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The Triglav Glacier: Seventy Years of Regular Observations

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Abstract

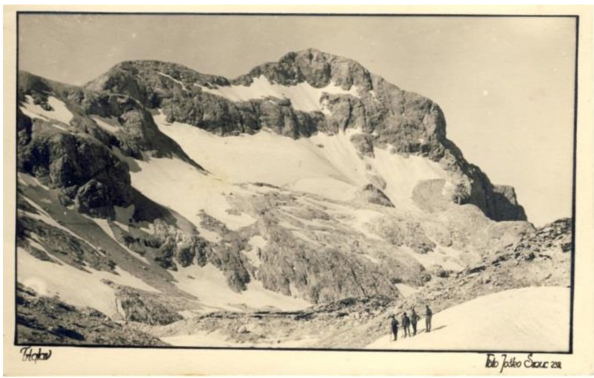
The Triglav Glacier is one of two glaciers in Slovenia; it lies in Triglav National Park. The year 2016 marks the passage of seven decades since the first survey of the glacier was carried out. For that occasion, an extensive research volume and an exhibition were prepared. The glacier's size in 1946 was 14.4 hectares, but it has since shrunk to just less than 0.4 hectares. The glacier no longer has all of the glacial characteristics. Therefore it can only be called a glacier due to its past, when it still had all the crucial alpine glacier characteristics.

Keywords

Triglav Glacier, Julian Alps, Slovenia, glacier measurements, climate change

Introduction

The year 2016 marks the passage of seven decades since the first formal survey of the Triglav Glacier was carried out on September 5th, 1946. The anniversary of regular research on the glacier was the reason for the exhibition on the Zeleni plaz 'Green Avalanche', as the glacier was called in the first written record from 1778. The exhibition started out at the Slovenian Alpine Museum in Mojstrana and then traveled to information centers and some larger places in Triglav National Park. The Triglav Glacier lies on the southeastern-most part of the Alps—namely, in the Julian Alps below Mount Triglav (2,864 m), the highest mountain in Slovenia. Based on Holocene glacial variations in the Alps, the Triglav Glacier is most probably a remnant of the Little Ice Age and cannot be considered a remnant of Pleistocene glaciation (FERK et al. 2017). Its size at the time of the initial survey was 14.4 hectares, but it has since shrunk to less than 1 hectare. The glacier no longer has all of the glacial characteristics; it has no crevasses and it does not move. Therefore it can only be called a glacier due to its past, when it still had all of the crucial alpine glacier characteristics. Regarding its location and size, it is not comparable to the large Alpine glaciers; more reasonable is a comparison with very small glaciers, known as glacierets (GABROVEC ET. AL. 2014), in neighboring Austria, Italy, and some Balkan countries (KUHN 1995; TRIGLAV ČEKADA et al. 2012; COLUCCI & GUGLIELMIN 2015).



Figures 1 and 2: The Triglav Glacier from the north in September 1940 (Photo: Joško Šmuc) and September 2012 (Photo: Jaka Ortar).

Methods

Annual observations serve as the base for establishing changes in the Triglav Glacier. Early surveys were simple: the researchers used a measuring tape and compass, which enabled them to measure the glacier's retreat from colored marks on the rocks around the glacier (MEZE 1955). In the 1990s, researchers started using more accurate geodesic measurements: standard geodesic tachymetric measurements, photogrammetric measurements (from both the ground and air), GPS measurements, and LIDAR (TRIGLAV ČEKADA & GABROVEC 2008; GABROVEC et al. 2014). The thickness of the ice was measured three times using the ground-penetrating radar method (VERBIČ & GABROVEC 2002; DEL GOBBO et al. 2016). The glacier has been systematically photographed (once a month from the same spots) since 1976, using a panoramic non-metric Horizont camera. The photos were transformed from a panoramic to central projection in order to allow the calculation of the area and estimation of the volume (TRIGLAV ČEKADA et al. 2011; TRIGLAV ČEKADA & GABROVEC 2013). The size of the glacier during the Little Ice Age can be determined based on moraine accumulation (ŠIFRER 1963; GABROVEC 2008). In addition to these surveys, the use of old paintings, photos, and maps is also important for evaluating long-term change (MEZE 1955; GABROVEC et al. 2014).

Figure 3: In 2013, ground-penetrating radar surveys of the glacier were performed. Photo: Matija Zorn.

Fluctuation of the Triglav Glacier

The extent of the glacier at the end of the Little Ice Age in the nineteenth century was reconstructed from the 1877 Austrian topographic map showing that the glacier covered 40 ha. The measurements of the glacier since 1946 can be divided into four time periods distinguishing two phases of rapid retreat and two phases of glacial stagnation; the latter two are primarily connected with greater quantities of precipitation during the accumulation season. The period of measurements from 1946 to 1964 is characterized by shrinking and thinning of the glacier from 14 to 10 ha. In the last years of this period, horizontal recession also occurred in the lower section. The second period, between 1965 and 1982, is marked by stagnation of the glacier. In these years the lower section of the glacier was mainly covered with snow at the end of the melting seasons, and only in central section ice was bare. During those years, up to the end of the melting season continuous snow fields extended all the way to the moraines from the Little Ice Age above the north face of Mount Triglav. The result of snow accumulation on the glacier was also seen in its increasingly convex cross-section. The turning point occurred in 1983 and was caused by the extremely warm summer. The period from 1983 to 2003 was marked by the most rapid melting of the glacier. The size of the glacier was then the smallest in the entire period of regular measurements (i.e., from 1946 onward). Typical of these years was intense thinning of the glacier, particularly in its upper section. The glacier annually thinned by 1 to 2 m and, in some sections, disintegrated into several parts. After the hottest summer in 2003, the measured area of the glacier was 0.7 ha, and later, in 2007 only 0.6 ha. After 2012, the glacier has never been completely exposed; it was entirely or partly covered with firn and/or snow from previous winters. Most of the ice melted at the upper edge of the glacier only (GABROVEC et al. 2013, 2014). An even greater change occurred in the volume of the glacier than in its area. During the observation period the glacier thinned by more than 35 m in some places. Its volume therefore decreased from 2 million m^3 in 1952 to 7,400 m^3 in 2013 (GABROVEC 2002; GABROVEC et al. 2014; DEL GOBBO et al. 2016).

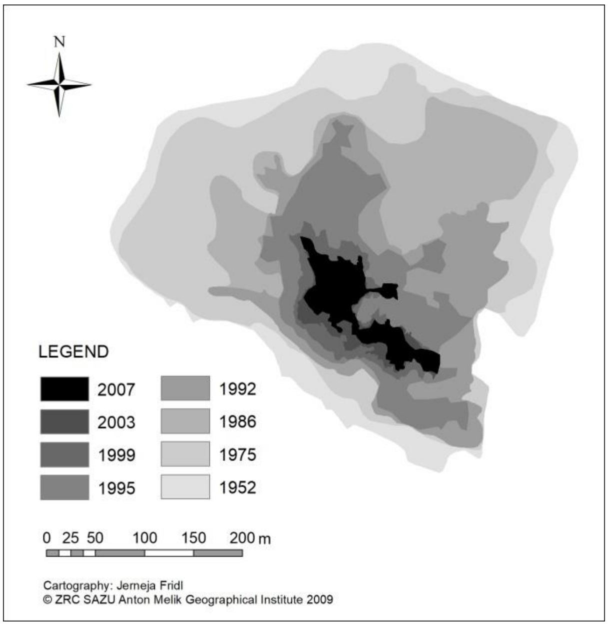


Figure 4: Changes in the glacier's area between 1952 and 2007.

Climate changes at the Triglav Glacier

Due to its small size, the Triglav Glacier is highly sensitive to climatic changes and hence a good indicator of them. The direct vicinity of the meteorological station near Mount Kredarica (2,539 m) makes possible an analysis of the dependency of the glacier's fluctuation on weather changes (GAMS 1994; GABROVEC & ZAKŠEK 2007; ERHARTIČ & POLAJNAR HORVAT 2010). The mean annual air temperature at the Kredarica meteorological station (2,514 m) shows an upward trend during the monitoring period, especially during meteorological summer (June–August), for +0.4 degrees Celsius/decade (GABROVEC et. al. 2014). The fall precipitation quantity is increasing. Solar radiance exposure data show an upward trend in winter and spring and a decreasing trend in fall, which corresponds to the precipitation increase. The maximum seasonal depth of the snow cover, usually measured in mid-April, is also decreasing (GABROVEC et al. 2014) and first/last day with snow cover (start/end of the snow season) are on average two weeks later/earlier.

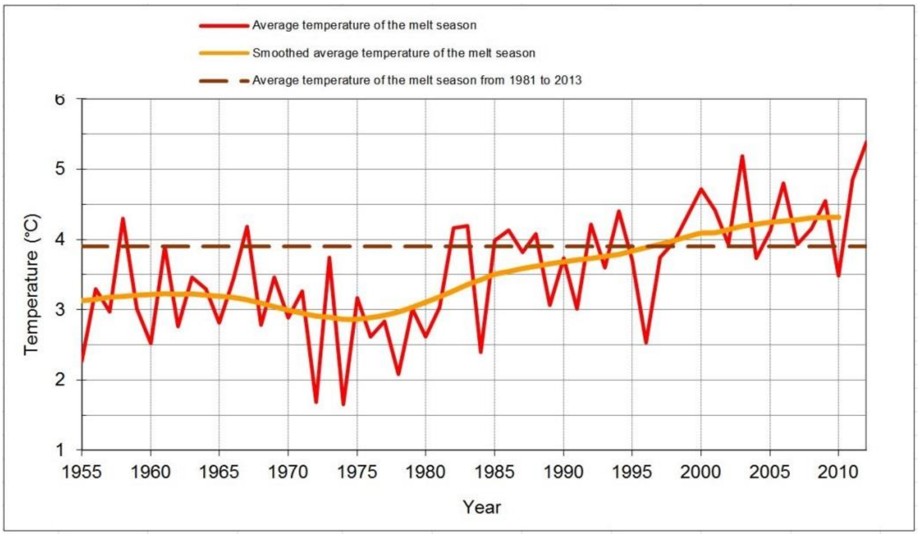


Figure 5: Average temperature of the melt season (May–October) on Mount Kredarica between 1955 and 2012 (Source: Slovenian Environmental Agency)

Conclusion

The glacier surveys and observations are strongly steeped in the rich cultural heritage connected to the highest Slovenian peak and Triglav National Park. As an object of study that is changing in a sensitive high-elevation environment—specifically, its shrinking over seven decades—the Triglav Glacier is one of the few direct evidences of climate change and its consequences. This exhibition on seventy years of observations, hosted by information centers in Triglav National Park, makes an important contribution to informing visitors about changing natural heritage as a result of climate changes.

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