,] Veit Helm[7], Jörg Brauchle[8], Johannes Fürst[1]

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The Patagonian icefields are one of the strongest changing ice masses outside the large ice sheets. The maritime climate on the west coast and the very strongWest-East moisture gradient lead to a highly sensitive setup against further climatic changes, especially regarding shift in the westerlies. The presentation will review concurrent activities of our groups. We will present ice volume and mass changes over different periods determined from bi-static TanDEM-X radar interferometry. Those results will be integrated with measurements from laser scanning, aerial photogrammetry and GNSS observations from various campaigns including surveys using the German research aircraft Polar-5 in Nov. 2021. Our study will be complemented with analysis of glacier front position changes as well as changes in ice dynamics of major outlet glaciers derived form Sentinel-1 time series. Results from measurements of ice thickness using a helicopter-based 25 MHz radar system in 2022 provide new insights in glacier geometry of Perito Moreno and Viedma glacier. Our data collection will be integrated into a new ice thickness reconstruction and shall form the base for subsequent ice dynamic modeling and sensitivity studies.

Poster

Arrested succession on fire affected slopes in the Northern Limestone Alps: Factors controlling krummholz pine dynamics and subalpine forest regeneration on the Arnspitze

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On the steep, subalpine slopes of the Northern Limestone Alps, forests dominated by *Larix decidua* Mill, *Picea abies* Karst and krummholz vegetation such as *Pinus mugo* Turra help minimize erosion, avalanches, and other geomorphological activity. They grow in extreme environments such as exposed mountain flanks or scree slopes, yet, *Pinus mugo* stands are very sensitive to forest fire, and regeneration after such events is slow or often absent. The reasons for this arrested succession and mechanisms by which it is overcome are still not fully understood. Potential causes of the observed arrested succession are 1) microclimatic inhibition due to extreme near-surface temperatures and drought, 2) vegetative competition by graminoids and forbs, 3) nutrient deficiency due to erosion of organic substrate, 4) grazing pressure on tree seedlings by chamois, and 5) missing topographic safe sites after fire. We investigated the effects of these agents on two subalpine slopes of the Arnspitze, which burned in 1946 and 1947, comparing them to comparable unburned areas. We found that mean monthly temperature as well as number of days with mean soil temperatures below freezing were significantly negatively correlated with plant species richness, and mean monthly temperature and moisture were also significantly negatively correlated with vegetation cover. The presence of isolated conifers dampened drought and heat, while lethally high temperatures for saplings of up to 52°C were recorded in their absence. In more vegetated plots, the occurrence of the shade tolerant *Picea abies* increased with respect to *Pinus mugo*. Soil analyses indicated that the sampled slopes were nutrient rich, hinting that nutrient deficiency is an unlikely cause of *Pinus mugo* regenerative failure. These results suggest that fire affected slopes display arrested succession due to the combined effect of climate, biotic competition, and grazing, which act as ecological filters to the establishment of tree saplings.

Poster

Potential biogeophysical effects of vegetation changes in complex topographical areas

Juliana Freitas Santos [1]*, Udo Schickhoff [1], Shabeh Ul Hasson [1]

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The interactions between the land surface and the atmosphere above have been extensively viewed. However, there are still some gaps to fill in order to provide better information for decision and policymakers, as well as, deliver a clearer understanding of those interactions. One of the gaps concerns the proper identification of the biogeophysical (BGP) effects of land use, land cover, and land management changes (LULCC). The BGP effects of LULCC might be negligible at global scales, but regionally they may exert great power of influence in sensitive environments such as mountainous landscapes. The potential BGP impacts on regional climate forcing from LULCC and treeline shifts have not been properly diagnosed in complex topographical areas. Therefore, our study aims to identify the potential effects of LULCC on the mountain climate using Nepal as a case study. We approach this issue through an assessment tool that derives the potential BGP effects of different land covers and LD derived from remotely sensed data (Duveiller et al. 2018). The assessment tool identifies the possible BGP effects by retrieving climate information, such as land surface temperature (LST), from areas of similar background but with contrasting land covers. The tool has been already applied in this fashion, however with a global focus. However, areas of complex topography were excluded from the original trial. Now, we apply the same tool in one of the highly topographical locations in the world by including (i) a finer dataset and (ii) mountain features to ensure similar climate background. We reach our goal by answering: How different land cover/land use/land management transitions might affect the local land surface temperature and precipitation at (a) different elevations, (b) different slope categories, and (c) different aspect/sun exposure or wind direction? The findings from this research aid regional climate modelers with a better understanding of BGP effects in mountains but also may support studies on treeline responses to future climate by including the climate feedback of the initiated shift in treeline.

Poster

Evaluating vegetation patterns across altitudinal gradients in the European Alps using the standardized monitoring approach of the Eurasian Dry Grassland Group (EDGG)

Svenja Wanke[1]*, Andreas von Heßberg[1], Nicolai Nürk[1], Mario Schanz[1], Alexander Schödel[1], Mani Shrestha[1] & Anke Jentsch[1]

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Elevational gradients in high mountain ranges are particularly suitable to study patterns and drivers of plant community diversity, yet there are only few studies that explicitly address this topic across the European Alps. Both species richness and trait diversity of plant communities are expected to increase at higher elevations due to increasing resource limitation, making elevation a good proxy for resource availability. Since 2009 the Eurasian Dry Grassland Group (EDGG) has been implementing a standardized protocol for vegetation sampling in grasslands across Europe and Asia, including alpine grasslands. Using this approach, high-quality data on plant species composition, productivity, and environmental parameters can be obtained, all the while ensuring a high degree of comparability between individual studies. Such coordinated, geographically distributed datasets on local grassland diversity, can be used to assess drivers of diversity across environmental gradients. Meanwhile, the EDGG method accrued over 32.000 independent plots across the whole Palaearctic, stored in the GrassPlot database, through numerous research expeditions and field workshops. The Disturbance Ecology Team of the University of Bayreuth has contributed EDGG plots from limestone grasslands across an elevational gradient in the European Alps: (1) Magredi at Tagliamento (145 m, Italy), (2) Hohe Leite near Bayreuth (500 m, Germany), (3) Brunnenkopf Alm in the Ammergebirge (1600 m, Germany), (4) Obergurgl in the Otz Valley (2600 m, Austria) and (5) Gran Paradiso National Park in the Aosta Valley (3100 m, Italy). Plant species richness on 10 m² ranged from 43 (Obergurgl) to 64 (Brunnenkopf Alm). Species richness showed a unimodal relationship with elevation, with the maximal species richness at 1600 m.

Poster

The 2015 Villarrica eruption in the Southern Andes of Chile: Retracing lava flows and lahar paths

Antonia Warnstedt[1]*, Johannes Jakob Fürst[1], David Farias-Barahona[2], Sergio Andrés Rivera Ibáñez[3]

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Lahars are high-energy, water and sediment-loaded flows that occur on volcanos and possess a high destructive potential, thus the understanding and modeling of their impact areas are of high interest to surrounding communities. This case study is targeting the eruption of glacier-capped Volcano Villarrica, on March 3rd, 2015, that triggered a subsequent lahar down its northern flanks, with a total volume estimated between 0.8 to 1.1 million m³. The objective of this study is to reproduce the lahar utilizing the physical and computer-based, multiphase mass flow simulation tool r.avaflow. Thereby reconstructing the lahars flow path as well as its properties with an emphasis on recreating its total volume and additionally testing the model sensitivity to the resolution of the underlying digital terrain model (DTM). The outputs a) include information about the inundated area, flow height, flow speed, the thickness and extent of entrained as well as deposited materials of different model scenarios, b) cannot be considered to be the only possible combination of parameters that fit to reproduce the lahar flow, due to equifinality, though all model parameters were selected in a physically plausible range, and c) subsequently, they illustrate the challenges during modeling process of coping with a large number of unknown variables. The model parameters had to some degree been tuned intrinsically without being predetermined. Overall, the model results were able to reproduce the lahar volume and runout area well but were highly influenced by the DTM resolution, the entrainment coefficient, and the basal and internal friction angles. Thus, the transferability to other lahar events that occurred at Villarrica should be tested, by constraining the basic physical parameters and creating scenarios depending on the available parameter information and combinations. Ultimately, this could contribute to the creation of probabilistic hazard maps.

Poster

Regional glacier mass change measurements in the European Alps from interferometric spaceborne SAR

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Glaciers and ice caps are known to be strongly affected by global climate change. Particularly, mountain glaciers located at low to medium altitudes, such as in the European Alps, have experienced a substantial mass loss during past decades with increasing rates of retreat during recent years. This on-going shrinkage of glacier ice volumes raises challenges for water supply, due to seasonal shifts in meltwater runoff magnitude, and increases the frequency of natural hazards such as slope failure or glacial lake outburst floods. In order to estimate regional glacier mass change, remote sensing acquisitions provide efficient measurements of glacierized areas at high spatial and temporal resolution. Acquisitions of the TanDEM-X twin-satellites enable accurate measurements of glacier surface elevation changes at a spatial resolution of up to 10m, independently from cloud coverage or illumination. Here, we show observations of regional glacier mass loss of the European Alps since 2000 by synthetic aperture radar interferometry (InSAR) of the bistatic TanDEM-X mission. Substantial surface lowering is measured from a large number of digital elevation models (DEMs) and major surface melt rates are observed across the entire European Alps at almost all altitudes. At current days mass loss rates, glaciers at lower elevations in the European Alps would disappear by the end of the 21st century. Eventually, the here presented methods and results provide important insights of regional glacier evolution as well as climatological and glaciological projections.