



Editorial: Processes controlling development of periglacial and paraglacial landscapes in rapidly changing polar regions: Part 2

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This special issue is a scientific tribute to the founders and researchers working at Stanisław Baranowski Polar Station of the University of Wrocław, which in 2021 celebrated its 50th anniversary (1971–2021). It was named after Stanisław Baranowski (1935–1978) – its founder and renown glaciologist, who tragically died after an accident in King George Island in 1978.

We are glad that submitted contributions represent very diverse scientific disciplines. In the first part of this special issue, we highlighted contributions from climatological, glaciological and hydrological studies. In this second part, we are presenting studies that focus on geomorphological, pedological and ecological topics. Most of these studies were logistically supported by our Station, which over the last few decades became an important platform for multidisciplinary research on climate change impacts, hopefully fulfilling the scientific mission envisaged by its founder Stanisław Baranowski.

Stanisław Baranowski Polar Station, located on Wedel Jarlsberg Land on the west coast of Spitsbergen, the largest island in the Svalbard Archipelago (Fig. 1), is an excellent focal point and logistical facility for the development of diverse environmental studies in the Bratteggt Valley. Paper by Wołoszyn and Kasprzak (2023) summarized key information on geological, geomorphological and environmental factors controlling landscape transformation after the rapid retreat



of the Bratteggbreen glacier in the last 40 years. One of the novel results extracted from remote sensing analyses are the calculations of the rates of vegetation cover expansion and detailed mapping of Bratteggbreen recession.

Korabiewski (2023) presented interesting contribution to cold region pedological research. His study documented processes responsible for soil formation along uplifted marine terraces in Kvartsittsletta. Particular attention



Fig. 1. Stanislaw Baranowski Polar Station in Spitsbergen in 2021 after 50 years of service to the polar researchers from the University of Wrocław and their Polish and international partners. Photos by Marek Kasprzak.

was paid on the periglacial processes such as solifluction and cryoturbation in soil development and spatial difference between old (high) terraces existing in periglacial conditions for several millennia and younger terraces exposed from the sea in the last 2000 years.

Debris cones with large debris flow tracks are one of the most characteristic features of slopes in the south-western Spitsbergen. Particularly well-developed forms are visible on the slopes in the close vicinity of the Stanislaw Baranowski Polar Station in the Gullichsenfjellet and Jens Erikfjellet massifs. Due to their abundance and morphological diversity, debris cones and debris flows that shape them are reliable sources of information about both the current state of the natural environment and its changes in the past. There is a significant increase in interest in these forms in the context of using modern ground-based and remote-sensing methods for the analysis of contemporary dynamics of polar environments (Owczarek *et al.* 2013; Tomczyk 2021; Senderak *et al.* 2021). Despite the numerous works on debris cones, further research is needed due to the dynamically changing Arctic environment as a result of rapid warming. There are still open questions as to how the dynamics of mass movements shaping the

debris cones will change with increasing permafrost degradation or the influence of interlocking biotic, climatic, and lithological factors.

The work by Latocha-Wites and Parzóch (2023) exemplifies the use of morphological features of debris cones as indicators of environmental change on the basis of 81 such forms located in the vast area between the Skoddefjellet and Jens Erikfjellet. They conclude that detailed analyses of the diversity of landform assemblages within debris cones, including main forms associated with debris flows, give information about the regional and local dynamics of geomorphic processes related to lithology, slope exposure and gradient. However, they highlight the need for multidisciplinary research on debris cones including modern dating methods. This can be compared with a study from the Bratteg Valley carried out by Senderak (2023). He presents a specific methodological approach to study the mechanisms of material transport on the talus slopes and underlined the need for detailed sediment granulometric measurements. The study of clast size allows the reconstruction of the dynamics of talus cone development and the identification of the main processes shaping each morphological zone from the distal to the proximal parts. This helps to improve our knowledge of the process-relief relationship and to reliably reconstruct former environments, based on the “debris cone archives”.

Last but not least, Jędrzycka *et al.* (2023) presented the results of an aerobiological study, which has so far been conducted to a limited extent in the Svalbard Archipelago. The authors conducted their measurements at Calypso-byen *ca.* 60 km to the north from Baranowski Station during the two summer seasons of 2014 and 2015, and their focus was pine pollen. Using GIS analysis, they determined the trajectory of pollen grain movement and proved that its grains found in pine-free Spitsbergen can originate from a number of terrestrial areas in Europe and North America, including Scandinavia, Iceland, Siberia and northern Canada. Pollen grains were transported by air masses over distances exceeding 2000 km.

In conclusion to most contributions presented in this volume, the rapid transformation of paraglacial and periglacial landscapes are among the strongest effects of climate warming in cold regions (Ballantyne 2002; Mercier 2008; Knight and Harrison 2014). The retreat of glaciers exposes new areas where different geomorphological processes operate and erase the effects of glaciation (Mercier *et al.* 2009; Strzelecki *et al.* 2018, 2020; Kavan and Strzelecki 2023). Important role is played by the permafrost, which interacts with subaerial processes in post-glacial landscape modification (Oliva and Ruiz-Fernandez 2015; Dobiński and Kasprzak 2022).

As for the years to come, Stanislaw Baranowski Polar Station established in summer 1971 in the forefield of the retreating Werenskioldbreen glacier became an important reference site to document a wide range of processes transforming glacial, periglacial and paraglacial landscapes in SW part of Spitsbergen, the major island of the Svalbard Archipelago. In 2022, the Station became a key

research facility of recently established Alfred Jahn Cold Regions Research Centre at the University of Wrocław. We are more than confident that in coming years the Station will serve new generations of polar researchers educated and trained at our university and bring progress in studies of cold region landscapes together with our national and international partners.

References

- Ballantyne C.K. 2002. Paraglacial geomorphology. *Quaternary Science Reviews* 21: 1935–2017. doi: 10.1016/S0277-3791(02)00005-7
- Dobiński W. and Kasprzak M. 2022. Permafrost base degradation: Characteristics and unknown thread with specific example from Hornsund, Svalbard. *Frontiers in Earth Science* 10: 802157. doi: 10.3389/feart.2022.802157
- Jędryczka M., Żuraw B., Zagórski P., Rodzik J., Mędrek K., Pidek I.A., Haratym W., Kaczmarek J. and Sadyś M. 2023. The origin of pine pollen grains captured from air at Calypsobyen, Svalbard. *Polish Polar Research* 44: 313–338. doi: 10.24425/ppr.2022.143312
- Kavan J. and Strzelecki M.C. 2023. Glacier decay boosts the formation of new Arctic coastal environments—Perspectives from Svalbard. *Land Degradation and Development* 1–8. doi: 10.1002/ldr.46958
- Knight J. and Harrison S. 2014. Mountain glacial and paraglacial environments under global climate change: Lessons from the past, future directions and policy implications. *Geografiska Annaler, Series A: Physical Geography* 96: 245–264. doi: 10.1111/geoa.12051
- Korabiewski B. 2023. Relict and contemporary soils on uplifted marine terraces of Kvartsittsletta, SW Spitsbergen. *Polish Polar Research* 44: 249–269. doi: 10.24425/ppr.2023.144541
- Latocha-Wites A. and Parzóch K. 2023. Can topographic features of debris cones (SW Spitsbergen) be geoindicators of environmental changes? *Polish Polar Research* 44: 291–312. doi: 10.24425/ppr.2023.144539
- Mercier D. 2008. Paraglacial and paraperiglacial landsystems: Concepts, temporal scales and spatial distribution. *Géomorphologie: relief, processus, environnement* 14: 223–233. doi: 10.4000/geomorphologie.7396
- Mercier D., Etienne S., Sellier D. and André M.F. 2009. Paraglacial gullying of sediment-mantled slopes: A case study of Colletthøgda, Kongsfjorden area, West Spitsbergen (Svalbard). *Earth Surface Processes and Landforms* 34: 1772–1789. doi: 10.1002/esp.1862
- Oliva M. and Ruiz-Fernández J. 2015. Coupling patterns between paraglacial and permafrost degradation responses in Antarctica. *Earth Surface Processes and Landforms* 40: 1227–1238. doi: 10.1002/esp.3716
- Owczarek P., Latocha A., Wistuba M. and Malik I. 2013. Reconstruction of modern debris flow activity in the arctic environment with the use of dwarf shrubs (south-western Spitsbergen) – a new dendrochronological approach. *Zeitschrift für Geomorphologie* 57: 75–95. doi: 10.1127/0372-8854/2013/S-00145
- Senderak K. 2023. Conceptual model for talus slope development in Bratteg Valley (SW Spitsbergen) based on sedimentology of debris deposits in periglacial zone. *Polish Polar Research* 44: 271–290. doi: 10.24425/ppr.2023.144543
- Senderak K., Kondracka M. and Gądek B. 2021. Processes controlling the development of talus slopes in SW Spitsbergen: The role of deglaciation and periglacial conditions. *Land Degradation and Development* 32: 208–223. doi: 10.1002/ldr.3716
- Strzelecki M.C., Long A. J., Lloyd J. M., Małecki J., Zagórski P., Pawłowski Ł. and Jaskólski M.W. 2018. The role of rapid glacier retreat and landscape transformation in controlling the post-

- Little Ice Age evolution of paraglacial coasts in central Spitsbergen (Billefjorden, Svalbard). *Land Degradation and Development* 29: 1962–1978. doi: 10.1002/ldr.2923
- Strzelecki M.C., Szczuciński W., Dominiczak A., Zagórski P., Dudek J. and Knight J. 2020. New fjords, new coasts, new landscapes: The geomorphology of paraglacial coasts formed after recent glacier retreat in Brepollen (Hornsund, Southern Svalbard). *Earth Surface Processes and Landforms* 45: 1325–1334. doi: 10.1002/esp.4819
- Tomczyk A.M. 2021. Morphometry and morphology of fan-shaped landforms in the high-Arctic settings of central Spitsbergen, Svalbard. *Geomorphology* 392: 107899. doi: 10.1016/j.geomorph.2021.107899
- Wołoszyn A. and Kasprzak M. 2023. Contemporary landscape transformation in a small Arctic catchment (Bratteggdalen, Svalbard). *Polish Polar Research* 44: 227–248. doi: 10.24425/ppr.2023.144542