Climate change monitoring in the developing world

Professor Martin Hoelzle outlines the need for climate change monitoring and forecasting techniques based around glaciers and, specifically, why his team is helping to amend the dearth of such strategies in the developing world

From your point of view, why is it important to study glaciers and related landforms in order to assess the impact of climate change?

Glaciers are fascinating, with their clean white or blueish hues and their monumental presence in mountain landscapes. Crucially, they are also key indicators and unique demonstrators of ongoing climate change. Their shrinkage and, in some places, their complete disappearance leaves no doubt as to the fact that the climate is changing at a global scale, and at a fast – if not accelerating – rate.

It is easy even for non-experts to see changes in glacier extent, and to understand the basic physical principle of snow and ice melting as temperatures continue to rise. As glaciers become smaller, the energy content within the atmosphere, the corresponding climate system and the environment on which we depend becomes greater.

However, ice is not always visible at first glance, as with glaciers. Sometimes, it is hidden in the frozen ground, where it is able to produce interesting landforms like ice wedges, pingos or palsas in the Arctic, or rock glaciers in mountain areas. These ice-related landforms are, in fact, the most prominent indicators of rapid climate change.

How is the Capacity Building and Twinning for Climate Observing Systems (CATCOS) project helping to provide a more comprehensive picture of climate change?

Locally measured data are important if we are to understand physical processes between the atmosphere and the ground surface or, in our case, the glacier surface. These data are necessary to construct reasonable models that will allow for better future forecasts, because the current models are only as good as our process understanding. Therefore, one of our most urgent tasks is to improve our knowledge of these processes, which is still fairly basic.

Today, one of the main research goals is the assimilation of different data sources such as information from satellites and ground-based measurements, together with good process understanding, in order to create models that allow us to improve our predictions with high resolution and spatial coverage.

Why is CATCOS focusing specifically on establishing measuring capacities for developing countries?

Today's monitoring networks are unevenly distributed around the globe, which is a fundamental problem for many important geoscientific analyses and corresponding applications. Developing countries must also contribute to worldwide data monitoring networks so as to achieve more complete global coverage.

This means that we need well-educated people in these countries to perform and analyse their own measurements. Today, we often have very well-developed measurement networks in industrial parts of the world such as Europe or the US, but in developing countries, many of these networks have been discontinued in the recent past, or never existed in the first place owing to political instabilities or lack of funds.

Therefore, CATCOS is supporting its colleagues in developing and emerging countries, and helping them contribute to the international research and monitoring community.

Your recent work is focused on re-establishing a former glacier monitoring

network in Central Asia. How has the landscape changed in the last decade in the countries you are monitoring?

Most glaciers in Central Asia, especially those situated in the lower altitudes of the Tian Shan and north western Pamir mountain ranges, are currently subject to a strong retreat. This is resulting in disasters related to floods, debris flowing from ice-dammed lakes and breaching moraine dams.

The increasing risk of far-reaching flood waves from large rock/ice avalanches in the surrounding destabilised mountain flanks will severely impact the people living in the valleys or close to the foothills of these mountains.

How will CATCOS enable decisions to be made about mitigation and adaptation strategies?

It is very important to collect accurate figures for runoff in the Central Asian region, where water distribution is already a highly political subject and a continuous basis for conflicts.

Good model projections for the region will enable local communities to prepare in advance for the coming changes, and will therefore help to prevent local, regional or even global tensions between the different countries affected.

Glacier data from Central Asia

The **Capacity Building and Twinning for Climate Observing Systems** (CATCOS) project provides an effective model for industrialised nations working to improve climate change monitoring in the developing world. Its work in Kyrgyzstan exemplifies both the ambition and the importance of this crucial endeavour

CLIMATE CHANGE REMAINS at the top of the global agenda as a priority for action. There is, however, a disparity, because while industrialised nations are contributing most to its effects, the true victims of climate change still tend to be the nations that most lack the capacity to influence its outcomes.

A recent infamous case study has been the Marshall Islands, a tiny, impoverished Pacific nation that has seen climate disaster after climate disaster, and that experts predict will need to be evacuated if global sea levels and temperatures continue to rise at their current rates.

The problem is that while developing and emerging countries stand to lose a lot as a result of climate change, they tend not to possess either the capacity or the political will to make any significant contributions to its mitigation. Many such nations are mired in poverty, corruption and conflict. Climate change – perhaps understandably – is far down on their 'to-do' lists. Like it or not, however, global problems require global solutions, and one of the biggest deficits currently facing climate science is a lack of sufficient data from less developed parts of the world.

CATCOS

This is where the Capacity Building and Twinning for Climate Observing Systems (CATCOS) project comes in. Funded by the Swiss Agency for Development and Cooperation (SDC) and coordinated by the Federal Office of Meteorology and Climatology (MeteoSwiss), this broad association of Swiss and international institutions is aiming to fill gaps in the global climate observing system (GCOS).

This is an ambitious mission, as these gaps are spread across the entire globe, and take many different forms. CATCOS project locations range from the Pha Din mountain pass in Vietnam to the La Conejera glacier at the Santa Isabel Volcano in Colombia, and its two main aims are to undertake atmospheric and terrestrial observations, and thus measure capacities for aerosol and greenhouse gases and support systematic monitoring of glaciers.

For their part, scientists from the University of Fribourg, led by Professor Martin Hoelzle, are coordinating efforts in the Central Asian nations of Kyrgyzstan and Uzbekistan. There, they are re-establishing a former glacier monitoring network based on new monitoring

> The primary function of this operation is to produce high-quality data that serve as Kyrgyzstan's contribution to the global climate observing system

CAPACITY BUILDING AND TWINNING FOR CLIMATE OBSERVING SYSTEMS (CATCOS)

OBJECTIVES

To fill gaps in the global climate observing system by strengthening capacities of 10 developing and emerging countries to systematically observe climate-relevant data.

KEY COLLABORATORS

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National Partners:

University of Fribourg • Federal Office of Meteorology and Climatology (MeteoSwiss) • University of Zurich (UZH) • Paul Scherrer Institute (PSI) • Material Science and Technology (EMPA)

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strategies, as well as ensuring that the project is sustainable in the years to come.

THE CENTRAL ISSUE

Central Asia stretches from the Caspian Sea to China, taking in five distinct countries and 1.5 million square miles. For many outsiders, this region is something of a mystery, but needless to say it shares many of the same problems as the wider world.

"The countries in Central Asia are especially vulnerable to climate change," explains Hoelzle. The fact is that vast mountain ranges such as those found in Kyrgyzstan contain similarly vast glaciers – the Tien-Shan range has a glacierised area of around 12,400 km^2 – and these are under threat from rising global temperatures. Ultimately, their melting could have a major impact on runoff, not to mention local communities and ecosystems, which will suffer in the future because of a lack of runoff during dry summer months and flood waters that come spilling down from the mountains to destroy settlements and disrupt agriculture.

As such, the Fribourg team set about resuming assessment of key Kyrgyz glaciers whose long-term monitoring programmes had been suddenly cut off, along with several other Central Asian programmes, in the mid-1990s. "The new monitoring strategy is partly built on old conventional methods like the glaciological mass balance measurements," Hoelzle explains – referring to measurements of the difference between snow accumulation and ice ablation on a glacier that allow researchers to assess whether a glacier is losing or accumulating mass. "At the same time, we have the application of new methods." These new methods include everything from satellite observations to ground-based technologies such as automatic weather stations and terrestrial cameras.

Taken as a whole, this suite of technology should be sufficient to gain a deeper understanding of the processes CATCOS is measuring and, critically, allow the team to develop models that can accurately predict the fate of the Central Asian glaciers.

THE NEXT PHASE

Phase 1 of CATCOS, which finished in early 2014, was focused primarily on the resumption of these measurements, with limited focus on ensuring the sustainability of the project. Now, the team is well into Phase 2 of the programme, a central component of which is ensuring that local scientists have everything they need to ensure that this time the monitoring efforts do not come to such an abrupt halt. They are being provided with training, as well as additional instrumentation for greenhouse gas measurements.

"We have been able to support some promising Kyrgyz students," enthuses Hoelzle. "They have learned very fast and were able to produce their first paper, which we sent to a well-known international journal. This represents a real success in our efforts to increase regional research capacity in this domain." Hopefully, this will be the first of many such achievements, and as the Kyrgyz arm of the programme steams ahead, another component of Phase 2 has moved into neighbouring Uzbekistan to resume glacier monitoring there.

THE RESULTS ARE IN

Of course, high-quality publications are one thing, but the primary function of this operation is to produce high-quality data that serve as Kyrgyzstan's contribution to the GCOS. Only then can a global picture of climate change impact be satisfactorily established.

The researchers have been able to infer some trends from the data they have produced so far, and unfortunately it is not good news. Taking the example of the Abramov glacier, one of the four key glaciers the team investigated in Phase 1, it has clearly undergone considerable mass loss – especially when compared to the earliest records from the 1960s. Worse still, the CATCOS team's findings indicate that this trend is ongoing.

No matter how gloomy the results of their analyses, however, the work being undertaken by these Swiss and Central Asian researchers will have profound impacts. With their information, efforts to mitigate – or at the very least adapt to – the oncoming effects of climate change can begin in earnest throughout the region. The recent Conference of the Parties (COP21) in Paris made explicit the need for international cooperation to overcome this global threat, and this team is a perfect example of such cooperation in action.

CATCOS BREAKDOWN

PHASE 1
2011-14: The focus was on Swiss institutions supporting the seven developing and emerging countries in the establishment or resumption of climate-relevant measurements.

Participating nations: Chile, Colombia, Ecuador, Indonesia, Kenya, Vietnam, Kyrgyzstan and Switzerland

PHASE 2
2014-16: In order to ensure the continuation of these measurements, the focus of this phase is on training, regional networking and improving the use of climate-relevant data.

Participating nations: All of the above, as well as Bolivia, Peru and Uzbekistan