Climate Change and the threat of disasters in The Pamirs and Himalaya[1]

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After the ebb of alarmism about Himalayan deforestation and the proposed downstream flooding of Gangetic India and Bangladesh, the next major scare was an emergency investigation of Lake Sarez, a large landslide-dammed lake in the High Pamir. Even more dramatically, the danger of a complete melt of Himalayan glaciers in the not too distant future was reported. The article investigates these alarms and corrects them on the basis of scientific knowledge.

Keywords: Himalaya, Pamir, glacial lake, glacier melt

Klimawandel und Katastrophen im Pamir und Himalaya
Nach dem Abebben des Alarms über die Abholzung im Himalaya und ihren Folgen durch Überschwemmungen in Indien und Bangladesch entstand eine neue Alarmstimmung, als befürchtet wurde, dass der natürliche Damm des durch einen Bergsturz entstandenen Sarezsee im Hohen Pamir brechen könnte. Noch dramatischer wurde die Gefahr des Abschmelzens aller Himalayagletscher in absehbarer Zeit verschwunden sein werden. Der Artikel beleuchtet diese Alarmmeldungen und korrigiert sie auf wissenschaftlicher Grundlage.

Cambio climático y catástrofes en Pamir e Himalaya
Tras la disminución de las alarmas sobre la deforestación en el Himalaya y sus efectos en las inundaciones en India y Bangladesh, la siguiente gran alarma surgida, fue la urgencia de investigar los efectos de un deslizamiento de rocas en el lago Sarez, ubicado en el Pamir Alto. Aún más dramáticamente fue reportado el riesgo previsible de un completo derretimiento de los glaciares del Himalaya. El artículo se enfoca en estas alarmas y las corrige en base a conocimientos científicos.

This account is an expression of concern about the melodramatic reactions to potential mountain hazards that seem to have proliferated since the UN declaration of 2002 as the International Year of Mountains. I am not wishing to suggest any connection between the two, merely the coincidence of timing. After the ebb of alarmism about Himalayan deforestation and the proposed downstream flooding of Gangetic India and Bangladesh (Byers 1987, 2007; Ives and Messerli 1989; Ives 2004; Hofer and Messerli 2006), the next major scare with which I was directly involved was an emergency investigation of Lake Sarez, a large landslide-dammed lake in the High Pamir (Schuster & Alford 2000). It was concluded that the threat of an immediate outburst that would put at risk up to five million people downstream was a gross exaggeration and that we had laid it to rest.

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1 This is a slightly re-worded version of Chapter 16 from the book: *Sustainable Mountain Development: Getting the Facts Right.* In press, Himalayan Association for the Advancement of Science, Kathmandu, Nepal (Ives 2013).

It appears that the claims about pending catastrophes have persistent lives of their own and the presumed dire threat stemming from Lake Sarez has been resurrected. Coincidental with this was widespread alarm relating to the presumed precipitous disappearance of all Himalayan glaciers. Initially the alarm was limited to the perceived immediate danger of catastrophic outbreak of glacial lakes, widely reported in the news media as "glacial lake outburst floods", or GLOFs. Nevertheless, it quickly enlarged to include the much broader issue of the effects of climate warming.

This paper therefore is devoted to the twin topics of exaggerated reporting about the dangers posed by Lake Sarez and Himalayan glaciers because the alarms follow a similar pattern to the earlier reporting on Himalayan deforestation. The original melodrama is best characterized by the 1979 World Bank report, that by AD 2000 all accessible forest cover in Nepal would be eliminated. The catastrophe assumed to accompany such deforestation, referred to as "The Theory of Himalayan Environmental Degradation" (Ives 1987), today is lost in the mists of time – and that is a rather short time. Yet the end of the millennium came and went and there may have been more forest remaining in Nepal in 2000 than existed in 1979. Nor was there any retraction by the agencies and individuals who first reported the alarms, except for a single instance (FAO / CIFOR 2005).

The current crisis-generating spree, once more, is largely based on sentiment and political expedience than established fact. It is a further reminder of Michael Thompson's provocative: "What would you like the facts to be?" (Thompson and Warburton 1985). The following account is included, therefore, because it illustrates how my personal mountain journey appears to have no end in sight.

1 Lake Sarez: Pamir aftermath

Despite our assumption that Lake Sarez had been declared relatively safe from catastrophic outburst (Schuster & Alford 2000), in April, 2003, there was a widely publicized assertion that the lake's natural landslide dam was in the process of rapid collapse. This was quickly demonstrated to be a false alarm. Nevertheless, early warning systems were installed and relief supplies of food, fuel, and housing were put in place below the lake along the Bartang Gorge so that the local villagers would have a high degree of security in the unlikely occurrence of a major flood. Regardless, there arose renewed interest in the possible danger posed by Lake Sarez. Several international conferences were held in Nurek and Dushanbe, Tajikistan, and annual surveillance of the lake was undertaken by the Swiss engineering firm that installed the early warning systems. The most recent conference was held in Nurek in 2009 when several proposals were debated. High-level delegates from several of the Central Asian republics and Russia urged that the lake level be lowered artificially by 50 to 80 metres, an amount believed to ensure absolute safety. It was proposed that difficulties posed by cutting directly through the unconsolidated landslide material could be avoided by tunnelling the bedrock on the valley side. This would also allow

Fig. 1: Map of Tajkistan

construction of a hydro-electric power station and the energy produced could then be sold to the neighbouring countries and so greatly reduce costs assuming purchasers could be found.

Given the altitude and remoteness of the lake and the high cost of constructing power lines over great distances through mountainous terrain, this proposal would require the infusion of huge sums of international funding (estimated at about one half billion US dollars), whether or not the threat was imminent.

A recommendation for a follow-up conference, to be held in 2011 to celebrate the hundred-year anniversary of the lake's original creation, was approved unanimously. Nevertheless, I was concerned to read in the United States journal, *Science,* an article entitled "Peril in the Pamirs" (Richard Stone, 18 December, 2009). This once again, although in a less dramatic tone than that of Pearce (*New Scientist,* June, 1999), raised the prospect of an imminent catastrophe of biblical proportions with millions of lives at risk!

Dr Jörg Hanisch, engineering geologist, who had been a key member of our 1999 team and had attended the 2009 conference, contacted me with his reaction to Stone's publication. We submitted a joint letter of protest to the Editor of *Science.* It is sufficiently brief and self-explanatory to be repeated here in full.

RESPONSE TO RICHARD STONE, *SCIENCE*

We found the 'News Focus' item in your December 18, 2009, issue (Vol. 326: 1614–1617) disturbing. Its title: Peril in the Pamirs, smacks of The New Scientist *on "meltdown in the Himalaya". For members of the 1999 UN ISDR/World Bank investigation, it is remarkable that Stone omitted reference to: "Usoi Landslide Dam and Lake Sarez" (UN-ISDR 2000) co-edited by Donald Alford and Robert L. Schuster, the world famous landslide expert.*

Meanwhile, between 2002 and 2005, the situation surrounding Lake Sarez was thoroughly investigated by Suisse Stucky Consultants. The results were that risks of dam failure were negligible: overtopping by substantial volumes of water cannot be totally excluded. Such waves can be created by major landslides rushing into the lake. To cover this remnant risk, a monitoring and warning system was installed and the affected people were trained systematically.

The first author of this letter was a participant in these investigations as a Panel of Experts member, which included Robert L. Schuster.

In 2009, another international conference was organized in Tajikistan by the World Bank. All participants agreed that there was no imminent danger for the downstream population.

It is not necessary to elaborate the differences in interpretation of facts and opinions of the posed threat. Nevertheless, one of us (JH), in response to a draft sent him by Stone, answered on condition that a subsequent version be returned for further examination. There was no compliance and vital data and opinion were omitted from the published version.

In Dushanbe in 1999, following the field investigation, one of us (JDI) reported to senior Tajik authorities that the biggest threat facing the people in the Bartang Gorge below the Usoi dam could be for the government to panic and effect a forced military evacuation.

(signed: Jörg Hanisch and Jack D. Ives, 15 February, 2010)

Our letter was not published, nor was any explanation offered despite the fact that Hanisch had commented on an early draft of Stone's paper on condition that any adjusted version would be returned for his approval before submission for publication. There had been no response.

It is widely understood that many natural cataclysmic events are exceedingly difficult, if not impossible, to predict. Thus, avalanches, glacial lake outburst floods, landslides, and giant rockfalls defy precise evaluation. The situation is rendered more difficult when such natural phenomena are trigged by earthquakes that make prediction even more uncertain. A real problem with such instances is how to balance a decision to go ahead with preventative action on humanitarian grounds against the usually very high costs involved. An overriding issue, however, is the tendency of the news media, and even self-serving scientists, administrators, and politicians, to seize

Fig. 2: The High Pamir, Tajikistan, locale of major earthquakes, gigantic landslides, and landslide dammed lakes. Lake Sarez, objective of the 1999 investigation, lies a few kilometres to the south.

any opportunity to create public alarm. Unease, panic, even unwise costly preventative measures provoked by public or governmental pressure, may be more disruptive than the potential event itself.

2 Glacial Lake Outburst Floods (GLOFs) revisited

Following the early studies of the United Nations University (UNU) team (Vuichard & Zimmermann 1987; Watanabe et al. 1994) on the Dig Tsho 4 August, 1985, disaster and Imja Lake in the Khumbu Himal, there was a hiatus in official interest. Two events changed this situation. The first was an alarm spread by the Sherpas of the Rolwaling Himal claiming that a large and rapidly expanding glacial lake was hanging over their villages and appeared to be on the point of over-topping its end moraine dam. It was no exaggeration.

It was widely reported in Nepal that a supra-glacial lake, Tsho Rolpa, was forming on the lower part of the Trakarding Glacier. It had developed over the same time

period, but it appeared much more unstable than Imja Lake. The initial alarm produced an immediate response. Much of the valley below was evacuated for several months, a hydro-electric power station much farther down-valley was temporarily closed, even scheduled air flights were suspended for a short period. The longer-term response was for the lake level to be artificially lowered by three metres with financial support from the government of the Netherlands. International consultants were hired, including Dr John Reynolds, who had had extensive experience with similar problems in the Andes, and scientific investigations were undertaken.

Two electronic early warning systems were installed and regular monitoring was set up. This effort collapsed, however, during the Maoist disturbance that left Nepal in the chaos of civil war between 1996 and 2006. Nevertheless, as a result of the publicity, the entrepreneurial news media began to sniff out a marketable story.

One of the most disturbing examples of news media opportunism is a 2002 report in *The New Scientist.* The article, written by Fred Pearce, was entitled "Meltdown in the Himalaya". In it he quoted John Reynolds as having predicted that "... the 21st century could see hundreds of millions dead and tens of billions of dollars in damage..." due to the outbreak of glacial lakes worldwide, but principally in the Himalaya and the Andes (Pearce 2002). Reynolds, however, insists that he was totally misquoted. There were several other claims by the news media that such outburst floods could extend for hundreds of kilometres, cross the borders of Nepal and Bhutan, and cause extensive damage to large Indian cities on the Ganges.

The danger of glacial lake outbursts is real (Ives 1986, 2004; Ives et al. 2010), but misquotation and gross exaggeration are totally inappropriate, if not unethical. Unnecessary responses by the national and international authorities and by innocent people living downstream of the glaciers in question can be extremely disruptive. This is discussed further below.

The second event that revived the earlier concern about the glacial lake outburst hazard was the decision by the World Bank, together with Germany and Japan as the major donors, to proceed with construction of a cascade of huge hydro-electric plants along the Arun River that lies immediately east of the Khumbu. The site chosen for the initial dam construction was designated Arun III. It is located in the mid-section of the Arun gorge below the international frontier with Tibet (China). Almost 90 per cent of the Arun watershed lies in Tibet and a preliminary survey identified several potentially dangerous glacial lakes – as the UNU mountain hazards mapping team had done so a decade earlier. The largest lake to be identified, the 'Lower Barun Glacial Lake', is located on the Nepal side of the border. Its volume was estimated to be 28,000,000 m^3 and a rough calculation indicated that, if its end moraine dam were to collapse, the ensuing flood surge would impact the construction site within a time lapse of about an hour.

In conjunction with the rapid build-up of post-1992 (Tsho Rolpa) glacial lake hazard awareness, the World Bank organized a meeting of 'experts' in Paris in April, 1995, to review the situation of Arun III. The group consisted of senior representatives of the donor countries, Germany and Japan, the World Bank, the engineering

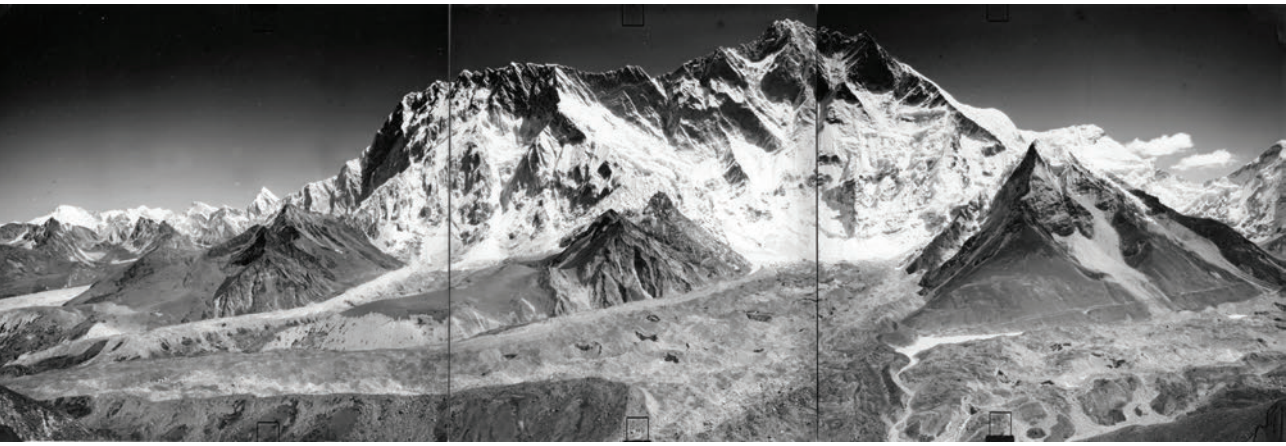

Fig. 3: The Imja Glacier in 1956, Khumbu Himal. At this time no supra-glacial lake has formed. The lower glacier (extreme right foreground) is mantled by morainic debris and rockfall. There are several small ponds amongst the rubble. The prominent skyline mountain crest is the Lhotse-Nuptse ridge (Photograph from the collection of the late-Fritz Müller).

companies involved in the project design, and Nepal itself (I was gratified to find that our former UNU colleague, Pradeep Mool, was representing Nepal). The engineering consultant firms were represented by Drs Wolfgang Grabs, Jörg Hanisch, and John Reynolds. Two independent, 'non-aligned experts' were invited. One was a long-time Swiss colleague, glaciologist and engineer, the late-Dr Hans Röthlisberger; the other, to my surprise, although hardly an 'expert', was me.

At the opening session it appeared that Hans and I were the only 'experts' present who had strongly negative thoughts about a hydro-electric scheme that would cost many times the GNP of Nepal and that it would have a huge environmental impact. Over a private dinner, Hans reflected that our negative reaction was based on our concern for the environment, although that topic was strictly outside the terms of reference of the consultation. He remarked that the World Bank was fortunate to have recruited two honest 'non-aligned' scientists because it was apparent from the large amount of literature sent to us earlier that the danger posed by the prospect of glacial lake outbursts was minimal and should not prevent a decision to begin construction if that was to be the only issue.

Just before leaving home to fly to Paris I had received from Dr Teiji Watanabe a manuscript describing his latest research on Imja Lake. It indicated that there was the possibility for a serious outburst, although more detailed research was needed. During the final morning's discussion in the World Bank's Paris offices I explained the availability of Teiji's manuscript. I was ruled out of order on the grounds that Imja Lake was located in a different watershed to the proposed site of Arun III. Although this ruling was eminently reasonable under the restrictive terms of the meeting, during the ensuing coffee break, the German government representative asked if I would

let her have a copy of Teiji's manuscript. With Teiji's subsequent permission, I forwarded a copy to her after my return home from Paris.

The concluding decision was that the Arun III project should proceed; the recommendation was unanimous. Soon after I learned through contacts in Switzerland that the German government, apparently reluctant to remain involved on environmental grounds, used the threat of Imja Lake to withdraw its support for the project. The reported justification to withdraw was that if Imja Lake should discharge, even though it was in a different watershed, there would be such a high level of public reaction that it would induce widespread opposition to the entire Arun Cascade proposal. Later, it became evident that the German government probably had been looking for an excuse to withdraw on environmental and economic grounds, but these were more difficult to sustain internationally. The German withdrawal caused the project to collapse.

An additional explanation is that, just at the time of World Bank decision-making on Arun III, James Wolfensohn was elected president and one of the first things he did was to cancel the project, I believe, on economic grounds. The aid money from Germany and Japan, however, was by no means lost to Nepal. Germany built the Middle Marsyangdi and Japan the Kali Gandaki power stations as alternatives.

3 Himalayan hazards and Climate Change

The issue of climate warming had only entered the 1992 Rio de Janeiro Earth Summit deliberations in rather general terms, and it does not appear to have been a primary factor in the United Nations decision to declare 2002 as the International Year of Mountains (IYM). Nevertheless, climate warming is now an all-embracing issue and has obvious relevance to our early UNU mountain hazards mapping work in the Khumbu. The manner of popularizing the danger posed by rapidly expanding glacial lakes is inappropriate. However, widespread linkage to climate warming did not occur to any great extent before the close of the twentieth century.

Pradeep Mool and his colleagues, working with ICIMOD, were already using satellite imagery to produce inventories of glaciers and glacial lakes in Nepal and Bhutan by the year 2001 (Mool et al. 2001a and b) and several university researchers and institutions independently undertook relevant fieldwork, especially in the Khumbu (Hambrey et al. 2008; Watanabe et al. 2009). I was invited by ICIMOD to spend eight weeks between early December, 2009, and March, 2010, to work with Pradeep and several of his colleagues to write a report for the UN International Strategy for Disaster Reduction (ISDR): *Formation of Glacial Lakes in the Hindu Kush-Himalaya and GLOF Risk Assessment* (Ives et al. 2010). This was followed by a second publication for the World Bank: *Glacial Lakes and Glacial Lake Outburst Floods in Nepal* (Mool et al. 2011). These publications contain strong cautions about the tendency to exaggerate.

The summer before leaving for Kathmandu (2009) I had been working with a group of colleagues to produce a paper entitled: *Global warming and its effects on the Himalayan Glaciers of Nepal* at the personal request of the editor of an on-line journal (Ives et al. 2009, unpub. MS). The manuscript was completed and submitted shortly before I left for Kathmandu in November, 2009. My co-authors were well aware of the exaggerated claims that were being spread by the news media (and not only by the news media) about the impacts of global warming on the Himalaya. We made it a central focus of the paper. As an introduction we inserted a number of the most outrageous claims we could extract from the popular press and other sources. These included the quotation from the 2002 issue of the *New Scientist* used above together with the following:

> *Himalayan glaciers could vanish within 40 years: 500 million people in countries like India could be at risk of drought and starvation.*
>
> (The Times, 21 July, 2003)

> *Glaciers in the Himalaya 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.*
>
> (Intergovernmental Panel on Climate Change, Cruz et al. 2007: 493)

There were also political contradictions such as when Shri Jairam Ramesh, the Indian Union Minister for Environment and Forests, gave the address of welcome at a scientific conference in India:

> *… the retreat of Himalayan glaciers is not due to Climate Change … has no scientific evidence and these scenarios are painted by the West.*
>
> (North Indian Times, *8* September, 2009)

The minister claimed that the order of magnitude of retreat by Himalayan glaciers is "... a couple of cm to a couple of metres every year ... and some are actually advancing." The overall pronouncement is as fallacious as the opposite extreme of the statements that it was intended to discredit.

The doomsday year of 2035 eventually was attributed to Professor Syed Hasnain. It had inadvertently slipped into the IPCC 2007 report and was widely distributed by the opponents of climate warming immediately before the international conference held in Copenhagen in December, 2009. It caused an acrimonious explosion and was one of the reasons for little progress during the conference. Yet, as was the case of quotations attributed to John Reynolds, Syed Hasnain flatly denied ever having made such a prediction. I was invited to dinner in Kathmandu (February, 2010) by Professor Hasnain when he discussed his Himalayan glaciological research and his denial – I have no reason to doubt his word.

The discussion had led from the hazards of Himalayan glacial lake outbursts (*jökulhlaup*)[2], claiming that millions of lives will be lost, to the subsequent speculation that all Himalayan glaciers will disappear by 2035 (or at least, in the near future). It was also predicted, as a consequence of glacier disappearance, that the major rivers of the region, the Ganges, Indus, Brahmaputra, Yangtze, and others would be reduced to seasonal streams. The next step in the melodrama would be the consequent death of millions due to drought and the collapse of agriculture (for extreme contrast in interpretation, see Alford 2011 and Alford et al. 2011).

Our co-authored manuscript was submitted for publication in October, 2009. It contained careful empirical research by Don Alford and Richard Armstrong which, amongst other findings, led to the hypothesis that the total volume of glacier ice in Nepal, if melted instantly, would add only about four to six per cent of the volume of that year's flow of the Ganges. Furthermore, it included Alton Byers's replication of the Fritz Müller / Erwin Schneider map and photographs from the 1950s. One of the photo-pairs shows the Khumbu Glacier; its snout had not retreated visibly between the 1950s and 2008 although appreciable thinning had occurred. A report published by the UN Environment Programme claimed that the Khumbu Glacier had retreated by five kilometres. Our co-authored paper also included Teiji Watanabe's 2009 research on the Imja Glacier from which he concluded that the danger of a catastrophic flood had been exaggerated.

The submitted paper did indicate that new, potentially dangerous, lakes were forming and glaciers were thinning and retreating – some smaller glaciers at lower altitudes had totally disappeared. There is no intention to imply here that climate warming is not reducing glaciers throughout wide areas of the Himalaya. It is! Nevertheless, the gross exaggerations, even falsifications, that we contested should have been self-evident.

The first group of anonymous reviewers approached by the editor of the on-line journal professed to be too busy to respond (under the circumstances, this appeared remarkable). The total comments and questions of the second group exceeded the length of the paper – in exasperation we withdrew it. I could not avoid the suspicion that there may have been an undertaking not to publish it close to the timing of the Copenhagen conference.

Some of the most recent and insistent representation of the likelihood of imminent large scale death and destruction is contained in a number of professionally produced videos and by extensive use of the Internet. Results from the original field survey and research stemming from the UNU's Khumbu mountain hazards mapping project of the 1980s are rarely encountered. Yet Watanabe and colleagues had been able to determine that Imja Lake, while its surface area had extended rapidly, had fallen in level by 37 metres since 1960. This contrasts with a mere 3-metre

2 The Icelandic term *jökulhlaup* (literally, glacier leap) has been used in Iceland for centuries to denote a giant flood emerging from beneath a glacier. It has been used in the scientific literature for more than a century.

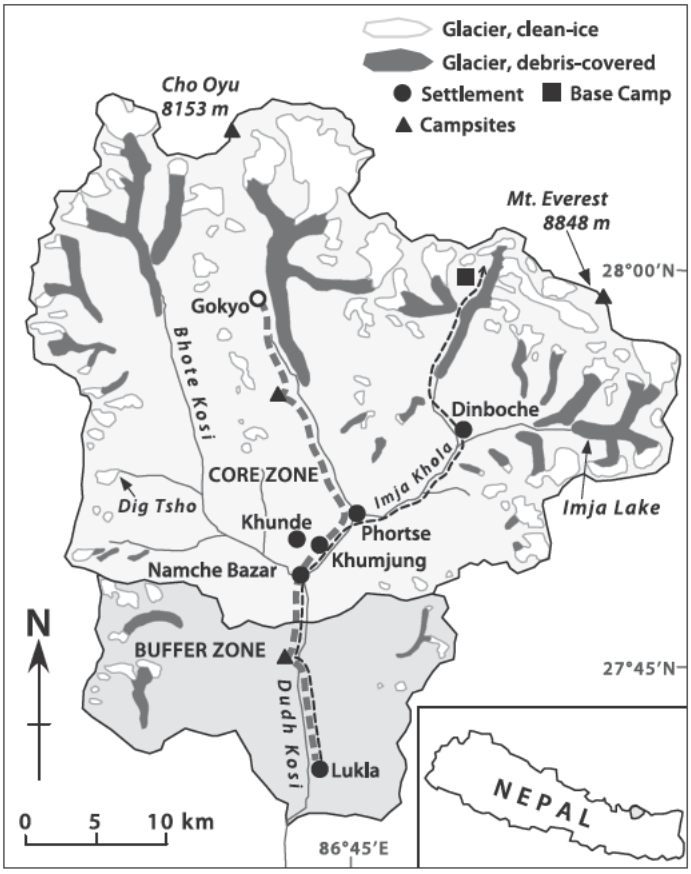

Fig 4: Map of Khumbu

artificial lowering of Tsho Rolpa in the early 1990s to contain the danger of an outburst (but see conclusion).

Imja Lake has been in existence for more than a half century yet no outburst has occurred, despite its continued enlargement. Earthquakes have long been recognized as one of the major processes that could destabilize the end moraine dams in this highly seismic region. Thus when the 6.9 Richter scale earthquake of 18 September 2011 struck Sikkim, eastern Nepal, and adjacent regions, there was concern that glacial lake outbursts would occur. Certainly the earthquake set off landslides and rockfalls, and caused a large amount of damage and loss of life, as far away as Kathmandu, well to the west of Imja Lake, but no precipitous drainage of a glacial lake (note that the term "large amount", as used here, is orders of magnitude less than the predictions of catastrophes that are being criticised).

Over the last several years videos have been used to exaggerate the potential large scale disaster of glacial lake drainage; this has included the BBC, PBS (US Public Broadcasting System), and most recently, the United Nations Development Pro-

gramme (UNDP). The videos are exquisitely filmed and edited and their narrators are accomplished professionals, although not glaciologists. I will use the UNDP video as an example. Produced for UNDP by Arrowhead Films, it is well worth viewing for the beauty of the footage of both the high mountain landscape and the local people. The narrator's first sentence claims that the Himalaya contain 40 per cent of the world's fresh water. This claim is at least an order of magnitude in excess of reality although it is difficult to refute with specific data. This, in large part, is because such data do not exist. The commentary contains no definition of what is meant by "40 per cent of the world's fresh water." If the ice sheets of Antarctica and Greenland are included, as is conventional, and if the volume contained in the North American Great Lakes, the lakes of northern Canada, Lake Baikal, and the lakes of East Africa is added, also a regular convention, then the claim of the video's first sentence is several orders of magnitude in error. When the first sentence contains such an obvious falsehood, the informed viewer must wonder how much can be accepted from the remainder of the video.

Manipulation by camera is as old as photography itself. I will provide only a single example, chosen from the UNDP video, because it centres on Imja Lake, widely promoted as the most dangerous glacial lake in the Himalaya. Within the first minute of the video the camera pans across an unnamed town that is being overwhelmed by a torrent of flood water. Houses are collapsing, vehicles are being washed away, and crowds of pedestrians are desperately struggling to escape. The scene then moves to a picturesque view of Imja Glacier, its lake, and the surrounding high mountains; then back again to people being washed away in an altogether different and unidentified raging flood. The narrator's voice is tense, dramatic, but the three scenes are not causally connected, nor are the instances of flooding identified. It may be assumed that the thousands, if not millions, of anticipated viewers are expected to make the obvious causal connection; but it is false, and we are left with the disturbing thought that there is no relationship between the graphically depicted towns being flooded and any glacial lake outburst.

The message of this chapter is twofold. First, society has been subjected to outrageous and alarmist exaggerations, even to the point of deliberate falsification, apparently by organizations and individuals, some of whom are generally perceived as responsible authorities. Second, the current alarms with which we have all been bombarded since at least 2002 have paralleled the earlier conventional wisdom of the 1970s and 1980s claiming that, by 2000, there would be no accessible forests left in Nepal (World Bank 1979; Asian Development Bank 1982; Norman Myers 1986), and that Gangetic India and Bangladesh would be under water after thousands of landslides, induced by 'ignorant' mountain farmers, had stripped both vegetation and soil off the Himalaya. Regardless, Larry Hamilton's early provocative statement, "it floods in Bangladesh when it rains in Bangladesh" warrants repetition (Hamilton, L., pers. comm., 1986). This common sense reaction by Larry has since been substantiated by an extension of the UNU mountain project, largely funded by Switzerland (Hofer and Messerli 2006) and applies with equal force to the current claims

Fig. 5: Aerial view of the Imja Glacier showing Imja Lake, 4 November, 1991. At this point in its rapid development the lake is more than a kilometre long. It drains through the broad end moraine in the immediate foreground, the source of the Imja Khola, Khumbu Himal, Nepal (Photograph courtesy of K. Kawaguchi).

that melting of all the Himalayan glaciers would significantly reduce the flow of the Ganges; it is the monsoon rainfall that supplies the overwhelming volume of water to the Ganges and Brahmaputra rivers, not glacier melt.

When we (UNU) began our Himalayan quest in 1978 we never expected that we would become involved in two intellectual-political controversies: first deforestation and environmental and socio-economic collapse; second, loss of all the Himalayan glaciers and consequent flooding, followed by a regional drought and the death of millions. Following the outcry in Copenhagen in 2009, the claims that Himalayan glaciers will disappear in the near future has at least helped to prompt an urgent request for much needed new research, systematic data collection, and rational thinking. Research is now rapidly expanding to ensure more accurate assessment of the interface between climate change and glacier and snow cover response. Nevertheless, it hasn't arrested the onslaught of exaggeration and confusion, now by widespread distribution of professional videos. Yet we are left with the very serious question – how to predict the likelihood of catastrophic natural events, in this case, glacier lake outburst floods, when there is no simple nor reliable method. To underplay the hazard would be equally irresponsible. This calls for the re-introduction of the word 'dilemma' that initially emerged from the Mohonk Process (Ives 2013: in press). Regardless, the time has long passed when the local mountain people should be in-

Fig. 6: By 2007 the lower part of the Imja Glacier was submerged by a lake (Imja Lake) more than two kilometres in length and in excess of 100 metres deep. The glacier is still retreating and the remaining sub-lacustrine ice is continuing to melt. This view, taken by Alton Byers, is from the opposite side of the glacier to that of Figure 3. Ama Dablam is the prominent peak on the extreme right skyline.

corporated into the research activities and their extensive local environmental knowledge introduced as a vital component in the search for practical solutions.

4 Concluding remarks on Imja Lake

Since the foregoing critical assessment was written, Dr Alton Byers of The Mountain Institute, in association with the U.S. Agency for International Development and other partners, led the first "Andean-Asian Glacial Lake Expedition" to inspect the problematic Imja Lake. This involved consultation with local people about their views regarding foreign researchers, possible threats imposed by the lake, and prospective solutions.

One of the results has been a partial reassessment of the danger of a lake outburst. The expedition was accompanied by Suzanne Goldenberg. *The Guardian* published her report on 10 October, 2011 as: *Glacier Lakes: Growing danger zones in the Himalayas.* To quote:

> *The extent of recent changes to Imja Lake has taken glacial experts by surprise, including Teiji Watanabe ... He said that he did not expect such rapid changes to the moraine which is holding back the lake... "We need action, hopefully within five years. I feel our time is shorter than what I thought before. Ten years might be too late."*

By subsequent e-mail exchange, Teiji indicated that he had not seen the report. However, he did point out to me that changes to the lake outlet through the moraine were occurring faster than he had previously observed, confirming in general the remarks attributed to him.

Obviously, such situations in nature do change unexpectedly. Imja Lake may be less stable than we have recently assumed. As was indicated in the 2010 ICIMOD publication (Ives et al.), a glacial lake outburst could occur tomorrow. Imja Lake could take ten years or more to burst; or it could drain slowly and safely; Dig Tsho did burst in 1985, resulting in several deaths and destruction of a small hydro-power station nearing completion. Nevertheless, the present situation requires planning and constant observation. It does not justify excessive alarmism or false reporting: the primary message of this paper.[3]

This contribution is a small token of my respect for Professor Christoph Stadel. We have shared the same commitment toward the mountains and their peoples throughout our long friendship that began with a joint venture in the Andes of Ecuador. May this continue for many more years into the future.

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3 The Mountain Institute (West Virginia, U.S.A.) has recently received extensive support from the USAID to develop a combination of social and scientific research on high mountain watershed problems in relation to climate change. This led to the expedition to Imja Lake, quoted above, and a continuation during the 2012 post-monsoon season. On the 2012 occasion an education and training workshop in association with the local people led to additional scientific data from Imja Lake and highly promising Sherpa participation. Amongst the scientific results, sonar-based bathymetric investigation revealed that the volume of water contained within Imja Lake is twice that previously reported (65 M cubic metres) and the glacier front retreated much more rapidly over the preceding three months than previously expected. The "High Mountain Glacier Watershed Program" , funded by USAID is co-managed by The Mountain Institute and the University of Texas at Austin (Alton Byers, pers. comm., 25th November, 2012).

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