Climate Stabilisation and Impacts of Sea-Level Rise

Robert J. Nicholls

School of Civil Engineering and the Environment
University of Southampton
Highfield
Southampton
United Kingdom

r.j.nicholls@soton.ac.uk (email)

Paper prepared for:

Avoiding Dangerous Climate Change
A Scientific Symposium on Stabilisation of Greenhouse Gases
1st to 3rd February 2005
Meteorological Office, Exeter, United Kingdom

20 January 2005

1. SUMMARY

This paper considers the implications of climate stabilisation for coastal areas with a strong emphasis on sea-level rise, as this is one of the most certain consequences of human-induced global warming. There are fundamental physical constraints which significantly delay the benefits of climate stabilisation for sea-level rise compared to atmospheric temperature rise. Hence, atmospheric temperature stabilisation does not translate into sea-level stabilisation: rather it leads to a slower rise in sea level which continues far into the future. This fact reflects the long thermal lags of the ocean system and has been termed *'the commitment to sea-level rise'*. Therefore, while climate stabilisation reduces the coastal impacts of sea-level rise during the 21st Century, compared to unmitigated emissions, the largest benefits may occur in the 22nd Century (and beyond). Further some impacts may only be delayed rather than avoided, although such a delay is beneficial in terms of increasing the time available to adapt. It is also important to note that the detailed benefits of any mitigation policy remain uncertain, due to the large uncertainty about the magnitude of future sea-level rise, even for a single emissions scenario.

Climate stabilisation will also reduce the *risk* of significant contributions to sea-level rise from the large Greenland and Antarctica ice sheets, which could amount to a 12- to 13-m rise over the next 1,000 years. The collapse of the West Antarctic Ice Sheet (WAIS) is of most concern as there is the potential for a rapid rise ($\geq$ 1 m/century) due to this mechanism. However, the risk reduction benefits of stabilisation are only beginning to be explored, as the breakdown mechanisms in both cases remain poorly understood, especially for the WAIS.

Given these constraints, a realistic stabilisation target for sea level is a target rate of rise rather than stabilisation of sea level. Hence, climate policy for coastal areas should consider an appropriate mixture of mitigation and adaptation. Adaptation is essential to manage the commitment to sea-level rise (the residual rise), while mitigation will reduce both the rate and the ultimate commitment to sea-level rise. This requires the joint evaluation of mitigation and adaptation, which use methodologies that capture the high consequence/low probability changes, especially WAIS collapse.

Important issues and questions are raised. The timescale of sea-level rise is challenging for policy as long timescales beyond 2100 need to be considered to understand the full implications of the different policy choices. But how far into the future climate policy should consider these issues? Lastly, given the inevitable 'commitment to sea-level rise' what are the implications for coastal lowlands and small islands? We can adapt but by what method: protect, accommodate or retreat, or most likely a combination of all of them.