Climate Change

Interview: Dr Eelco Rohling

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Key words : red sea, ipcc, ice sheets, global warming, environment, climate change,

Fast-Rising Sea Levels in the Red Sea

26 Dec, 2007 03:16 pm

Scitizen interviews Dr Eelco Rohling, who, along with colleagues, studied the changes in salinity of Red Sea water. Their research illustrates that , per century, sea levels rose well above the IPCC's estimated rise (the IPCC does not account for dynamic ice-sheet processes.)

What is the main purpose of your research?

Our project is based on the fact that the Red Sea method for sea-level reconstruction – which we have pioneered since 1998 and especially 2003 – offers a continuous series of measurements through time, in contrast to dated fossil coral reefs, which offer only loose points in time. As a result, the Red Sea method for the first time allows us to estimates the rates of sea-level change, which has always been very hard to get at with the conventional techniques.

In this specific paper, we use the method in combination with fossil coral data to estimate the rates at which sea level rose above its present position (0 m). The last time this happened was during the last interglacial period, 124-119 thousand years ago. At that time, CO2 concentrations were similar to pre-industrial values, but a different orbital configuration of Earth around the Sun meant that global temperature was about 2 deg C higher than today (there is some debate about this number), and especially climate around Greenland was about 3 to 5 deg C warmer than today (a much more robust number). Similar temperatures are projected by IPCC to develop over the next century. Hence, the DRIVER for warmer conditions may have been different than today, but the values were rather similar to those expected by AD2100.

We do NOT engage in future predictions – that is best done by using models. However, our study provides hard data about the possible rates of change in the natural system, and those are much higher than what IPCC predicts. The discrepancy very likely reflects the fact that IPCC does not include dynamic ice-sheet responses. We know from the last interglacial that sea level rose to a mean position about 6 m above the present, and that up to half of that came from partial Greenland ice-sheet melting. For the other half we have to think about (West) Antarctica. Clearly, therefore, the rises during the last interglacial reflect dynamic ice-sheet processes. The discrepancy between our observed rates (mean rate of rise of 1.6 m per century) and the IPCC predictions (up to 58 cm per century) therefore likely reflects the dynamic ice-sheet responses that yet remain to be incorporated in IPCC.

Your study illustrated climate variability. Can you take our readers through the summary of your research: the reconstruction model and subsequent conclusions? Why did you focus on the Red Sea basin?

The Red Sea is a marginal ocean basin that has several unique attributes: (1) it is highly evaporative and received only negligible imported freshwater flux (rainfall or river-inflow) from outside; (2) the Red Sea is in a climate zone that has always been very arid; (3) the Red Sea's only natural connection with the open ocean is through the narrow and especially also shallow (137m) Strait called Bab-el-Mandab. Only so much water can be 'squeezed' through a small hole, and with the high evaporation from the basin, the strait's limiting effect on refreshment of water within the basin means that there is a strong build-up of salt concentrations in Red Sea waters. Along with this, the stable oxygen isotope ratio changes, and this ratio can be accurately measured on microfossils. Hence, we can use changes in the stable oxygen isotope ratio to calculate sea level, by calculating the change in Red Sea water refreshment as a function of sea-level change in the already shallow strait (using a hydraulic control model for water exchange through the strait).

We have worked on similar concepts in the Mediterranean (in fact, that's where I started with these ideas), but that basin has a deeper sill, and considerable freshwater import, so the signals there are by far not as pronounced and clean as in the Red Sea. In 2003, my PhD student (now newly appointed faculty member in Bristol) Mark Siddall, whom I co-supervised with Dr David Smeed (fluid-dynamicist) captured the concepts in a fully quantified model, thus developing the sea-level calibration.

Since then, we have been working hard with especially the group in Tuebingen to expand the records of past change in stable isotope ratios in the Red Sea through time. Part of that remit was to get a sense of the rates of sea-level change through the last interglacial, when we knew sea level reached above the present.

The research's figures for sea levels were considerably higher than IPCC's estimates. Was this unexpected? With the results of you and your colleagues' study on the Red Sea, what are the implications for the immediate future in climate change?

I don't think this was too surprising, since we knew that IPCC does not (yet) account for dynamic ice-sheet processes in their predictions. Hence, our values capture the component that IPCC does cover, as well as that component which they did not (yet) include. What IS surprising, though, is the size of the discrepancy. I emphasise that the low end of our estimates in the paper (which states between 0.6 and 2.6 m per century) is rather unlikely, because it relies on a very extreme assumption of dating problems. This is an extreme view on the uncertainty, and it is therefore not likely at all that the low

end of the range would apply. It is much more likely that the actual rates of rise are near the mean value (1.6 m per century).

It is hard to say what the implication is for the immediate future. I would prefer to turn that around, if I may. The implication of our study is that it is critical that dynamic ice-sheet processes are better quantified and incorporated in the ice-sheet models that feed into the IPCC process. Once that is done, then projections can be made with the 'improved' models for future sea-level rise. I think that ultimately we will find that we best prepare for rates of 1.5 to 2 m per century, or more, to be on the safe side. Nature is telling us something: sea-level rise can be very rapid indeed, and we underestimate it at our own peril….

Reference:

Rohling, E.J., Grant, K., Hemleben, Ch., Siddall, M., Hoogakker, B.A.A., Bolshaw, M., and Kucera, M., High rates of sea-level rise during the last interglacial period. *Nature Geoscience*, in press (2007).

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