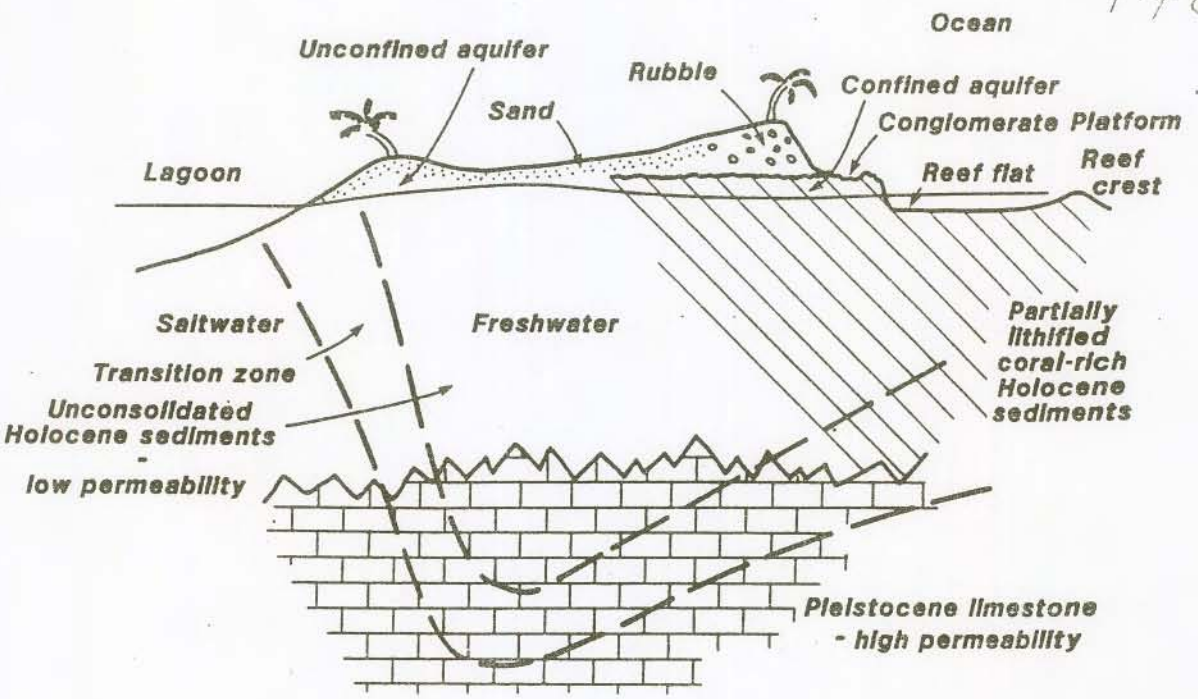
KIRIBATI
VULNERABILITY TO ACCELERATED SEA-LEVEL RISE:
A PRELIMINARY STUDY



by

C. D. Woodroffe

Department of Geography, University of Wollongong
Wollongong, Australia

and

R. F. McLean

Department of Geography and Oceanography, Australian Defence Force Academy
Canberra, Australia

based upon research and a field visit funded by
Department of Arts, Sports, Environment and Territories
Government of Australia.

using the IPCC Common Methodology
for assessing vulnerability to sea-level rise.

February 1992.

KIRIBATI
VULNERABILITY TO ACCELERATED SEA-LEVEL RISE:
A PRELIMINARY STUDY

by

C. D. Woodroffe

Department of Geography, University of Wollongong
Wollongong, Australia

and

R. F. McLean

Department of Geography and Oceanography, Australian Defence Force Academy
Canberra, Australia

based upon research and a field visit funded by
Department of Arts, Sports, Environment and Territories
Government of Australia.

using the IPCC Common Methodology
for assessing vulnerability to sea-level rise.

February 1992.

Contents

List of Tables

List of Figures

List of Plates

Introduction

The Republic of Kiribati, in the Central Pacific, comprises 33 small islands almost all of which are atolls, straddling the equator and the international date-line (Figure 1). There are three distinct archipelagoes, the western Gilbert Islands chain which comprises 17 islands stretching from 2.5° N to 1.6° S of the equator; the Phoenix Islands group comprising 8 islands all in the southern hemisphere; and the Line Islands group comprising 8 islands, spread over more than 2000 km of sea, some more than 4000 km from the capital of Kiribati, Tarawa in the Gilbert Islands (Figure 2). These account for a total land area of around 820 km^2, of which more than half is accounted for by the island of Kiritimati (Christmas) in the Line Islands, and a sea area of 3.55 million km^2. The islands are generally low-lying and composed of poorly consolidated sands. The one exception is the island of Banaba which is a limestone island which rises to 78 m; this island has been extensively mined for phosphate.

The islands of the Republic of Kiribati share the characteristics that they are small and low, and thus they appear especially susceptible to anticipated sea-level rise. The concern of the people of Kiribati (I-Kiribati) has been expressed by the former president of Kiribati, the Honourable Ieremia Tabai, who has said 'if the greenhouse effect raises sea levels by one metre it will virtually do away with Kiribati... In 50 or 60 years my country will not be here', and who has brought the issue to the attention of the world.

Broad assessments of the vulnerability of nations to sea-level rise have suggested that Kiribati is one of the most vulnerable of all nations. Thus Pernetta (1988) assessing South Pacific nations, placed Kiribati, in the most vulnerable category along with Tokelau, Marshall Islands, Tuvalu and the U.S. Line Islands. Articles in the popular press, including the Pacific Islands Monthly, have speculated that the islands of Kiribati 'may disappear forever' (Roy and Connell, 1989b).

This report, based upon limited fieldwork in Kiribati, represents a preliminary assessment of the vulnerability of the Kiribati nation to accelerated sea-level rise. It adopts, as far as is possible, the Common Methodology for the assessment of vulnerability of coastal areas to sea-level rise, compiled by the Intergovernmental Panel on Climate Change (IPCC) Response Strategies Working Group's Advisory Group on Assessing Vulnerability to Sea-level rise and coastal zone management (20 September 1991).

The report is based upon existing knowledge and available data. It includes the results of limited fieldwork in Kiribati, and indicates areas where further research and data compilation are required.

Acknowledgements

This study was funded by the Department of Arts, Sport, Environment and Territories, Government of Australia. The study was undertaken at short notice, and comprised a period of 10-14 days in the field and a similar period of data collation and write-up. We wish to acknowledge the co-operation and collaboration of the Government of Kiribati, and in particular of Nakibae Teuatabo, Secretary for Environment and Tererei Abete, Environmental Officer. We also greatly appreciate the assistance of Tebutonga Ereata, Acting Land Surveyor. We thank Laurie Maher and the staff of the Australian High Commission in Tarawa for their assistance. We are most grateful to Scott Smithers and Andrew Caudle for their assistance in the field, and appreciate further assistance with surveying from Tererei Abete and Naomi Biribo. We particularly express our appreciation to the people of Maiana for their hospitality. For assistance with the compilation of this report we would like to thank Sophie Perry, Joanne Glynn, Steve Beaman and Oliver Wady, and for their cartographic skills we acknowledge Richard Miller and David Martin.

Executive summary

Below we summarise the major findings at each of the seven steps of the IPCC Common Methodology for the assessment of vulnerability to accelerated sea-level rise (ASLR) as they were applied to Kiribati. We provide a critique of the shortcomings that we interpret for this approach in this case, and we outline our recommendations for further study, and assistance required.

Step 1: Delineation of study area and specification of ASLR scenarios

1) It is important that all areas of Kiribati be incorporated into a full vulnerability profile of the nation because the entire country is vulnerable. A range of case studies at a variety of scales have been examined in this study, but much of the data are incomplete for these examples.

2) The IPCC Business-as-Usual high and low scenarios were adopted as ASLR scenarios for this study (30 cm rise and 100 cm rise by 2100, Table 1).

3) Pacific Ocean water-level trends reconstructed from tide gauges, and from large intertidal corals (microatolls), in Kiribati do not indicate a trend of rising sea-level as rapid as the global average, and do not yet show any identifable acceleration.

4) There are pronounced seasonal and interannual variations in mean sea level in Kiribati related in particular to El Niño, suggesting that the islands have a certain resilience to changes in water level, but also making determination of net change more difficult.

5) The majority of the islands of Kiribati are probably subsiding at an imperceptibly slow rate (<0.2 mm/yr).

Step 2: Inventory of study area characteristics

1) The best sources of information for most islands in Kiribati (see Appendix) are the topographic maps and the several sequences of aerial photographs. The latter in particular represent an important and underexploited environmental database.

2) The reef islands of Kiribati are geologically very young, and appear to have developed in the last 3000-4000 years during a period when relative sea level has fallen from a level around 1 metre above present.

3) The sediments of the islands are calcareous, formed almost entirely from the skeletal remains of organisms, and are continuing to be produced on the reefs and in the lagoons.

4) There are a range of coastal types, representing various grain sizes and stages of lithification, each of which exhibits a different degree of vulnerability both to present erosional and accretional forces, and to accelerated sea-level rise.

5) Coastal vegetation communities, particularly mangroves, offer a protection to the coast, and decrease shoreline erodibility.

6) The Kiribati economy combines a rather limited cash economy with a traditional subsistence economy. These are inextricably interlocked and cannot be effectively compared using the benefit/cost procedures advocated in the IPCC Common Methodology.

Step 3: Identification of development factors

1) Kiribati (GDP $Aus40.7 million) has an extremely narrow economic base, dependent on copra production and fish exports (both took a downturn in 1990), and substantial foreign budgetary assistance. It is unlikely to change markedly in the next few years.

2) The population has been increasing at 2.2% per annum, and combined with migration from the outer islands there has been rapid urban growth on South Tarawa with increasing, unacceptable levels of overcrowding on Betio and Bairiki.

3) At present the country's major developments relate to improving infrastructure particularly through the construction of causeways. For such infrastructural projects, as for the construction of any 'protective works' that might be needed in the face of accelerated sea-level rise, Kiribati is dependent upon international aid.

Step 4: Physical changes and natural system responses

1) The shorelines of reef islands in Kiribati are naturally dynamic; sediment is continuing to be produced; beaches both accrete and erode; and there a seasonal and year to year shifts in the patterns of sediment movement. There are also important coastal rock types, conglomerate and beachro

2) The climate of Kiribati is dominated by fluctuations, particularly in rainfall, but also in other factors (including sea level) associated with E Niño, and more research will need to be done in order to determine hov physical changes on the islands are related to this regional pattern.

3) In view of these uncertainties, there can be no consensus as to what effect sea-level rise will have on islands. At least three different types of impact have been forecast; erosion of sediment from the shore; redistribution of sediment on the shore; or accretion of new sediment the shore.

4) The effect of accelerated sea-level rise on groundwater remains uncertain but is largely dependent upon the response of the islands themselve effect on reefs is likely to be one of enhanced reef growth, though thi will in turn depend upon the health of the reef.

Step 5: Identification and specification of response strategies

1) The people of Kiribati do not have an option to retreat from ASLR; nor ca they do nothing in that they are already combating problems of ero accretion of the shoreline unrelated to changes of sea level. The ful protection option is clearly impossible for the entire nation as it has enormous perimeter despite its small surface area.

2) Measures which accommodate sea-level rise seem the most appropriate, and could involve various planning strategies as well as some infill or reclamation of selected islands. It is beyond the scope of this brief study to examine the options in detail.

Step 6: Vulnerability analyses

1) We have demonstrated that it is presently not possible to forecast the physical impacts of sea-level rise on shorelines which already undergo complex patterns of erosion and accretion. We have also indicated that the interlocking of cash and subsistence economies and the receipt of foreign budgetary assistance renders the benefit/cost approach inappropriate at this stage.

Step 7: Identification of tasks and needs

7.1.Shortcomings of the IPCC Common Methodology

1) For the Republic of Kiribati, much of the fundamental data required for the IPCC Common Methodology is not readily available. Details of land use, land capability, natural vegetation distribution, sediment type, agricultural production, etc., are not stored in any central retrievable system. There is generally little or no information on elevation, which is particularly important in assessing vulnerability to ASLR.

2) There is almost no information on the natural dynamics of the shoreline. Kiribati lies in a part of the Pacific affected by El Niño, which accounts for major variations in climatic factors and water levels. There is no information on rates of sediment production, patterns of sediment movement, or rates of sediment deposition.

3) In view of the dynamic nature of the shoreline, it is not possible to calculate areas of land that will be lost, or indeed areas that might be gained, under conditions of sea-level rise. It is clear that the shoreline will continue to change whether the sea rises, falls or remains stable. Reef scientists are divided in their view of the most likely effect of sea-level rise on reef islands.

4) The Kiribati economy combines a limited cash economy with a traditional subsistence economy, and substantial international aid. It is not possible to assess these three elements within the benefit/cost framework proposed in the methodology.

5) It is clear that total protection, as is suggested as one scenario in the IPCC Common Methodology, is not a viable option for a nation such as Kiribati where the perimeter is extremely large, but the total area very small. Even total protection of one or two islands could only be undertaken on receipt of aid from overseas.