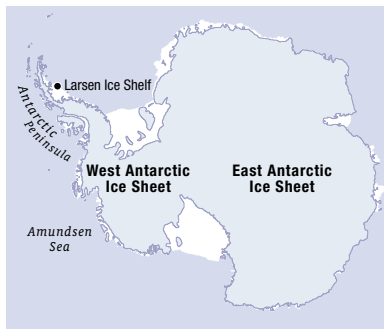
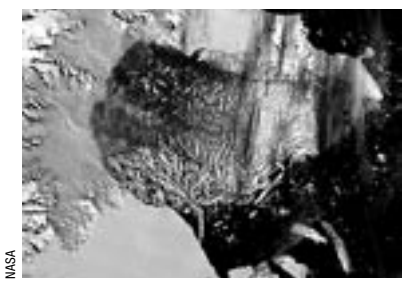
New concerns on the stability of the west Antarctic ice sheet

Increased global temperatures are taking their toll on the Antarctic ice shelves. Here are eight points of concerns regarding the west Antarctic Ice Sheet. BY GINO CASASSA



HUGO AHLENIUS

BELOW MODIS satellite image of the collapse of Larsen B ice shelf.


NASA

1. Antarctica accounts for 91 percent of the total mass of ice on the Earth, contained in a vast ice sheet up to 4.6 kilometres thick. If the Antarctic ice were to melt entirely, it would raise global sea level by 55 metres, a truly catastrophic scenario. Thankfully, this full-scale melt-down of the Antarctic ice is unlikely to occur over the East Antarctic Ice Sheet (EAIS), which accounts for 50 metres of global sea level and is considered stable because its bed lies well over sea level.

2. Some believe that the interior of the Antarctic continent is too cold to be affected by potential melting produced by surface warming of a few degrees expected to occur from over the next century. On the contrary, parts of inland Antarctica, such as the South Pole, are growing because of enhanced snow precipitation in a warmer atmosphere, which can retain higher humidity.

3. However global warming is already having a discernable effect on the fringes of the continent, as evidenced by the dramatic break-up of the Larsen A ice shelf and other smaller floating ice shelves on the Antarctic Peninsula, where summer temperatures are frequently above zero.

4. There is evidence that these peripheral changes are having a strong effect on glaciers of the inland Antarctic ice due to ice dynamics. The glaciers that used to feed Larsen A ice shelf have accelerated threefold after the collapse of the ice shelf, suggesting that the ice shelves have a critical role in restraining the flow of the inland ice. A similar behaviour might be occurring on the Amundsen Sea sector of the west Antarctic Ice Sheet (WAIS), where Pine Island and Thwaites glaciers have lost significant portions of their fringing ice shelves, and show signs of recent acceleration. This ice sheet is a fraction of the size of the dominating east Antarctic ice sheet, but its mass is still great enough to raise global sea-level by five meters.

5. The east Antarctic ice sheet is known as a continental ice sheet since it is supported by land above sea level. Unlike its eastern sister, the western ice sheet is a marine ice sheet which is grounded on bedrock well below sea level. In addition, the underlying bedrock in many areas has a downward slope away from the coastline. This circumstance could result in a run-away effect leading to total collapse should the edges of the ice sheet start to retreat due to an initial trigger such as atmospheric and/or oceanic warming. The western ice sheet would therefore largely disappear if the ice would melt.

6. The west ice sheet has been the subject of considerable research over the last 25 years.

Theoretical: Modelling has been developed to understand the nature of potential instability of West ice sheet, and the roles that ice shelves play in stabilizing the ice sheets. Differing views exist on the importance of the buttressing effect of ice shelves. Early models predicted an important stabilizing role of ice shelves, but later more sophisticated models suggested an insignificant role of ice shelves. There is now compelling evidence that shows the relevant stabilizing role of ice shelves, and in a few cases this new information is already being incorporated into the models.

Experimental: Of the major glaciers – ice streams – in the Antarctic Peninsula and in western Antarctica studies are being conducted to detect whether they are speeding up or slowing down. Results in the west ice sheet are contradictory. Ice streams in the Ross Sea sector are slowing down while the glaciers in the Weddell Sea are in near steady state.

Overall conclusion reached by the scientific community by the mid-1990s was that the west ice sheet appeared to be relatively stable, and any retreat of the ice sheet would occur relatively slowly over hundreds or thousands of years, despite loss of ice shelves.

7. Over the last few years, new evidence that changes may indeed be happening faster than previously thought has emerged:

Recent satellite image analyses show that the ice streams in the Amundsen region are clearly retreating, thinning and accelerating, particularly Thwaites and Pine Island glaciers;

New theoretical models suggest that ice shelves are important for the stability of ice sheets;

Small glaciers on the Antarctic Peninsula have speeded up greatly following the collapse of the Larsen A ice shelf.

8. A new urgency has been injected into the study of the stability of West ice sheet. A team from the Center for Scientific Studies of Santiago (CECS), NASA and the German Geological Survey (BGR) plans a new series of investigations, concentrating on the Amundsen Sea region in 2004/2005.

GINO CASASSA is Head of the Glaciology and Climate Change Laboratory at Centro de Estudios Científicos in Valdivia, Chile. He is the glaciology representative of Chile's Scientific Committee for Antarctic Research (SCAR), and member of the International Council of Scientific Unions (ICSU) Planning Group for the International Polar Year 2007. He is currently also the head of the Andean Working Group on Glacier Mass Balance sponsored by the International Commission on Snow and Ice/International Association of Hydrological Sciences.

Climate is a north/south challenge

The *Polar Environment Times* spoke to ØYSTEIN DAHLE about the recent international climate debate on the rise of sea levels from ice melting on the poles due to increased global temperature and the consequences to developing nations like Bangladesh.

"We, in the western world, have not sufficiently recognized the fact that the changing climate is a north/south problem. We have already seen a number of the climate related extreme weather events around the world and we know that these changes first and foremost will hurt the developing nations. In the Western part of the world we have resources to meet any kind of challenge from for example rising sea levels. But in the developing world no such resources are available and the victims will be the many poor and unprotected people", Mr. Dahle says.

He mentions two possible strategies in which the world can deal with these issues:

"The first is the adaptation strategy, in which the world accepts that we in the future will have to deal with more frequent extreme weather events. We prepare ourselves, make sure not to settle in vulnerable areas, and we adapt in different ways. This strategy equals a defeat: We are giving up too easily.

The second and more important strategy is based on the Kyoto Protocol and the realization that the Kyoto goals are far from enough but a step on the way. We have to recognize that climate change is a human creation and that it is extremely difficult to get remove the causes, but that we have no other option than to try."

ØYSTEIN DAHLE is director of the board for the World Watch Institute and member of the GRID-Arendal Board of directors.

South American glaciers on the retreat

Recent studies indicate that most of the South American glaciers are drastically reducing their volume at an accelerated rate and could even disappear in the next few decades. BY GINO CASASSA

HUGO AHLENIUS

Southern South America accounts for about 65 percent of all Andean glaciers. The main areas in this region are the northern Patagonia Icefield with an area of 4,200 km^2, the southern Patagonia Icefield with an area of 13,000 km^2, and Cordillera Darwin with an area of 2,000 km^2. These icefields contain the largest glaciers in the southern hemisphere outside of Antarctica, and are a potentially invaluable source of present and past environmental information from the mid-latitudes, providing a link between the southern tropical and equatorial regions and Antarctica.

There are currently many examples of drastic glacier retreat within the southern South American icefields. O'Higgins Glacier has retreated 15 kilometers during the last century in what is probably the largest retreat in all of South America. A recent thinning of 14 meters a year has been measured at Upsala Glacier, and a record thinning of 28 meters a year has been detected at HPS 12 Glacier in Falcon fjord.

Glaciers of all the South American Andes, including the tropical and equatorial regions, cover a total area of 31,000 km^2. Although they store an equivalent global sea level rise of only a few centimeters if they were to melt completely – which represents much less than ten percent of the total volume of mountan glaciers of the world – they are presently contributing more than ten percent of total global sea level rise from mountain glaciers. Glaciers have a critical importance for the water resources in the region, and are of great significance to mining, tourism and agriculture. There have also been numerous incidents of catastrophic glacier floods and mudflows originating from glacier melt due to volcanic eruptions, which have affected human activities and settlements, causing several tens of thousands of casualties, such as in Nevado del Ruiz, Colombia, the Cordillera Blanca in Peru, east of Mendoza, Argentina, and at the Copiapó River, the Villarrica Volcano and the Paine National Park in Chile.

The Chacaltaya glacier in Bolivia, which provides water resources to the City of La Paz, is predicted to melt completely within the next 15 years if the present atmospheric warming trend continues into the future. The incidence and speed of glacial retreat has generally accelerated during the last decades, and hundreds of years old glaciers will collapse within our own lifetime.

The global picture for Andean glaciers

Although a few glaciers around the world are advancing and increasing in volume – in response to increased local precipitation, such as in New Zealand and Norway – there is an overall tendency for retreat and thinning as a result of the global climate warming observed during the last one and a half centuries, since the so-called Little Ice Age, the last cold period which affected the Earth during 1400-1900 AD.

A direct effect of glacier retreat is sea level rise. The water frozen in all the glaciers of the world, mainly in the ice sheets of Antarctica and Greenland, but also in smaller ice caps and glaciers, would be sufficient to raise sea level by 70 meters at a global level. Global sea level is presently rising by nearly 2 millimeters per year, partly due to glacier melt.

Signs of recent glacier wastage have been detected in the ice sheets of Greenland and Antarctica, and also in many of the earth's mountain ranges, including Africa, the European Alps, the Himalayas, Alaska and the Andes.

In spite of important studies carried out on South American glaciers by European, North American, Japanese, and South American scientists, many basic scientific issues concerning the present and past glaciations in South America and their relation to climate are yet to be explored and studied. Moreover, the potential impact of the retreat of glaciers on the environment and human activities has yet to be adequately assessed.

Climate change needs to be better understood

The climate is undergoing drastic changes on a global scale, with clear evidence of recent warming. In nine of the last twelve years, the mean global average temperature has been higher than at any time since the start of historical records at the beginning of the 19th century. The mean global temperature during the 1990s is probably the warmest of the last 1,000 years according to records, and the extreme heat which affected Europe this summer is not running counter to the trend: temperatures were recorded at five to ten degrees higher than normal, in several cases exceeding 40ºC.

There is a general consensus within the scientific community that global warming is at least partly due to the enhanced greenhouse effect as a result of the burning of fossil fuels since the Industrial Revolution. It is not clear yet how much of this warming is attributable to anthropogenic greenhouse gases as compared to warming due to natural climate variability since the Little Ice Age. The role of natural solar variability in global warming is also not clear. There is high priority in resolving these issues, especially considering ongoing international efforts to limit the emission of greenhouse gases, in particular the ratification of the Kyoto Protocol.

Continued research on the world's glaciers – including those of South America – will contribute important knowledge for understanding why, how and how quickly our global climate is changing.

For GINO CASASSA brief see top left article.