Eelco Rohling heads up the Natural Environment Research Council project, A centennial-scale sea-level record for the last 450,000 years, which aims to understand the complex relationship between sea level, ice volume, and the temperature fluctuations that affect these interlinked elements

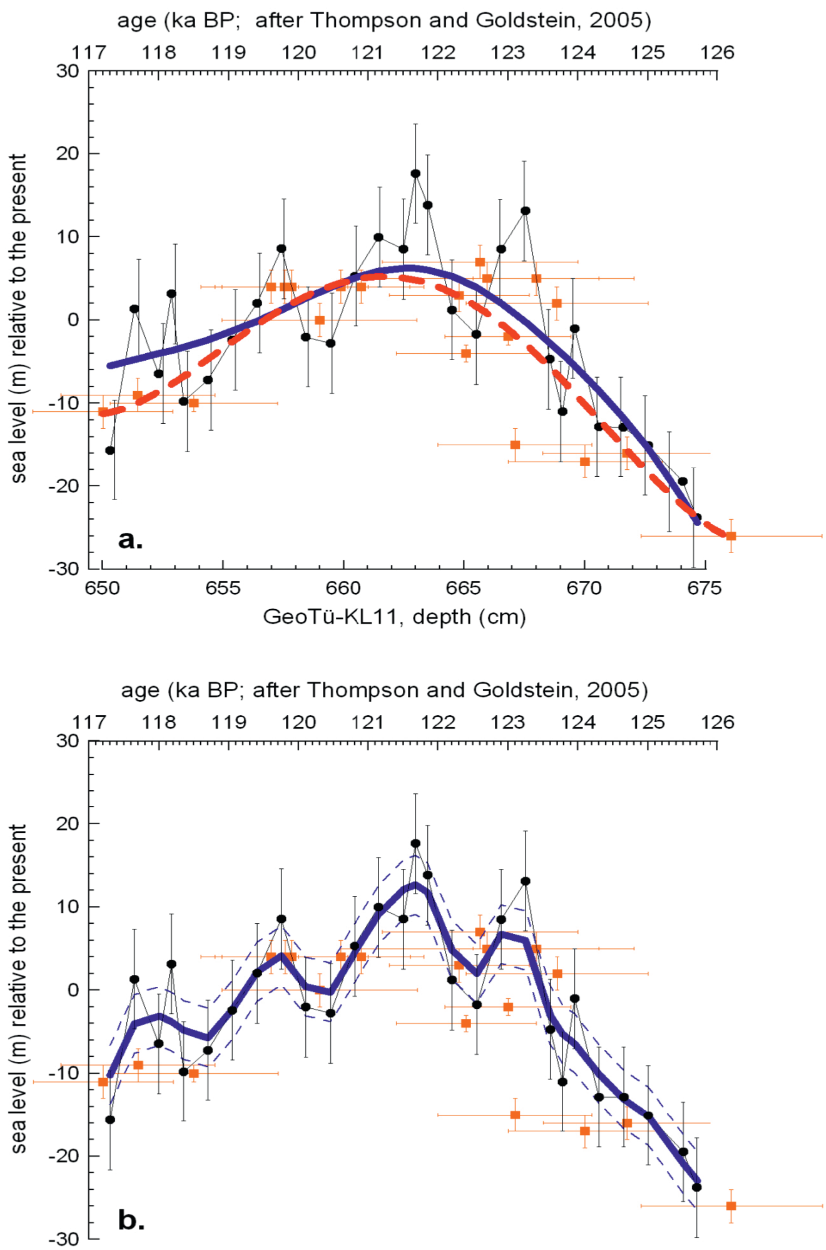
The value of historical data on sea level changes

To understand the present, and to forecast the future, you would be wise to first look back and understand the past. This is a premise that the project with the helpfully self-explanatory title *A centennial-scale sea-level record for the last 450,000 years* is relying on in its unique investigation into sea-level history. With climate change so highly prioritised in global concerns this study could produce important pre-historical data; data that in Eelco Rohling's view could be of great use to climate and environmental modellers.

Essentially, the study is looking at sea level and its close relationship with global ice volume in that global ice volume fluctuates when ice volume becomes water volume when it melts and in reverse, water volume decreases when ice forms. By looking at past sea-level fluctuations and aligning this data with other historical information such as earth's climatic history, earth's orbital shifts around the sun (also affecting climate) etc, a fuller picture of environmental cycles and their effects can be pieced together.

The study is using the Red Sea for its data, which unlike the Mediterranean for example, has a very simple water cycle and no major rivers to factor in. The Red Sea basin is perfect for this type of analysis, and there is no other basin in the world that comes close in terms of suitability for the project's aims. It is a large basin, has strong evaporation, demonstrates a simple water cycle and has a very small strait to the open ocean – basically all the criteria needed for the study to be most effective.

It is important to note in this study that although the project is researching sea-level change it is not looking at a physical marker of where sea level stood, but rather,



Sea level variability during the Last Interglacial (stage 5e; 117–126,000 years ago) is looking at something that actually indicates the basin state; it is looking at a real physical response to sea-level change.

Core method

So with the sea selected the next task was to get at the 'tell-tale' marine sediment that contains revealing data from oxygen isotope ratios in carbonates.

Rohling describes the process they use to get at the isotopes. "What we do is we take a corer – essentially a tube with a big weight and drop it onto the sea floor from a ship. The tube then fills up with sediment from the sea floor, which is hoisted up and we extract the sediment from these tubes by cutting them open length-wise and splitting them. It's like a drainpipe if you split it length-wise in two halves, and they are full of sediment from the sea-bed. By going from the top of the sediment downwards you go back in time, so you sample through it in high resolution – in centimetre resolution. We analyse both the sediment itself for the oxygen isotope composition – oxygen isotope ratio – but also look at another part of the sample, namely the micro-fossils. We get the micro-fossils out and we run specific micro-fossil based isotope analyses, always using the same species, always of the same size. We do that for every step, going down in centimetres or half centimetres, and as a result we get, in discrete time steps, the isotopic record."

– we're talking over thousands of years. What we find is that the rates of change are actually surprisingly high. So sea level can go up very quickly, but it can also go down very quickly." Rohling continues, "My argument is always that if it has happened within the recent geological past then that is certainly within the remit of what is possible in the future. The system knows how to do it. I think that then creates a number of interesting issues – for example the IPCC (InterGovernmental Panel on Climate Change) suggested that sea level could rise by up to 60 centimetres over the next century. But they openly acknowledge that they don't have ice dynamics in their models. We don't have ice dynamics in what we do, but what we are doing is looking at what the earth system has done in the past. So we don't need to know exactly which processes are behind it, we are just looking at the impacts of all the processes together and trying to understand what the system can do.

"What we have found is that, for one stage that we call stage 5e, there were rates of rise of 1.6 metres per century – which is a completely different ball game! Similar rates have now also been found for other periods in the recent geological past."

This data is very important when attempting to form national strategies for flood protection for instance. Lots of

The importance of this work lies in figuring out how the system works. It was always thought that ice volume was a slow-changing process – we're talking over thousands of years. What we find is that the rates of change are actually surprisingly high

Data for strategies

So why conduct this research? At present, there is enough ice in the world to increase the sea level by about 65 metres, and global warming means a high potential for sea level rise. It is therefore important to study and attempt to understand how the relationship between temperature and ice-volume worked in the past in order to calibrate the processes that are currently being modelled.

Rohling elaborates: "The importance of this work lies in figuring out how the system works. It was always thought that ice volume was a slow-changing process

considerations need to be taken into account in developing these sort of plans for the next century. The two key questions that Eelco Rohling's project is posing within this context are: 'what is the likely rate of sea level rise, and what is the maximum amount by which it could rise?'

"What we can do with the sort of data we supply is to put bounds on the envelope of what is possible. So basically the absolute maximum rate that we have found then begins to inform all sorts of protection plans so they can be effective in the case of an extreme scenario." ★

At a glance

Full Project Title
A centennial-scale sea-level record for the last 450,000 years

Project Partners
University of Tubingen, Germany (Professors Kucera and Hemleben)

Contact Details
Coordinator, Prof Eelco Rohling
T: +02380593042
F: +02380593059
E: E.Rohling@noc.soton.ac.uk or ejr@soton.ac.uk

Eelco Rohling

Project Coordinator

Eelco Rohling did his PhD at Utrecht University in 1991, on Sapropel (anoxic sediment) formation in the Mediterranean and then became a Dutch Research Council Postdoctoral Fellow(1992-1994), part of which was spent as Guest Investigator in the Physical Oceanography department of the Woods Hole Oceanographic Institution, Massachussetts.
He was Invited Professor at the National Museum of Natural History in Paris in May 1994. He came to The University of Southampton as Lecturer in July 1994, and rose through the system to a Professorship in 2002 at The School of Ocean and Earth Science, based at The National Oceanography Centre. In May 2008, he was made Correspondent (Fellow who lives abroad) in the Royal Dutch Academy of Arts and Science.