Glaciology in the Himalaya

Duncan Quincey

The Himalaya is the highest mountain range in the world and is home to Mount Everest (8848 metres above sea level). Because of the extreme topography, and an abundant snowfall associated with the Indian Monsoon, many of the world's longest glaciers can also be found here. They represent one of the most stunning natural environments you can see today. Here, a group of glaciologists explain why they are interested in these glaciers, and how they rely on teamwork to be able to better understand how these glaciers are responding to climatic changes.

What is a glacier? A glacier forms when snow accumulates over many years and compresses into glacier ice. What makes them unique is their ability to move. They flow like very slow rivers, mostly downhill and under the force of gravity. There are an estimated 198 000 glaciers in the world, covering around 726 000 km^2.

Working on glaciers is all about teamwork. Glaciologists travel as a team, eat as a team, often they even sleep as a team. During the day they divide tasks among the group, and never work individually. They are in constant contact by walkie-talkie and often collect small amounts of data each that they then collate in the evening into one large dataset to answer their research question.

Dr Phil Porter, University of Hertfordshire

"I supply my hydrology data to glacier modellers so that they can forecast how water supplies may change in the future."

I am a glacier hydrologist and study how meltwater is generated and drains from glacial environments. As glaciers continue to shrink, it's important to understand how this will impact water supplies. Predicting how much meltwater glaciers will produce is not easy though! We need to know how much ice is melted at the glacier surface, but this is complex because thin layers of dark-coloured debris accelerate melt by absorbing solar energy and transmitting it to the ice below, whereas thick debris layers may slow melt, because the debris insulates the ice.

The inside of the glacier is also made up of a complex network of tunnels through which meltwater travels on its way out of the glacier and we can't easily see inside the glacier to understand how this impacts meltwater transport and storage. However, by undertaking fieldwork to measure surface melt rates and flow from the glacier, we are able to build mathematical models to forecast meltwater production.

Himalayan snow and ice melt is a vital water resource for approximately one fifth of the world's population.

This article continues on page 12.

Key words
glacier
glaciologist
water resource
imaging

The picture on pages 10-11 shows Dr Ann Rowan, University of Sheffield, at work.

Measuring discharge from a glacier is much the same as gauging a lowland river anywhere else in the world. Here, Dr Ann Rowan is measuring the concentration of fluorescein dye that has just been injected upstream which, with a bit of calibration, gives the discharge rate at that moment. Photo by Morgan Gibson, Aberystwyth University.


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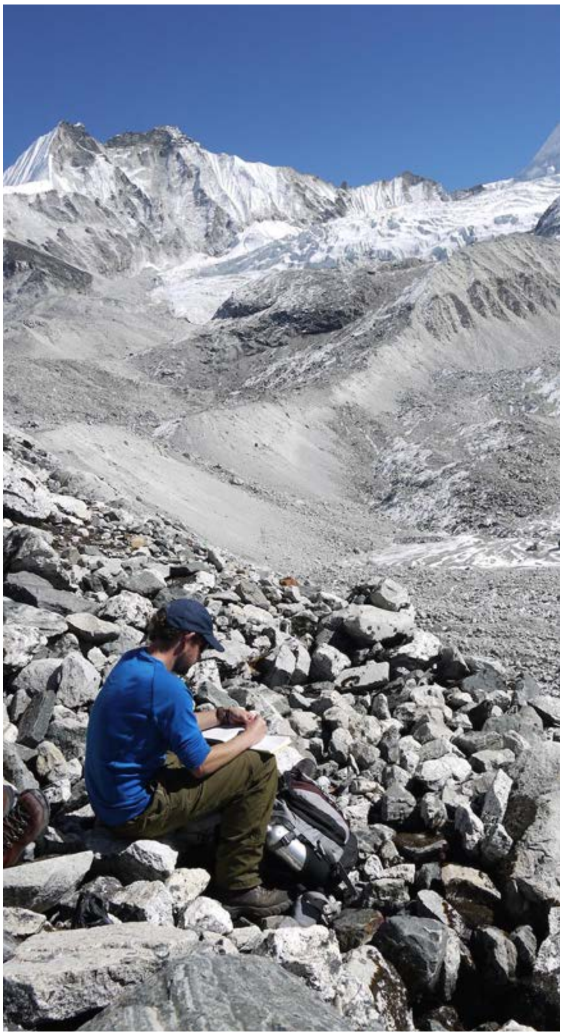
Some glaciologists spend their time abseiling into the glacier and mapping the internal hydrological network – this is known as glacio-speleology.

Glaciers contribute approximately 29% to the current rate of sea-level-rise – that's around 260 000 000 000 tonnes of water melting every year.

At 15 km long and descending from Mount Everest, the Khumbu Glacier is the highest glacier in the world.

Glaciers store about 75% of all the world's freshwater.

Some glaciers are so remote it can take several weeks of hiking just to reach them.



Dr Matt Westoby, University of Northumbria

"I need satellite images from remote sensing scientists to be able to measure how fast lakes are growing and when they might burst."

My main area of interest is glacial hazards and the risks posed by glacial lakes. These lakes form through the growth and merging of numerous small melt ponds on a glacier surface, or when water collects at the edge of the glacier. Glacial lakes can contain a staggering amount of water – for example, the largest lake in the Mt. Everest region, Imja Tsho, contains over 60 million cubic metres of water, which is enough to fill over 25 000 Olympic-sized swimming pools! A large rockfall or avalanche into a lake can release the stored water and produce a devastating glacial lake outburst flood.

My research uses case studies of past flood events to simulate the full range of possible outburst scenarios for glacial lakes. This information is useful for hazard managers, who can then inform local communities of the potential risk posed by upstream glacial lakes.

Dr Tristram Irvine-Fynn, Aberystwyth University

"I need information from glacier hydrologists to be able to understand how my tiny bugs may adapt to changes in water supply."

My scientific research demands I spend lots of time 'in the field', actually walking all over glaciers and the surrounding landscape, making measurements, taking samples and recording any observations I think are interesting or important. Some of these measurements are of microscopic organisms that live on glacier surfaces and are moved around by the meltwater. Amazingly, it turns out there are over one hundred trillion trillion of these micro-organisms living just on the surface of Earth's glaciers and ice sheets!

These tiny life forms have important roles to play in global nutrient cycles and can influence the ecology of streams or ponds that are fed by glacial meltwater. These micro-organisms can also contribute to meltwater production because they contain pigments (to protect them from the Sun's UV rays) or chlorophyll (to photosynthesize, like plants), which makes them darker-coloured compared to the white glacier ice, so that they warm up in the sunlight and help melt the ice. As you might guess then, I work very closely with hydrologists to tackle questions about how glaciers melt.

Becoming a glaciologist

The UK has many hundreds of glaciologists working in research centres and universities. If you enjoy travelling and a bit of adventure this could be a good career to choose – consider taking a science subject (including Physical Geography or Geology) at university and you may end up getting paid to visit some amazing locations!

Dr Ann Rowan, University of Sheffield

"I need field data from all of my colleagues to feed into my glacier models. This way we can make accurate simulations of how fast the glaciers are melting."

I'm a glaciologist and studied Geology and Earth Science at University. I use computer models to describe how glaciers respond to climate change, and to quantify the impact of glacier change on water supplies. Glaciers flow in a similar way to treacle (because ice deforms under its own weight) and we can describe the physics of ice flow mathematically using differential equations.

The changes that we see over time in the shape and volume of glaciers occur because the glacier's mass balance changes either by increasing as more snow is added than ice is melted each year, or decreasing because more ice melts each year than is replaced by snowfall. By making a calculation for the change in glacier mass balance over time and combining this with what we know about the physics of ice flow, we are able to make computer models that can predict how glaciers will change in the future and what this means for the water supply in countries such as Nepal and India.

Dr Duncan Quincey, University of Leeds

"I supply my satellite images to glacier modellers so they can predict how long it is before glaciers disappear."

I am a remote sensing scientist, which means I am interested in any images of the Earth's surface acquired by aircraft or by satellite. The development in this field has been extremely rapid in recent years. We can now routinely collect images from satellites that are more than 400 km above the Earth with a spatial resolution (i.e. the size of each pixel in the image) less than 50 cm. That means we can almost resolve people walking in the street using images acquired from space.

For the glaciers of the Himalaya, this exciting technology means we can do two main things. The first is to quantify rates of glacier surface lowering, which tells us how quickly the glaciers have melted in the past. The second is to detect how fast the glaciers are flowing, which is an important consideration in predicting how quickly they will melt in the future. Although we have such amazing images to work with these days, I never miss an opportunity for fieldwork – it is far more exciting than working in the office!

Working at such high-elevations requires a lot of support from Nepalese porters and Sherpas who are already well-acclimatised. Sherpa people are a particular ethnic group who originate from the mountain regions and so are well-qualified to guide visitors who often have little knowledge of the terrain. Porters are generally not Sherpa people, originating often from the lowlands. They are strong however, carrying loads of 30-50 kg each, in baskets that they wear around their foreheads. Yaks can carry heavier loads (50-100 kg per yak) and often travel in 'yak trains', negotiating precarious looking suspension bridges along the way. The Sherpas, porters and yaks are all critical members of the scientists' expedition team.

Duncan Quincey is a glaciologist in the Department of Geography at the University of Leeds.

Look here!

More information and some amazing images of glaciologists at work:

www.swisseduc.ch/glaciers/

www.rockyglaciers.co.uk