Climate Emergency

When the Ice Melts 1: Longest field data analyses regional climate change in Chhota Sigri glacier of the Himalaya

This is a Suno India production and you are listening to Climate Emergency.

What you are hearing is the highest maximum temperature of Manali from 2005-2020. There has been an increase in temperature steadily affecting the glacier run offs.

One such glacier is Chhota Sigri, which is in the Lahaul Spiti valley of the western Himalayas. This nine-kilometer long glacier is an important water resource that supports the livelihood of people.

According to a recent Hindu Kush-Himalaya (HKH) Assessment, even if global warming is constrained to the most ambitious target of 1.5°C (according to the 2015 Paris Agreement), at least 30% of the permanent glacier cover in the Hindu Kush Himalayan region could meltdown within this century, leaving behind 2 billion people in peril.

Research and observations on glaciers and their behavior are very limited in India. In a recent paper published in the Journal of Glaciology, scientists have come up with new data that is straight from the glaciers. Such regional data, experts believe, could be more accurate, and help us understand regional climate change, and their impact on the glaciers.

Hi, I am Sharada Balasubramanian, and I am here with the first part on climate change and Himalayan glaciers for Suno India's Climate Emergency Podcast.

At Chhota Sigri glacier in Himachal Pradesh, scientists combined field data and satellite data to look at glacier health. Data from 20 years was analysed to understand these impacts. However, scientists believe 20 years is not enough, and there is a need for a long-term monitoring of these glaciers to better understand their movements and behaviour.

Arindan Mandal, a researcher and the first author of this paper, from New Delhi's Jawaharlal Nehru University's School of Environmental Sciences works with a specific group that focuses on glaciers. He talks more about his work in the Himalayan glaciers.

Arindan: My paper is based on almost 20 years of study in Glacier called Chota glacier in Himachal Pradesh, right, so this is one of the longest 30 Glaciers in the entire Hindukush Himalayan region for many aspects of glacier and climate interaction, for example, glacier mass balance, which is I mean, one of the best indicators of glacier health change over a particular time, then glacial hydrology, then glacier ice velocity change, and many other aspects we have discussed in the new paper published in the Journal of Glaciology, which is one of the best in our field.

As experts say, glaciers are the best indicators of climate change as they are directly related to

climate. For instance, if there is any fluctuation in temperature or precipitation, glaciers are directly affected. Glaciologists, globally, often talk of mass wastage in glaciers. How much of glacier mass are we losing, and how less is the accumulation of mass when there is a change in climate- this was analysed in Chhota Sigri glacier.

Mohammad Farooq Azam, a glaciologist and a professor at the Indian Institute of Technology, Kanpur, talks about the impact of climate on glaciers, and how, in turn, that can impact water availability in the downstream Himalayan rivers.

So, in a balanced state everything is balanced, climate is not changing, glaciers are gaining their mass during winter snow, snow is falling and they are providing water for irrigation, hydro power generation during summer.

When glaciers lose mass, there is an imbalance. There is less accumulation of mass, hence less water availability. This leads to an imbalance state. And in future, we may not have enough water during summer.

The seasonality of the water flowing from the Himalayan rivers is important for certain crops. And based on this water availability these specific crops are sown in northern India.

Looking at this glacier helped in understanding the future impacts on water availability. Arindan explains why this glacier was looked upon as a benchmark glacier.

Arindan: We call it benchmark glacier based on the data set availability. I mean, in the Himalayas, you have more than 30,000 glaciers, in different sizes, and you have hardly 30 of them studied so far in the entire Himalayas. So out of all those studies, Chhota Sigri glacier has the longest dataset. In every aspect, you take mass balance, you take hydrology data, or you take any other kind of glacier study chemistry or anything. So that's one of the basic parameters for this benchmark glaciers from this data ability perspective. Another perspective is that all the big glaciers or all of the glaciers cannot study because a lot of manpower is needed, it is a rugged terrain, etc. Chotta sigri is one of the best glaciers because the size is almost 15 kilometres square. Some scientists can cover all the area to study the elevation gradient. The elevation gradient is almost 1000 meters from top to bottom. Everybody can access a spot, for example, in Siachen you have seen 1000s of gradients. Glacier starts at 3000 and ends at 6000, the gradient is very high, and we can't access all the parts of the glacier. So this Chhota sigri has most of these features that are quite perfect to study for a scientist or for a group of scientists. So these are the two perspectives for calling it as a benchmark glacier. In 2002, there was a big programme from
UNESCO, in this glacier because in the Himalayas, there are no data in the earlier time. So, a lot of worldwide scientists came together to strengthen the glaciology and studies in the Indian region or in the surrounding subcontinent. So that happened in this Chhota Sigri glacier due to glacial accessibility and many types of good features in the glacier. From that time, the glacier was considered as benchmark glacier. And we have continued studies from that time only.

Host: So, can you explain the relationship between glacier health and climate change in

reference to the Chhota Sigri glacier?

Arindan: The principal objective in this paper is mass loss, which is called mass balance. Mass balance is basically simple. It's a balance of input and output. The input you can say is the snowfall, which develops the glacier ice and snow, and the output is the water which is flowing out from the glacier. From these two components, you get the balance, which is the simple mass balance. If the balance is positive, then mass is gaining, the glacier is in good health, or advancing, and if water has gone out more than input, the glacier health is going into negative balance, and is deteriorating, it's simple. So for example, in some years, you have a very high precipitation in winter or in summer. And in summer that's why you have less snow, I mean less snow melt. You have a lot of snow deposited on the glacier, in that case in that particular year, glaciers might face less melt. So, we may have a little advanced or maybe just in equilibrium, but the deteriorating condition depends on every year's meteorological parameters. And then another important topic is the glacier surface ice velocity. See we call it a glacier when there is a particular amount of ice in a valley and it moves downwards. In that gravity, the glacier flows downstream. So, generally, when you have good mass or enough mass that glacier will slow down. When you don't have enough mass, then there will be mass loss, and the glacier will reduce its velocity. So, we found that in this glacier in the last almost 20 years, the velocity has decreased almost 25 to 40%. So is a clear indication of glacier mass loss. Simultaneously, you have almost 0.5 meter water equivalent of ice loss every year, you can easily see that the glacier is in deteriorating health. I mean the mass balance is also losing, glacier ice velocity has also reduced. If we connect this, you get the clear picture. You have many perspectives to see how glaciers are really behaving to climate change.

Scientists say that both glaciology and hydrology go hand in hand when it comes to water resources. These glacier studies are crucial to understand what is happening on the ground. The reason for this is as simple as the fact that we have thousands of glaciers, and it is practically impossible to look at each one of them. When only modeling is used, without using any field data, it could be far from reality, and perhaps, misleading too. Precisely why, this study is much more significant. Because it incorporates data straight from the field. This paper showed all the data, and also ensured it was available in the public domain, so that researchers could use it to improve their models.

Host: And you also mentioned about use of satellite imagery right, for this particular study. So how has it like contributed to getting more significant information or has that changed the way you do research or how has that contributed to understanding a better understanding of this glacier?

Mohammad Farooq: So the contribution of satellite research is also important. Because, for instance, if we cannot go in a particular time, for instance, in September 2018, there was a big snowstorm in the valley, and we all were stuck in Manali. It was not accessible. We knew somehow that we could not perform anything because the situation was very bad. So in that case, satellites help us to fill that data.

Satellite data is more accurate if you are observing for 10 years or looking at seasonal data. For

instance, this will show the variation seasonally or annually. Scientists take 10-year data from satellites and from the field, compare and assimilate them to generate all possible accuracy in arriving at the mass balance data.

Also, scientists say that this is not a long enough time period to estimate if precipitation is increasing or decreasing. However, what they say by looking at more data is that- if this melting occurs, there will be glacier mass loss, and this will impact the future river runoff. And this runoff is crucial for people dependent on these rivers for irrigation or livelihood.

Arindan: And they are saying that this might mean glacier loss will increase the runoff for this particular time for say, 2040s or 2050s you will have a peak discharge- very high discharge because of a high melting but going into 2070s or 2060s you will have reduced discharge because area will be very less and glacier area will no longer giving the enough amount of water to the downstream rivers. So, the peak time of this discharge, in our scientific language we call it peak water, many studies predicted that in the Himalayas, this big discharge will be around 2040 or 2050. And in around 2060 or 2070, you will have quite a low amount of water in the rivers and then slowly the water will finish. So far, they have predicted but these are all our models, study models. Yes, we need ground data set or in situ data sets to strengthen these statements or study. And that's what we are doing in JNU.

Their studies also indicate that glaciers are not going to vanish soon. Arindan said that the Himalayas is responding, just as similar to the other glaciers in the world- and it's not a very extraordinary or alarming situation as of now.

Here's another challenge though. For collecting this very data from the field was not an easy task. With the tough Himalayan conditions, trekking on ice, facing flash floods and unknown calamities, non-accessibility to glaciers, collecting data is indeed difficult. Arindan talks more.

Arindan: You have a lot of challenges on the glacier when you do not have many people. So for example, in 2015, I and two of our students, and four helpers, were hiking up to the glacier accumulation, I mean, glacier's highest point for measurements. And we had faced the big crevasse on the glacier, one of our helpers, was leading the team. We were roped up in the mountain. And what he saw is, the first one who was leading, he just fell down into the crevasse. We somehow rescued him by a rope. But when we saw the depth of the crevasse, it was super, super deep, more than 100 -200 meters. Very dangerous to see. And they could not perform our fieldwork anymore because of a lot of traumatized conditions. I mean, these are many challenges we need to face.

The challenges of data collection in the Himalayas is indeed daunting. The scientists, however, say that this data will push the research forward. And how, Arindan says more.

Arindan: As I told you, we have almost 30,000 glaciers or even more in the Himalayas, and we studied hardly 30, which represents less than 1% of the total area of the Himalayan glaciers. So that itself shows that we need to study more, especially in the field. So, for example, in Chhota Sigri this glacier is almost 15 kilometre square. In the Himalayas, we have 40,000 square

kilometre of glaciers, so that's negligible. So we need to study more, maybe bigger glaciers, we need more numbers, more understanding from different parts. So that's the major recommendation. So, we should take maybe a glacier, maybe all institutions who are working, they all should take one glacier each, in field to strengthen all these conclusions, at least in the Indian Himalayan region. I think all the institutions should come together. Then, they should select glaciers in different regions and climatic conditions, and should have an overall understanding of how to study these glaciers. That's what we are doing, institutions are doing and the government is doing. For example, in Nepal, ICIMOD has done a great job, they have called good scientists from the world. And they have studied a few of Nepali glaciers in different regions, East, West Everest, and now they have a very good understanding. Maybe in India, we are lacking that, but yes, like in Chhota Sigri, we have published a big data set and have a bigger understanding, and this will help a lot to scientists and motivate them to take more glacier studies.

Host: Say if you are able to generate data, do you think you will be able to say a solution which we can advocate on? Something you could propose on?

Arindan: We can't stop it. We, maybe, can reduce it by taking governmental measures. For example, there is tourism in Himachal, mostly these tourists don't even bother about the climate. Vehicle emission and plastic, maybe if you control it, maybe there will be reflection in glaciers after 20-30 years. Maybe you will have less melt. There are many things to study. The only thing is we can prepare for it. You have heard about lake outburst, you can just prepare yourself by moving out from the area, but you cannot stop anymore. Whatever we have done, we just need to look for less vehicular emission and pollution. Maybe then the glaciers will be happy a bit.

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