

Rock glacier inventories and kinematics: a new IPA Action Group

Reynald Delaloye¹, Chloé Barboux¹, Xavier Bodin², Alexander Brenning³, Lea Hartl⁴, Yan Hu⁵, Atsushi Ikeda⁶, Viktor Kaufmann⁷, Andreas Kellerer-Pirklbauer⁸, Christophe Lambiel⁹, Lin Liu⁵, Marco Marcer¹⁰, Brianna Rick¹¹, Riccardo Scotti¹², Hideyuki Takadema¹³, Dario Trombotta Liaudat¹⁴, Sebastián Vivero⁹, Maria Winterberger¹

¹ *University of Fribourg, Department of Geosciences, Switzerland, name.surname@unifr.ch*

² *Laboratoire EDYTEM, CNRS/Université Savoie Mont-Blanc, Pôle Montagne, Le Bourget-du-lac, France*

³ *Faculty of Chemistry and Earth Sciences, Department of Geography, Friedrich Schiller University Jena, Germany*

⁴ *IGF - Institut für Interdisziplinäre Gebirgsforschung, Österreichische Akademie der Wissenschaften, Innsbruck, Austria*

⁵ *Earth System Science Programme, Faculty of Science, The Chinese University of Hong Kong, Hong Kong, China*

⁶ *Faculty of Life and Environmental Sciences University of Tsukuba, Japan*

⁷ *Institute of Geodesy, Remote Sensing and Photogrammetry Working Group, Graz University of Technology, Austria*

⁸ *Department of Geography and Regional Science, Working Group Alpine Landscape Dynamics (ALADYN), University of Graz, Austria*

⁹ *Institute of earth surface dynamics, University of Lausanne, Switzerland*

¹⁰ *Laboratoire PACTE, Institut d'Urbanisme et de Géographie Alpine, University of Grenoble Alpes, France*

¹¹ *Department of Geography, University of Montana, Missoula, USA*

¹² *Departement of Biological, Geological and Environmental Sciences (BiGeA), University of Bologna, Italy*

¹³ *Department of Environmental Science, Niigata University, Japan*

¹⁴ *IANIGLA- CCT CONICET Mendoza, Argentina*

Abstract

A new IPA Action Group (2018-2020) is intending to promote the integration of permafrost creep rates (rock glacier kinematics) as a new associated parameter to the Essential Climate Variable (ECV) Permafrost within the Global Climate Observing System (GCOS) initiative supported by the World Meteorological Organization (WMO), characterizing the evolution of mountain permafrost on the global scale. The main scopes of this group are to sustain the first steps toward the organization and the management of a network dedicated to rock glacier mapping (inventorying) and monitoring all around the world and the definition of the necessary standards.

Keywords: Rock glaciers, inventories, monitoring, kinematics, standards, global network, Essential Climate Variable

Background

In mountainous terrain, frozen ground with sufficient ice content may be continuously in motion. Considerable volumes of fine- and coarse-grained debris material are involved in building up rock glaciers as a typical morphological feature of many mountain ranges in the periglacial zone. Even if there is still many discussions about the actual movement processes, rock glaciers appear to move at a rate, which is in particular depending on the temperature profile between the permafrost table and the main shear horizon at depth. Warmer permafrost conducts to higher motion rate, especially when the temperature is rising close to 0°C. Such warming may even lead to subsequent partial or complete destabilization of the rock glacier.

Rock glaciers inventories have been set up in many regions over the world for decades but without any real coordination. Rock glaciers have often been distinguished between intact (active/inactive) and relict landforms on morphological indices only, as for instance observable on aerial photography. Development in remote sensing technologies in particular, e.g. InSAR or photogrammetry, and the greater availability of appropriate satellite imagery, has recently permitted to include more detailed kinematic information within rock glacier inventories. New initiatives are rising in many regions with various methodologies, sometimes overlapping, and there is an obvious need for coordination and as far as possible for standardization.

Monitoring of rock glacier velocities provides clue information on the transfer rate of sediments along mountain slopes and on the impact of climate change on rock glacier stability. Observing or deriving a rock glacier kinematic variable on a global scale appears to be technically feasible using in particular satellite SAR interferometry, but also in combination with terrestrial geodetic surveys and photogrammetry analyses.

Objectives and scope of the Action Group

The Action Group intends to sustain the first steps toward the organization and the management of a network dedicated to rock glacier mapping (inventorying) and monitoring in all relevant mountain regions on Earth including definition of the necessary standards.

More specifically the Action Group aims to coordinate efforts to:

- define widely accepted standard guidelines for inventorying rock glaciers in mountain permafrost regions, including indications on the activity rate,
- promote the use of satellite SAR interferometry, e.g. Sentinel-1A data, for monitoring the rock glacier activity at a regional scale and define appropriate standards and guidelines,
- integrate as far as possible local-scale based monitoring data based on aerial and terrestrial geodetic surveys,
- initiate the development a world-wide rock glacier database, including kinematics,
- set up standard guidelines for selecting an appropriate number of rock glaciers per region that can be then used to assess temporal trends with decadal to intra-decadal time steps,
- build up and manage a web platform for visualization and open data access.

The Action Group is expecting that in the long run rock glacier kinematics could be recognized by the permafrost community (e.g. GTN-P) and later by the WMO as a new associated parameter to the ECVs of Permafrost. Rock glacier kinematics could be integrated in the monitoring strategy of international programs in addition to the observation of permafrost thermal state and active layer trends.

Organization of the Action Group

The basic idea of the group is to federate scientists for coordinating efforts and regrouping know-how and data on a single place (open access database) and define consensual baselines for inventorying rock glaciers and including kinematics information.

Co-authors of this abstract have agreed to take part to the scientific core group of the action in its initial stage. The core group emphasizes the need for networking and bringing international experience at participating, thus is far from being restricted in its initial form.

Timeline and expected deliverables

The Action Group will be active over a two-year period, from mid-2018 to mid-2020. It will be launched at EUCOP5 in Chamonix. Two Action Group Workshops are foreseen in 2018 and 2019, with field trips in rock glacier prone regions.

The Action Group will be closed at ICOP 2020 in Lanzhou. It expects to set up the generally accepted guidelines for inventorying rock glaciers including kinematics information and to design and establish a dedicated (pioneer) web platform allowing an open access to rock glacier inventorying and monitoring data.

Acknowledgments

Acknowledgments go to the IPA Executive Committee for having accepted to support this Action Group.