

Morss Colloquium Report

Where land and sea meet: managing shoreline change over the next 100 years

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Scientists estimate that sea level may rise 2 feet or more over the next century. However, these estimates are quite uncertain, because we lack a detailed understanding of the behavior of the Greenland and Antarctic ice sheets. How fast could sea level rise? How would rising sea level affect our coastline?

These questions, and many others, were the subject of a recent Morss Colloquium: *Where land and sea meet: managing shoreline change over the next 100 years*. The colloquium was held on the 20-25 September 2009, at the Woods Hole Oceanographic Institution, in conjunction with a scientific meeting on the long-term history of sea-level change: *Understanding future sea level rise: the challenges of dating past interglacials*. The scientific meeting brought together an international group of sea level experts, and we took the opportunity to hold a Morss Colloquium that brought together this scientific expertise with policy makers to exchange ideas and discuss the impact of future sea level rise on society and policy decisions.

The scientific meeting was focused on the challenges of coral dating, which is key to developing an accurate history of sea level change. A crucial goal is to extract information about ice sheet response to temperature change by examining the history of sea level over the last several hundred thousand years, particularly warm periods, with a range of temperatures similar to the present and future climate. Understanding potential magnitudes and rates of future sea level change is an urgent societal and scientific problem that is clearly an issue of global importance with a direct impact on human society. The Intergovernmental Panel on Climate Change estimates that sea level may rise as much as 2 feet over the next 100 years. However, these estimates do not take into account the effect of changes in ice-sheet dynamics, and there is concern that future sea level rise may be significantly underestimated. Much of the ongoing research on the sea level rise problem is focused on the dynamics of modern ice sheets and satellite observations of ice-sheet mass balance. However, there is another important piece of the sea level and climate puzzle. The longer-term history of sea level change that is evident in the geological record provides crucial information about the link between climate forcing and sea level response, as well as critical constraints on future sea level rise. Making the best use of the presently available long-term sea level data and defining future research goals requires a collaborative effort between geologists, geochemists, geophysicists and climate modelers. How can the geological record inform planners and decision makers? How can scientific research on the sea-level problem best be aligned with the needs of planners and policy makers? The goal of the Morss Colloquium was to bring together an international group of science, economic, and policy experts with the intent of fostering the interdisciplinary collaboration necessary to move the field forward in a transformative way.

Each day's session began with paired keynote addresses of broad interest that were attended by the wider WHOI community. One keynote summarized a key scientific question being discussed at the meeting, while the other touched on some aspect of societal impact and policy decisions. Some of the highlights of the keynote addresses: Mark Siddall, a climate

modeler from the University of Bristol talked about the use of sea level histories in models for predicting future sea level rise. Richard Alley, a glaciologist from Pennsylvania State University spoke about predictions of next 100 years ice sheet and sea level change. Robert Theiler, a scientist with the United States Geological Survey, described a probabilistic model for evaluating potential sea level rise impacts on society and infrastructure. Julia Knisel, a spokesperson from Massachusetts Coastal Zone Management discussed state and regional guidance on sea level rise adaptation planning. Porter Hoagland from WHOI's Marine Policy Center, and John Whitehead, an economist from Appalachian State University, gave their respective views on the economic impacts of future sea level rise. The keynotes were recorded and the video can be viewed under the "Workshop Program" tab at <http://www.whoi.edu/SeaLevelRiseWorkshop>

The week-long meeting culminated in a public forum, held Friday afternoon at the Redfield Auditorium in Woods Hole village. This public outreach portion of the Morss Colloquium was extremely well attended, successfully engaging the public and the wider Woods Hole community. After an opening introduction by colloquium organizer Bill Thompson, there were four short talks of broad interest, presented at a level that was accessible to the public at large. Mark Siddall (University of Bristol) talked about *"Insights into the next 100 years of sea-level rise from the long-term history of sea level change"*. Edouard Bard (College de France) discussed *"Lessons from sea level history: how fast can sea level rise?"* Megan Higgins (Roger Williams University School of Law) outlined the legal and policy implications of *"Sea level rise impacts on beaches and coastal property."* And finally, E. Robert Theiler (United States Geological Survey) presented *"Sea-level rise on Cape Cod: How vulnerable are we? What can we do?"* The highlight of the afternoon was the panel discussion, where the assembled group of scientific and policy experts addressed questions raised by the audience. In addition to the afternoon's speakers the panel also included Julia Knisel from the Massachusetts Office of Coastal Zone Management, John Whitehead, an economist from Appalachian State University, Andrew Ashton, a coastal zone specialist from WHOI, and Porter Hoagland from WHOI's Marine Policy Center. Some highlights of the panel discussion are given here, the entire event was recorded and can be accessed on the web: [Where Land & Sea Meet : Woods Hole Oceanographic Institution](#)

What is the current rate of CO₂ change?

Rob Thieler: "CO₂ is tracking at the highest IPCC scenario, projections that were considered outrageously high a few years ago."

Should coastal property be protected or abandoned? What is the states role?

Julia Knisel: "Massachusetts recognizes that this is a serious problem, there are recommendations under review by officials and stakeholders, but there is no easy solution. How will the legislature respond? At the Mass DEP website, under the state climate change advisory committee, you can find a draft proposal for coastal management."

Porter Hoagland: "We need to align incentives so that property owners face the full cost of sea level rise, and do not encourage people to live on the coast."

Is climate change really caused by human activity, or is it just natural?

Mark Siddall: "The paleo data gives us the baseline for natural change, which has been left way behind by the CO₂ and temperature change of the past century. We really know the natural

baseline for last almost one million years. We left that baseline at exactly the time of global industrialization.”

Rob Thieler: “It is important to remember that if we could stop all emissions of CO₂ now, sea level would continue to rise for the next several centuries.”

What are pros and cons of beach renourishment?

Megan Higgins: “Beach renourishment is expensive and not a long-term solution. Furthermore, it gives homeowners a false sense of protection, and may not be the best use of resources.”

Julia Knisel: “Soft solutions such as beach nourishment and dune building are preferred alternatives to hard structures like seawalls.”

John Whitehead: “Some states find beach retreat costly and consider beach nourishment the best mitigation strategy.”

Rob Thieler: “Beach nourishment has unacceptably high economic and environmental impacts. At the national level, there is already not enough sand to satisfy today’s needs. On Cape Cod we have lots of sand, but it is no solution for 2100.”

Andrew Ashton: “Cape Cod is relatively new, having been created by retreating glaciers a mere 10,000 year ago. To expect the shoreline to stay still is unrealistic, barrier beaches need to move to survive. Trying to ‘hold the line’ in the face of continuing sea level rise could doom barrier beaches.”

Why do the IPCC models give such a wide range of sea level rise predictions?

Mark Siddall: “The biggest unknown is us, the human race. How much CO₂ will we burn over the next century? Human behavior is the largest source of uncertainty in the IPCC projections.”

The current sea level rise projections are in the form of smooth curves. What is the potential for abrupt change?

Edouard Bard: “Both modelers and observationalists agree that climate change exhibits threshold behavior. That has been the whole point of the group gathered here. The current models do not include ice sheets, which we know is wrong. In the past there were sea level rise events that were ten times faster than today. Keep in mind that the IPCC numbers do not take into account the behavior of the ice sheets, only ice melting and thermal expansion. Our community considers the IPCC estimates low. We are trying to push the modelers. Ice sheet models now are where we were 20 years ago with ocean models.”

Rob Thieler: “Richard Alley said it best. We have isolated the wild card, which are the ice sheets. But have we not made the investment in understanding and modeling of ice sheets. We need to focus intellectual and monetary resources to get a better handle on ice sheet behavior.”

Who will bear the costs associated with future sea level rise?

Edouard Bard: “This comment may be a bit controversial. There has been a lot of focus on the cost of future sea level rise, but we have been spared a lot of cost by using fossil fuel that is in fact too cheap. The problem is that the people who will feel the consequences are not those that saved the money. Up to us as scientists to educate and communicate the problem. There has been a lot of talk about a carbon tax. This is not really a tax, but a redistribution of

money from the oil to take care of the problems. Every society will have to cope with these kinds of problems and there is a global diplomatic problem associated to this. We have talked a lot about Cape Cod, but we also talked about other countries that will feel the sea level problem much more severely, countries such as Bangladesh, for example. Here we are speaking about costs, in their countries they are talking about lives, they are talking about survival. It's a difficult, tricky problem. The costs are linked to one full century of easy living with cheap oil."