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Study Analyzes Strengths and Weaknesses of Glacier Monitoring Systems Around the World

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A new study (<https://doi.org/10.1659/MRD-JOURNAL-D-19-00021.1>) in *Mountain Research and Development* published earlier this year evaluates a set of country-specific glacier monitoring programs which are managed under a global framework. It did so with the aim of making data from such programs more easily accessible. The study was also meant to aid countries in improving their monitoring programs and finding gaps in the network of programs.

Glacier monitoring is crucial to research in glaciated areas because glacial melting influences energy production, natural hazard prevention, freshwater supply and irrigation downstream of glaciers. Nadine Salzmann, a glaciologist at the University of Fribourg, Switzerland, told GlacierHub that such monitoring is critical because “we need clear and ‘relatively easy to understand’ climate indicators and monitoring is a fundamental part of any glacier research.”

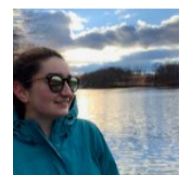
Mauri Pelto (<https://www.nichols.edu/faculty/mauri-pelto>), a professor of environmental science at Nichols College, told GlacierHub that in the context of this paper, the term glacier monitoring refers “to annual measurement of glacier mass balance, frontal position and completion of glacier inventories that are shared as part of the World Glacier Monitoring Service (WGMS) network.”

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The authors of the study used the [Global Terrestrial Network for Glaciers \(https://www.gtn-g.ch/\)](https://www.gtn-g.ch/) (GTN-G) framework, an internationally coordinated framework for the monitoring of glaciers, to assess all glacierized countries' glacier monitoring systems. GTN-G is jointly run by three organizations dedicated to studying snow, ice and glaciers which are based in Switzerland and the United States.

The GTN-G framework was selected because it provides quantitative and comprehensive data on glaciers around the world. It includes ground-based studies at individual glaciers and remote sensing studies using technology like satellite imaging to better understand groups of glaciers in mountain systems.

Tier 1	Multicomponent system observations across environmental gradients
Tier 2	Extensive glacier mass balance and flow studies within major climatic zones for improved process understanding and calibration of numerical models
Tier 3	Determination of glacier mass balance using cost-saving methodologies within major mountain systems in order to assess the regional variability
Tier 4	Long-term observations of glacier length change data and remotely sensed volume changes for large glacier samples within major mountain ranges to assess the representativeness of mass balance measurements
Tier 5	Glacier inventories repeated at time intervals of a few decades using remotely sense data

The GTN-G framework has five tiers of factors which it monitors to assess the status of glaciers (Source: Box 1, [Worldwide Assessment of National Glacier Monitoring and Future Perspectives \(https://doi.org/10.1659/MRD-JOURNAL-D-19-00021.1\)](https://doi.org/10.1659/MRD-JOURNAL-D-19-00021.1))

The results gleaned from the GTN-G framework are significant because the effects of worldwide glacial melting will ripple across populations reliant on glacial meltwater. Melting will impact the lives of millions whose drinking water supply and irrigation-dependent agriculture will be disrupted as the glaciers melt. According to the study, 140 million people live in river basins where at least 25 percent of the annual runoff comes from glacier melt.

[Christian Huggel \(https://www.geo.uzh.ch/geolean/en/units/3g/staff/?content=christianhuggel\)](https://www.geo.uzh.ch/geolean/en/units/3g/staff/?content=christianhuggel), a professor of Glaciology and Geomorphodynamics at the University of Zurich, told GlacierHub that “glacier monitoring in many ways stands out as a starting point for different impacts downstream of melting, e.g. river runoff/water resources and different populations and economic sectors that depend on it.”

Glacier monitoring programs increase the data available on the status of glaciers and the roles they play in their ecosystems. When a community in a glacial ecosystem has greater awareness of its dependence on glacial meltwater, it can be prompted to adapt to the changes occurring and to prepare for some of the hazards that come with glacial decline like short-term flooding and long-term drought.

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“Local communities, national governments and global/international organizations need to understand how their glaciers, which are important sources of water, among others, respond to climate change, how they change and decline,” Huggel told GlacierHub.

A glacier in Switzerland’s Zmutt Valley (Source: [cvtperson](https://www.flickr.com/photos/131806380@N05/) (<https://www.flickr.com/photos/131806380@N05/>) / [Creative Commons](https://search.creativecommons.org/photos/c145b972-5b3a-4c5c-9ce9-6478f11d4fe9) (<https://search.creativecommons.org/photos/c145b972-5b3a-4c5c-9ce9-6478f11d4fe9>)).

The research team created country profiles for 34 nations and four regions independent of national boundaries. They highlighted three of the country profiles which show that variation in national systems. The first example was Kyrgyzstan. Under the Soviet Union the country had a well-established monitoring system that was abandoned for about two decades before being partially revived. The second was Bolivia; it began a monitoring program, but suffered the loss of one its benchmark glaciers when it melted entirely around 2009, limiting their ability to make long-term comparisons. Switzerland was the third example. The Swiss program is described as one of the most well-coordinated glacier monitoring programs with secure funding, long-term planning, and enough glaciers included in the network that it is not at risk of losing its benchmark.

The detailed information compiled on each country’s glacier monitoring system is intended to raise awareness of the challenges facing each system and to illuminate what future needs might be to maintain them. The study states that countries in Europe and North America, and Chile, China, Kyrgyzstan, and Russia seem to have more stable programs while those in Asia and South America will require support.

Salzmann stated that she “would like to see more direct financial support for countries to take these measurements and that funding should maybe depend on sharing of the data.”

The results also break down information on monitoring systems by continent and provide suggestions for what each continent’s system should improve on. For instance, in South America glaciers cover about 31,000 square kilometers of land and are important to the freshwater supply of many communities. However, the glacier monitoring network is incomplete and the study calls urgently for more complete glacier inventories.

An aerial view of mountain glaciers in the Andes (Source: [eae](https://www.flickr.com/photos/80539888@N00/) (<https://www.flickr.com/photos/80539888@N00/>)/[Creative Commons](https://search.creativecommons.org/photos/3ba72631-4b89-47a8-9ee5-1b253b11c4fe) (<https://search.creativecommons.org/photos/3ba72631-4b89-47a8-9ee5-1b253b11c4fe>)).

When asked about the importance of sharing glacier monitoring system related data openly among the countries affected by glacier melt, Pelto told GlacierHub that “it is useful now and this would be enhanced by more comprehensive reporting of glacier measurements to WGMS.” He elaborated, citing [studies \(https://www.cambridge.org/core/journals/journal-of-glaciology/article/historically-unprecedented-global-glacier-decline-in-the-early-21st-century/2F1E3ACB111A03F9BA83D11439F5D681\)](https://www.cambridge.org/core/journals/journal-of-glaciology/article/historically-unprecedented-global-glacier-decline-in-the-early-21st-century/2F1E3ACB111A03F9BA83D11439F5D681) whose important conclusions were only reached because data was shared among glacierized countries.

Earlier this week, *Nature* released a [letter \(https://www.nature.com/articles/d41586-019-03700-3\)](https://www.nature.com/articles/d41586-019-03700-3) signed by more than 35 scientists urging the parties to the UN Framework Convention on Climate Change to increase their support for international cooperation in glacier monitoring efforts. Pelto was one of the co-signatories. Levan Tielidze, a glaciologist at Tbilisi State University, who has [written \(https://glacierhub.org/2019/06/18/glacier-decrease-in-the-georgian-caucasus/\)](https://glacierhub.org/2019/06/18/glacier-decrease-in-the-georgian-caucasus/) about the effects of glaciers melting in Georgia, was also party to the letter.

The study is meant to function like a springboard for scientists and decision-makers as they work to improve glacier monitoring systems. The authors hope that their research will provide a valuable source of information in that process. It is also intended to highlight gaps in glacier-related data to avoid ill-informed decision-making that could have negative consequences for the people whose lives are impacted by glaciers. The authors call for all glacierized countries to submit their glacier data to repositories with open-access within the GTN-G community so that different communities can learn from each other. The authors also hope that the study will act like a baseline for global glacier monitoring and be repeated at regular intervals to report on developments on the subject.

Huggel emphasized the importance of the study with regard to global climate policy: He stated that the “monitoring of glaciers and their decline permits national governments to defend their case in front of the international community (like at the upcoming COP25 conference [an annual meeting of the Conference of the Parties to the UN Framework Convention on Climate Change].) He underscored the importance of glacier monitoring, saying that “only through documented monitoring of glaciers can [national governments] make a case how showing much they’re impacted by climate change.”

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