Senate Standing Committee on Environment and Communications
Legislation Committee
Answers to questions on notice
Environment portfolio

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Hearing: Additional Estimates

Outcome: Outcome 3

Programme: Australian Antarctic Division (AAD)

Topic: East and West Antarctc ice sheets

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Senator Whish-Wilson asked:

In respect of findings by AAD and its partners about the stability and mass of both the East and West Antarctic ice sheets:
1. What are the latest research findings?
2. What are the ongoing plans for research into the stability and mass of both the East and West Antarctic ice sheets?

Answer:

1. AAD and its partners predominantly work on issues in the East Antarctic sector, although Australian researchers are involved in satellite based and modelling assessments which cover the whole continent, including West Antarctica. Three methods of assessment are employed: (i) a gravity-based approach in which the ice sheet's mass is quantified from satellite measurements of its gravitational attraction, (ii) altimetry, where satellite and airborne measurements are used to detect height changes that are then converted to thickness and hence mass change, (iii) an 'input/output' measurement which uses estimates of snowfall (from meteorological data, measurements and satellite data) and measurements of speed and thickness of the ice where it crosses the coastline (its grounding line) to estimate loss. The different methods have different advantages and shortcomings and cover differing time periods, but recent advances are delivering broadly consistent estimates from the three approaches.

   Recent assessments indicate that Antarctica as a whole is losing mass (around 134 billion tonnes per year, Gt/y). This is mostly the result of large loss from West Antarctica concentrated in the Pine Island and Thwaites Glacier region. This net loss is also seen to be increasing with time: that is, there is an acceleration in loss.

   For East Antarctica, there is little overall mass change. Various studies show small losses or gains within the error of measurement. There is considerable regional variability, with increases (mostly inland) and losses in some coastal areas and catchments, including the largest East Antarctic glacier, the Totten Glacier. The Totten Glacier is also observed to be thinning near the coast at up to two metres per year, and its catchment is losing mass. Some increase in snowfall is expected in a warmer climate, in which air has increased capacity to hold moisture. To the extent that this is occurring, it offsets the overall loss of ice, but because records are relatively short, it is not yet clear if some high snowfall years reflect a climate-driven change or background variability.

Turning to the issue of stability, work from US and UK scientists has recently identified that major West Antarctic glaciers are retreating and 'unpinning' from underlying high points. In these areas, ice rests on bedrock below sea-level and the topography makes continued retreat inevitable once a critical point is reached. For these glaciers, further retreat commits to ongoing ice losses equivalent to three metres of sea level rise or more over centuries. Some experts have suggested that this point of commitment has already been crossed.

In East Antarctica, stability was thought to be less of a concern until quite recently. The ice sheet is higher, thicker and colder than the lower elevation West Antarctic ice sheet and was thought to rest largely on bedrock highlands. Recent international collaborative work by AAD researchers has led to revised understanding. Using airborne radar, the work has revealed large tracts of bedrock below sea-level, with topography in some areas that may be vulnerable to unstable ice retreat, just as in West Antarctica.

In particular, this includes the large Totten Glacier and its catchment. Loss of all ice in the Totten Glacier catchment that rests below sea level would deliver at least 3.5m of sea level rise, and likely more as the whole ice sheet is reconfigured. The latest research pertaining to the Totten Glacier, from Australian work in 2015, shows that relatively warm deep ocean water is present at the Totten Glacier front, and that deep bedrock channels or pathways exist that can carry this warm water to the ice where it leaves the coast. This warm water access combined with changes in the warming ocean is the likely explanation for the thinning and ice loss presently observed in the Totten Glacier.

2. Ongoing research into ice sheet mass balance is a major part of the Australian Antarctic Strategic Science Plan. Projects are underway to continue observing, understanding and modelling the changes taking place, so that future changes can be projected.

   Key projects include continued airborne mapping of detailed topography beneath the ice and also the seafloor along the coasts. This will provide the boundary conditions necessary to model ocean currents that bring warm water to the ice-ocean interface and to model the ice flow over bedrock, and how this will change as the ice thins and retreats.

   Other projects include observational studies based on oceanographic surveys near the ice margin, sensors mounted under floating ice shelves and monitoring of ice thickness changes from satellite and airborne sensors.

   The observational work is complemented by development of computer models of ocean and ice sheet and coupling these together with global climate models.