PROCEEDINGS OF SCIENCE

The Mieminger Schneeferner – an extreme Citizen Science project on a small glacier in Tyrol

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Abstract: The Mieming Schneeferner project is an extreme citizen science initiative that uses remote sensing to gather and analyze climate data from a remote glacier. Initial findings spanning the last four years corroborate earlier research while revealing new avenues for scientific inquiry, highlighting the impact of climate change at a local scale and educational level.

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1. Introduction

The Mieminger Schneeferner, a small glacier in the Tyrolean Alps, sits at 2300-2450 meters on the south side of the Mieminger Kette. Isolated and hard to access, it was studied by Michael Kuhn [1 & 2] and later neglected. This glacier, nicknamed "fish" or "whale" due to its distinctive shape, began to lose volume and its shape since the hot summer of 2003. During the 5th Austrian Citizen Science Conference, a collaboration emerged between the University of Innsbruck and Meinhardinum Stams school to involve citizen scientists in monitoring the glacier. This "extreme citizen science" project builds on research from the 1990s [1+2] and examines the glacier's response of small glaciers to current climate conditions [9].

2. Methods

In October 2019 the glacier was roughly measured and surveyed onsite. On this occasion several spots on the rockface above were marked with luminescent colour which can be seen from the observation point at the Meinhardinum school in Stams using a Swarovski Optik ATX spotting scope. On each spot the lowest rock marking is on the height of the ice edge. Markings above are placed in intervals of 5 meters. In 2021, 2022 and 2023 the rock markings were refreshed and additional markings placed showing the new ice edges.

In November 2019 an observation room was installed at school enabling 27 students aged 14-15, led by two teachers, to undertake continuous and intense observations of the glacier throughout the year. Since then the glacier is photographed daily, at first manually by students, from December 2019 on automatically using a timed remote-control release every 3 hours. The photos are taken with a Sony Alpha 6000 mounted on the spotting scope with a TLS APO camera adapter provided by Swarovski Optik. Until March 2020 students additionally recorded daily weather conditions, the visibility of the rock markings and well as the occurrence of avalanches and forming of crevasses. The aim of these observations was to monitor the accumulation process during winter and the retreat of snow cover and ice in late spring. Further analyses are based on the manual comparison of the photographic material by the involved teachers. In autumn 2023 28 students (14 ys) will join the project.

3. Results

In the past four years the glacier has been observed intensively and its changes were recorded. This allowed a comprehensive comparison (see figure 1): Each year a huge amount of snow is accumulated in the upper parts of the glacier and preserved until late summer despite its low altitude and south to south-east exposition. From June (2021, 2022) or July (2020, 2023) onward melting continues until late October exposing talus deposits to various degrees and glacial ice. Melting becomes visible first in the eastern part of the fish-shaped glacier. The lower part of the “tail fin” separates. Later gravel emerges in the middle part of the glacier accelerating the melting in this area which eventually leads to the separation of the western “body” and the eastern “tail fin”. This melting pattern also corresponds with the findings that in the western part much more snow is accumulated and mostly present throughout the year. Onsite inspections showed that few centimeters to decimeters below the gravel surface ice is present in all parts of the fish. Thus the gravel serves as a protective layer for the ice which can only be seen openly on few occasions after snow melt. Only on the upper western part, which is shadowed by the mountain

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ridge from midday onward, ice and snow can endure also above the gravel. In summer 2022 ice retreated considerably in the eastern parts. This may be due to (a) the deposit of Sahara sands in March 2022 which accelerated the melting of snow as and (b) a comparatively high precipitation rate in early summer 2022 with no summer snowfall at the glacier.

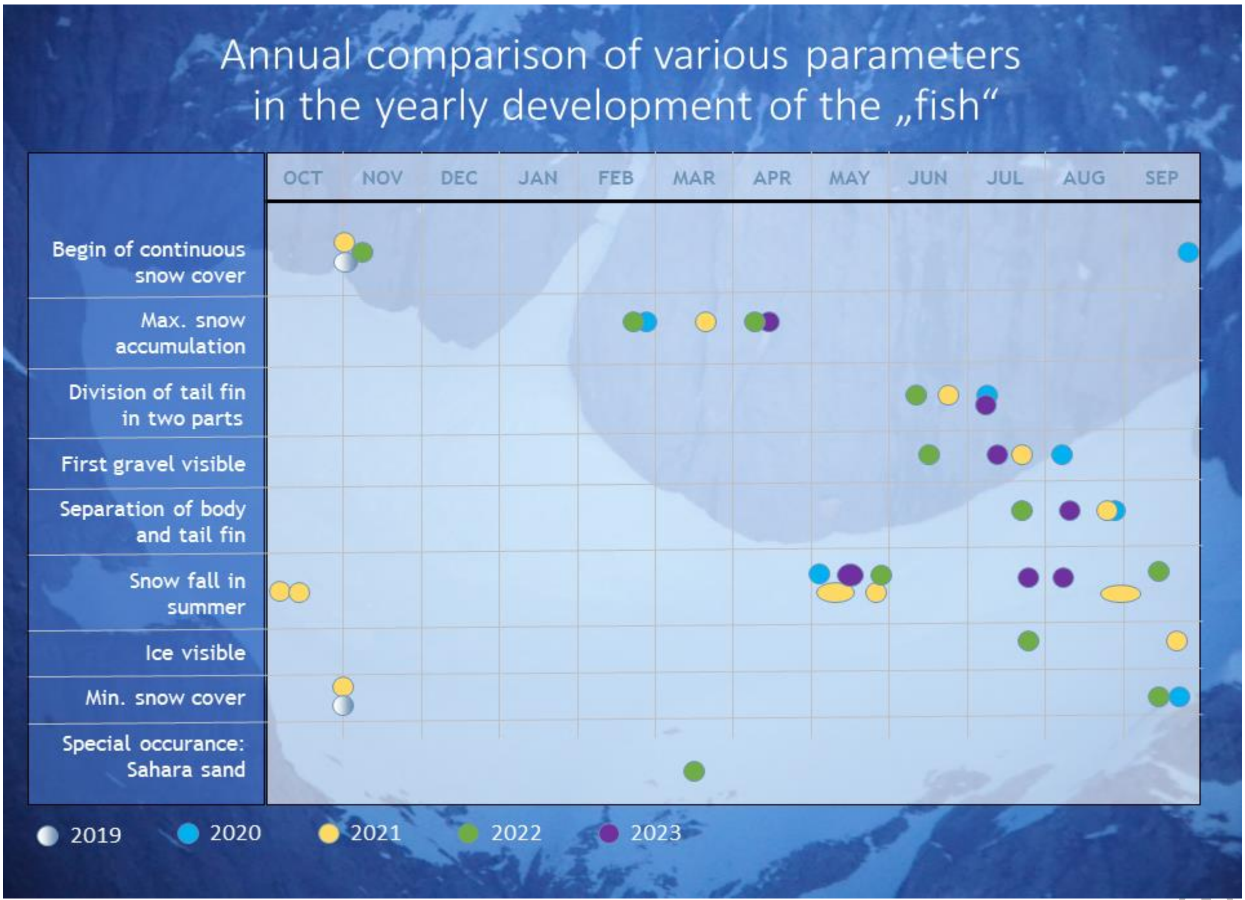

Figure 1: Comparing the photographic material containing more than 11.000 individual shots allows the annual comparison of various parameters through the years.

This can also be demonstrated by the comparison of rock markings attached to the lowest part of the rock visible: Between 2021 and 2022 an ice loss of 6m was observed in the upper parts of the glacier. In the two previous years (2019 to 2021) combined only 2m were lost (see figure 2).

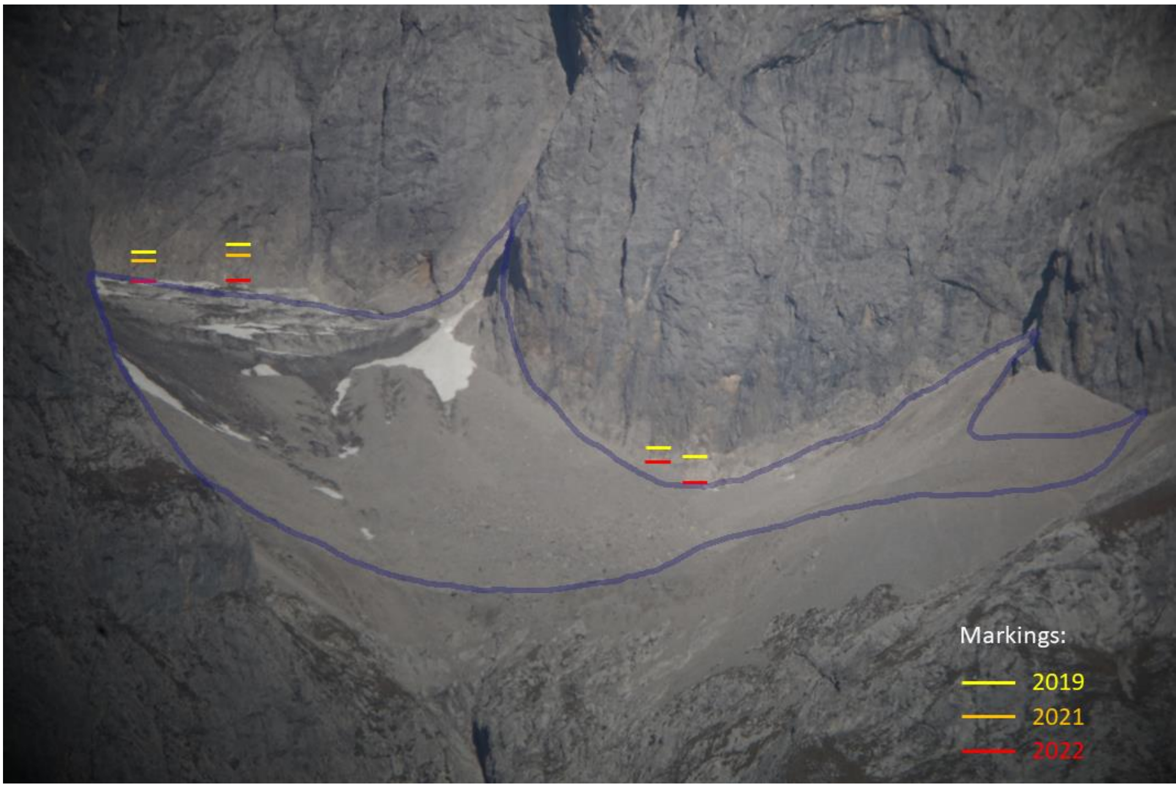

Figure 2: Marking of the ice edge in 2019, 2021 and 2022 shows the increasing rate of ice retreat and volume loss. The blue line indicates the extension of recent ice with and without talus deposits and the fish shape of the Mieminger Schneeferner. Photo taken from Stams via telescope 31.10.2022

Kuhn [1] described the Mieminger Schneeferner as an "avalanche-fed cirque glacier". Especially in spring loose snow avalanches can be observed, feeding the lower parts of the glacier. The origin of these snow masses is not clear. It is questionable how much snow the very steep area around the glacier can hold for the formation of avalanches feeding the glacier. On the other hand, avalanches originating from the steep western flank of the glacier itself with visible tear-off edges can regularly be observed. Furthermore, the location of the glacier on the lee side of the mountain ridge suggests a significant proportion of snowdrift in west-weather conditions. The observation of glacial ice is rare, mainly seen between the transition from snow to gravel. Only in September 2022 the upper western part of the glacier was completely free of snow and ice visible.

4. Discussion

The Mieminger Schneeferner project can be described as a small Extreme Citizen Science project as it is run by a small group of citizens outside a university, because it is a community driven process, from data collection to processing [3].

Participants are deeply involved in the research process through co-creation which supports collaboratively identifying the problem, forming the research questions, designing the tools and methods to support data collection, and collecting and analysing the data [4]. The disadvantages of the Extreme CS approach are partly the discontinuous way of working and keeping the high level of motivation. The advantage is the high commitment of the citizens and the financial independence.

This small local project is a good illustration of how climate change education can be implemented on a local level. The connection between motivated citizens and schools leads to positive results.

On the one hand, the observations of Kuhn [1 & 2] can be underlined by the observations of the last few years and the question arises as to how strongly the wind drift influences the snow height on the Mieminger Schneeferner more [5] and how avalanche activity has played a subordinate role in recent years.

Since this project only uses remote sensing methods, it is only possible to quantify the melting of the glacier at specific points and not over the area. The question of ELA cannot be answered with the method used either. Due to the extreme situation and danger of avalanches and rockfall other standardized glaciological methods have not be carried out yet. Somehow, it seems that this type of observation is due to safety issues the best way to get data and insights about the behaviour of the "fish" and delivers an idea how small glaciers react to the current climatic situation.

The continuation of the project depends on the further implementation in the daily school routine and the even better connection to the local population.

For the pupils involved, the project was a good opportunity to get to know scientific practice, starting with the research design, the data collection and the analysis of the data. Especially the long period and the process of data generation was a positive point for the students and contributed strongly to their scientific literacy [6] and can be pointed out as a good way to learn more about science. Several added values of citizen science projects with schools [6] can be proven like regional impact of research, co-creation, democratization of knowledge and education[8].

Citizen Science projects like this can contribute to better understanding local scientific questions and can answer questions even without big funding but with high motivational level of citizen scientists. Especially in environmental education, this approach can be applied to future projects and thus easily introduce students to climate change issues.

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