

Himalayan Glaciers – Behaviour and Climate Change

Himalayan Glaciers – A State-of-Art Review of Glacial Studies, Glacial Retreat and Climate Change. V.K. Raina, November 2009

Review by Cliff Ollier

This book is a Discussion Paper issued by the Ministry of Environment and Forests, Government of India. Dr. Raina is an ex-Deputy Director of the Geological Survey of India, he spent many years studying the glaciers of the Himalayas, and has now produced a splendid over-view of the situation. He describes the history in investigation, details of glaciological studies, conclusions drawn from the studies, and finally a review of Global Warming and Glacier Retreat.

Here I shall refer to the main facts presented, and the basic conclusions, but put the emphasis on the last section, climate change, because the publication has already aroused vitriolic reactions from some quarters.

Himalayan glaciers show variable behaviour over the past hundred years. Most have retreated, some have stayed almost static, and some have a record of advance and retreat. This parallels the rest of the world, where most glaciers have been retreating since the end of the last glacial period. Many have shown alternating periods of advance and retreat.

Many people nowadays attribute the glacial retreat to anthropogenic global warming (AGW). But how can we tell when AGW started to affect the issue, or could all the changes we see be entirely natural, as they have to be for the pre-nineteenth century changes? Since glaciers have been retreating for thousands of years, why should the retreat of the past hundred years be attributed to a special cause? Can we find within the observed evidence some tests for deciding between natural and anthropogenic causes?

I believe that Dr Raina has provided the evidence, and interpreted it correctly.

Before getting into details, I shall explain the principles of glacier behaviour (which are also described in the book), so that the reader can understand the significance of the observations summarized later.

The Glacier Budget – why do glaciers advance or retreat

In general glaciers grow, flow and melt continuously with a budget of gains and losses. Snow falls on high ground, compacts, and becomes solid ice. More precipitation of snow forms another layer on the top, so the ice grows thicker by the addition of new layers at the surface. When the ice is thick enough it starts to flow under the force of gravity. A mountain glacier flows mainly downhill, but can flow uphill in places, as in the rotational flow that creates cup-shaped cirques. The flow of ice is generally slow, as expressed in the common metaphor "glacially slow", but the rate is variable. Some glaciers "surge", meaning they have short periods of accelerated flow. Flow rate depends on stress and so on thickness of the ice, and a relatively small increase in thickness results in a large increase in flow rate.

When the ice reaches a lower altitude where temperature is higher it starts to melt and evaporate. (Evaporation and melting together are called ablation, but for simplicity I shall use 'melting' from now on). If growth and melting balance, the glacier appears to be 'stationary'. If precipitation exceeds melting the glacier grows and advances. If melting exceeds precipitation the glacier recedes. The position of the snout is the simplest indicator of where the balance lies, but does not indicate the cause.

Flow is mainly by a process called creep, essentially the movement of atoms from one crystal to another. Only the lower part of the glacier can flow plastically: the upper ice is brittle and cracks to form crevasses in the rigid ice carried along on the plastic lower ice.

Himalayan glaciers present yet another distinctive problem. Some mountain glaciers start from icecaps that flow at the edges, so there is continuous flow from the snow-collecting area to the glacier snout. In the Himalayas relief is great and the peaks are so sharp that snow falling on the peaks reaches the glaciers in the valleys via avalanches. So the growth of a glacier depends not just on the precipitation but on the frequency of avalanches. It could happen that increased temperature in the mountains caused increased avalanching, thickening the glaciers and cause *increased* flow of the glacier.

The Himalayan Glaciers

Raina divides the history of research into Himalayan glaciers into three phases. In the early phase from first exploration to 1957 there was the accumulation of much topographic detail. From 1957 to 1970 a more holistic approach was taken, ice thicknesses were observed, and understanding of glaciers improved. After 1970 a Hydrological Programme dominated the work on glaciers, which included measurements of glacier thickness, calculation of ice volumes for each basin, and mass balance assessment. It was found that the major factor for the retreat of glaciers is the relatively less snow precipitation during the winter, rather than enhanced melting in the summer. The glacier mass balance shows an inverse relation with monsoon precipitation.

There are thousands of glaciers in the Himalayas, and glaciers within the Himalayan region display different behavior.

The main evidence for glacial retreat or advance is the changing position of the snout of glaciers. This is an easy and convenient thing to observe (though in the Himalayas it is harder than in most parts of the world), but as explained earlier the position of the snout depends on many factors and not just temperature.

Raina provides descriptions of large glaciers such as Siachen glacier (74 km long and the second longest outside Polar regions), and Gangotri, (the largest in the central Himalayas and regarded as the source of Ganges) down to small ones just a few kilometres long.

The most fascinating accounts are of the growth and retreat of the different glaciers. Here is a sample:

Gangotri was retreating at 20 m per year up to 2000, but then slowed, and since September 2007 has been at a standstill.

Siachen glacier advanced 700 m between 1862 and 1909 and retreated 400 m between 1929 and 1958, since when retreat has been very small. The snout has retreated just 8-10 m since 1995.

Other contrasts are that Sonapani glacier retreated 500 m in the last 100 yr, whereas Kangriz glacier shows virtually no retreat.

The small (2km) Machoi Glacier has a continuous record of snout observations since 1875, and shows no major retreat in the last 50 years.

Bhagirath glacier retreated 320 m between 1962 and 2005 (7.4 m/y), but only 1.5 m in 2006.

In the early phase of Himalayan exploration glaciers were in general retreat, but even then Mirapin and Hassanabad advanced rapidly.

In Kumaon three glaciers retreated, including Pindari (425 m in 57 years), but Poting glacier was stationary.

Three surging glaciers of Kumdan behaved differently during 1958: Aktash and Chong Kumdan were advancing, but Kichik Kumdan was retreating.

Chong Kumdan glacier has three limbs:

The southern limb advanced 1.25 km up to 1990 and then retreated by 0.75 km up to 2006.

The northern limb, from 1993 to 2007, “is continuously surging ahead and has advanced by about 2.5 km. (16.7 m/y)”

The central limb retreated between 1997 and 2001, after which it surged. Between 1990 and 2007 the central limb advanced 1.75 km.

Kichik Kumdan glacier has two limbs.

The northern limb retreated 0.53 km between 1990 and 1997, then advanced up to 2004, and then retreated again by 0.6km.

The southern limb initially retreated up to 1992, advanced until 2005, and then retreated again in 2006 and 2007.

Glaciers further back in time

Modern dating methods allow determination of the age of ice itself and of associated landforms.

The Gangotri glacier once flowed for another 47 km beyond its present snout, to the town of Jahla. This extension has been dated to 58,000 years ago, which is well beyond the start of any possible anthropogenic global warming. Similarly Durung Drung glacier extended 15 km farther downstream 21,000 years ago.

Dating of ice close to the snout of the small Gara glacier showed the ice was 250-300 years old. It has taken 300 years for ice in the accumulation zone to reach the snout 2.5 km distant. Fluctuations of the snout of the Gara glacier reflect the weather or climatic conditions of 300 years ago, not the temperature of today: the position of the snout today is a summary of events over the past 300 years. Raina postulates that many glaciers are responding to natural warming that occurred during the Mediaeval Warm period of the 11th century.

In the same way fluctuations of the big glaciers, Gangotri or Siachen, may be a response to the climate of 6000 years ago or 15000 years ago respectively.

Comparison with glaciers in the rest of the world

One of the weaknesses in this book in my opinion is the fairly brief comparison of Himalayan glaciers with those elsewhere in the world. Dr Raina seems to accept the general, oversimplified IPCC view of universal global warming and glacial retreat everywhere, but this is not so. Advance and retreat of glaciers is a world wide event, but local exceptions are common. In the European Alps glaciers advanced in the 1750, 1820 and 1850 and about 1885 to 90. Since then the Alpine glaciers have generally retreated, with more rapid retreat in the 1930s and 1990s (dates that do not correlate with any notable periods of CO₂ accumulation). The Himalayan glaciers do not match the Alpine record, probably because global temperature is not the main control.

There is plenty evidence that the icecaps of Greenland and Antarctica are in fact growing rather than shrinking. The ice on Mount Kilimanjaro is retreating not because of warming but because of decreasing precipitation.

Some glaciers are extending, like the Hubbard Glacier in Alaska, although other glaciers in its vicinity are in retreat. The Hubbard Glacier is a popular place for visitors to observe the almost continuous break-up of the ice front, often making icebergs the size of a multi-story building, yet the glacier has advanced since it was first observed in 1895, and now threatens to close a fiord and the livelihood of local residents. The Hubbard Glacier is advancing, like the advancing glaciers of the Himalayas, because increased precipitation makes the glacier thicker.

In brief, there is plenty of evidence around the world to support Dr Raina's conclusions.

Raina's Main Conclusions

Since the earliest recordings there has been general retreat, but retreat slowed down in the nineties and has come to a standstill in the case of many glaciers including the Siachen, Gangotri, Machoi, Darung Drung, Zemu, Bhagirath Kharak and Satopanth.

Sometimes there is no similarity between the movements in two branches of the same compound glacier.

“Ultimately the movements [of glaciers] are due to climate and snowfall in particular, but the factors are so varied that the snout movements appear to be peculiar to each particular glacier.”

Snow precipitation is the dominant factor in glacier advance or retreat.

“A glacier... does not respond to the immediate climatic changes, for if it be so then all glaciers within the same climatic zone should have been advancing or retreating at the same time.”

I believe that these conclusions are correct, and congratulate Dr. Raina on providing conclusive evidence that the behaviour of Himalayan glaciers, or even their modern changes, cannot be attributed to the single cause. He has demonstrated that the ruling theory that anthropogenic global warming controls Himalayan glaciers is untenable.

Problems for advocates of Anthropogenic Global Warming

With thousands of years of natural advance and retreat, what is the evidence that the latest general retreat of glaciers is caused by a new factor, anthropogenic global warming? But the AGW alarmists go further, and use their alleged behaviour of glaciers as proof of future impending doom unless we reduce carbon-bearing greenhouse gases. The IPCC's 2007 Working Group II report asserted that Himalayan glaciers **“are receding faster than in any other part of the world and, if the present rate continues, the likelihood of them disappearing by the year 2035 and perhaps sooner is very high if the Earth keeps warming at the current rate”**. Such claims are unsupported, unscientific and wrong.

Surely it is up to the AGW proponents to offer proof for their special case theory. If the AGW camp wish to assert that glacier retreat is due to global warming, they need to demonstrate how such warming affects the glacier budget.

When is it supposed that AGW set in, and how can it be demonstrated?

Dr Raina's data suggest that the position of a glacier snout results from several factors. What is evidence to deny this and show that the position of the glacier snouts is controlled by global warming, and anthropogenically induced warming at that?

Dr Raina has shown that at the same time (including the present) some glaciers retreat, some advance, some stay in the same position, and some fluctuate rather rapidly. Why the difference? Raina writes “A glacier ... does not necessarily respond to the immediate climatic changes, for if it be so then all glaciers within the same climatic zone should have been advancing or retreating at the same time.” How can we explain the diverse behaviour of glaciers by temperature and greenhouse gases? Do the AGW proponents suppose different amounts of climate warming for some and not others? Do they imply different amounts of CO₂ production in different areas? This seems impossible because contrasting glacier behaviour is often in immediately adjacent areas.

Raina describes a gradient of increasing melting from NW (Kashmir) to SE (Sikkim). The AGW explanation is presumably increasing heating in the same direction, and perhaps an accompanying increase in anthropogenic CO₂. In this sparsely inhabited and industrialised area this seems most improbable, and it is up to the AGW camp to provide a hypothesis to explain the trend and provide the evidence for their hypothesis.

The fallacy of a single cause is a well-known failure of scientific thinking, yet the idea that AGW controls the future of the planet, let alone the behaviour of glaciers, is constantly pushed upon us. All the evidence suggests that there are many factors affecting glaciers. To paraphrase Raina, “It is unlikely that the snout movement of any glacier can be claimed to be the result of a single factor, namely today’s temperature”.

Raina writes “But to postulate that a glacier can warn of the climate changes likely to take place in future is a big question mark”. I would suggest it is totally illogical.

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