REPORT 0% THE AI) HOC PLANNING GROUP ON SEA LEVEL ANJ) ICE SHEET VOLUME VARIATIONS

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Monitoring of sea level and ice sheet systems is critical in the understanding of global change, Climate models used to study the effects of atmospheric greenhouse gases predict an overall increase in the global temperature over the next century of from 1 to 4 degrees centigrade. [Hansen *et* al., 19811. An increase of this magnitude could have numerous catastrophic effects, nol the least of which would be a global rise in sea level due to a combination of melting polar ice caps and continental glaciers, and the thermal expansion of sea water. The global rate of sea level rise during the last century has apparently been some.what in excess of 1 mm/yr [e.g., Barnett, 1983; Peltier and Tushingham, 1989; Douglas, 1 991; Trupin and Wahr, 1 991]. The causes of the sea level rise need to be quantified. Only about 10% of its rise can be. accounted for by thermal expansion of the oceans; lakes, groundwater and mountain glaciers may explain -- 0.7 mm/yr of the increase [Meier, 1990]. Greenland and Antarctica arc proposed candidates to explain the unaccounted-for portion of the rise. However, it is not clear at this point whether Antarctica and Greenland are gaining or losing ice. Clearly, efforts must be intensified to measure ice sheet volume changes.

Careful geodetic measurements are required to separate sea level change signals from other geophysical effects (such as postglacial rebound) and to validate the output of global anti regional predictive models. Such observations include state- of-the-art determinations of sea level and ice volume changes taking into account the effects of visco-elastic processes in geodynamically unstable shorelines, transfer of groundwater to the oceans, glacial rebound and tectonic processes. Optimal use should be made of classical measurements, as provided for example by the GLOSS tide gauge network of the IOC and by absolute gravity determinations, and of new space techniques including altimetry, Very Long Baseline Interferometry (VLBI), satellite laser ranging and the Global Positioning System (GPS). The potential applications of new types of measurements, such as temporal variation of the geopotential, need to be evaluated, and the development of a better understanding of interactions between the different processes contributing to sea level change should be given priority.

The potential contribution of space geodesy is revolutionary. When we consider the high accuracy obtainable with such techniques, the full impact of global monitoring is very promising indeed. Many scientific groups are involved in various stages of such activities; however, it appears that these activities are not sufficiently coordinated with each other. Hence, results obtained regionally are not always utilized to the full potential on a global scale.

This Ad Hoc Planning Group (membership is given in Table 1) was formed at the IAG Executive Meeting held at the Ohio State University (March 1992) based on the report of the IAG Ad Hoc Working Group on Global Change [Dickey *et al.*, 1 992]. We were asked to suggest ways and means of coordinating the existing activities with the ultimate goal of proposing it as a separate program 01 linking it to a core program within the International Geosphere-Biosphere Program (IGBP). We are pleased to report that we have been successful in having "Determination of the. Rates, Causes and Impacts of Sea Level Change" included as a Framework Activity within the. IGBP (Core Project, Land-Ocean Interactions in the Coastal Zone (LOICZ) (see attachment from Pernetta and Milliman, 1995). Note that the "lee Volume Changes and Ice.-Water Mass Interchange" has also been incorporated into that program. An Open Science Meeting, "Second LOICZ Open Science Meeting: The Dynamics of Global Change and the Coastal Zone" was held 24 27 April 1995, at The Marine Science Institute, University of the Philippines, Quezon City, Philippines. Bill Carter represented the Planning Group at this meeting and led an evening meeting devoted to this framework of activities.

Our Ad Hoc Planning Group has reached its goals and we recommend that a follow-up be actively continued within the IAG at a high level through a formation Of a Special Commission. Currently, there are several activities addressing sea level within the IAG; we recommended a unified effort which would serve as a link to IOCZ and IAPSO.

At the IUGG General Assembly at Boulder, our recommendation was accepted. A Special Commission on Sea Level and Ice Sheet Variation was formed with Bill Carter as Preside

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Table 1. Membership

ACKNOWLEDGMENT

The author gratefully acknowledges the active role played by many of the Planning Group Members (Table 1). The work of the author presents the results of one. phase. of research carried out at the. Jet Propulsion Laboratory, California Institute of Technology sponsored by the National Aeronautics and Space Administration.

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LOICZ Framework Activity 6 - Determination of the Rates, Causes and impacts of Sea Level Change (from IGBP 1 and Ocean Interactions in the Coastal Zone Implementation Plan, Pernetta and Milliman, 1995)

Introduction

Sea level variations are a component of environmental change that has both global causes (at least in part) and global implications. Present global estimates for future rates of sea level change (e.g. IPCC reports) are essentially empirical in that they are semi-quantitative "best guesses" incorporating information about a number of complex processes (steric, non-steric, tectonic and isostatic effects, ice-water mass interchange). Furthermore, for any particular locality or region they are likely to be of only limited use on account of local variability in these processes which results in rates of change up to two orders of magnitude greater than, or opposite in sign to, the present global average of a rate of rise of about 2 mm per year. Improved forecasts of rates of sea level change are needed for each of the four research foci of the LOICZ project, particularly in relation to the development of realistic scenarios of change within coastal environments over the next 10 to 100 years. This Framework Activity will complement existing international projects concerned with sea level by promoting further studies of the rates, causes and prediction of sea level change in the context of the aims and activities of the LOICZ project. It aims to stimulate greater collaboration between geophysical scientists who measure sea level and study causes of change, and environmental scientists who are investigating the various impacts (including socio-economic ones) of variations and trends in sea level.

Overall objectives

The overall objectives of this Framework Activity are to promote the development of a capability for estimating and predicting more reliably present rates and future variations of sea level change over local to global scales, and to assemble and make available the results from such studies to regional and national research projects conducted as contributions to the LOICZ Core project.

The LOICZ approach

Current knowledge of the rates and causes of sea level change will be reviewed in the context of the LOICZ project, and the conclusions disseminated in a form useful for planning new research projects and for evaluating environmental impacts. Regions where coastal erosion is likely to be severe will be identified. Close contact will be maintained with the Scientific Committee on Oceanic Research (SCOR) reporting on sea level change.

LOICZ will work with the International Association for Physical Sciences of the Ocean (IAPSO), the International Association of Geodesy (IAG) and other international and national organisations to encourage the collection of observations on sea level in order to identify causes of change and to validate the output of global and regional predictive models. Such observations include state-of-art determinations of sea level and ice volume changes taking into account the effects of visco-elastic processes in geodynamically unstable shorelines, transfer of groundwater to the oceans, glacial rebound and tectonic processes. Optimal use will be made of classical measurements, as provided for example by the GLOSS tide gauge network of IOC and by absolute gravity determinations, and of new space techniques including altimetry, Very Long Baseline Interferometry (VLBI), satellite laser ranging and the Global Positioning System (GPS). The potential applications of new types of measurements, such as temporal variation of the geopotential, will be evaluated, and the development of a better understanding of interactions between the different processes contributing to sea level change will be given priority. LOICZ will encourage the sharing of instrumentation and software for collecting sea level observations (particularly within developing countries), and for archiving and disseminating the results in a standard format. The objective use of model results and predictions in planning and policy decisions will be fostered and, through the requirements of LOICZ research initiatives, the development of large scale models that incorporate regional and local scale models for global predictions of sea level change will be stimulated.

Task T.6.1 Assessment and measurement of sea level change in the context of LOICZ research

Rationale

Variations in sea level have local, regional and global causes and impacts. There is an immediate need to ensure that the most reliable data on rates and causes of sea level change are readily available to support LOICZ research activities concerned with the effects of current and predicted variations of sea level on coastal environments and resources.

Specific objectives

- Review knowledge of the rates and causes of sea level change in the context of the scientific research objectives of the LOICZ project
- Assess the impacts of future sea level changes in relation to the use and management of coastal resources, and help define the needs for better understanding of the causes of sea level change and for improved predictive capability of future sea level
- Identify the regions where sea level change poses the greatest environmental and socio-economic threats, and help collect information required to model, disseminate and interpret the results in support of planning and policy decision making

Implementation

This task will require close collaboration among marine scientists, ocean modellers, geodesists and geophysicists to determine the observational data required to resolve quantitatively the various factors contributing to observed sea level changes, and then to assimilate this information into a comprehensive simulation model in order to improve predictions of global, regional and local sea level change for the next 10 to 100 years. The model must include the effects of ocean circulation, ice water mass interchange, geodynamic processes (plate motion, glacial rebound), coastal morphodynamics (see LOICZ Focus 2), and human activities such as freshwater management and extraction and shoreline engineering. An international network of scientists undertaking the field observations and modelling studies will be established. High priority will be given to forming or strengthening research teams and to convening workshops within regions that have the highest risk of adverse impacts due to sea level change on the coastal environment and on socioeconomic activities

Outputs

- Publication of periodic review's on current knowledge of rates and causes of sea level rise
- Publication of global and regional coastal zone maps showing where sea level change poses the greatest environmental and socio-economic threats, with supporting information on probable causes of sea level change and on research needed to quantify and understand better the causes of sea level change in aid of policy decision making
- Improved access for research scientists and environmental assessment groups to databases on sea level change
- Improved procedures for determining current rates of sea level change, identifying the causes, predicting future trends, and initiating actions to minimise the environmental and socio-economic impacts