

**GLOBAL CHANGE:
A RESEARCH STRATEGY FOR AUSTRALIA 1992 - 1996**

Progress Report

Will Steffen
GCTE Core Project Office

[Prepared on behalf of the National Committee for the IGBP, Australian
Academy of Science]

1. Introduction

The Australian global change research programme has been developed under the auspices of the National Committee for the IGBP, established in 1986 by the Australian Academy of Science. Planning for the research programme was initiated in 1988 with a national conference on global change and Australia, sponsored by the Academy and the Commonwealth Department of the Arts, Sport, the Environment, and Territories (DASET). This meeting was followed by a series of 13 planning workshops to identify specific problems and produce a science plan for Australian participation in the IGBP. This plan provides the basis for proposals to funding agencies for IGBP and related research, including aspects of WCRP, particularly the World Ocean Circulation Experiment (WOCE). The workshop topics were selected to meet national needs for prediction of environmental changes, as well as contributing Australian scientific expertise to global aspects of the IGBP.

The workshop reports were combined to produce an integrated Australian global change research programme. This programme is described in the report "Global Change: A Research Strategy for Australia 1992 ~ 1996" published in June 1992 by the Australian Academy of Science. Below we outline the structure of the programme, briefly report its current status, describe some new initiatives, and describe the programme's relevance for the Asian region.

2. Structure of the Programme

The Australian global change research programme consists of 10 major projects, each involving a multi-disciplinary team of scientists from several Australian research institutions. The projects and their objectives are:

- (1) Atmospheric Chemistry, Biogeochemistry and Ecosystem Dynamics in Tropical Northern Australia [Short Title: Northern Australia Tropical Transect - NATT]

To understand, describe and predict the biogeochemical, hydrological and ecological relationships between the land surface and the atmosphere in northern Australia, and the changes to these relationships under conditions of global change.

- (2) Energy and Water Exchanges between Atmosphere and Land Surface

To model and measure, as completely as possible, the surface energy, water and CO₂ balances of a heterogeneous region at space scales from plant canopy to 200 km and time scales from 1 hour to 1 year; and hence to develop and validate methods for translating models and measurements between scales.

- (3) Impact of Changes in Carbon Dioxide, Climate and Land Use on Agriculture and the Environment

To understand and quantify the impacts of global change on the Australia terrestrial biosphere, including the implications for sustainable management of Australian renewable resources.

- (4) Ozone Depletion and the Impact of Ultraviolet-B Radiation on Terrestrial and Marine Plants

To determine and quantify the effects of enhanced ultraviolet-B radiation on the photosynthesis, growth and structure of Australian terrestrial and marine plants, and to determine the interactive effects of ultraviolet-B radiation with other environmental stresses.

- (5) Nature and Causes of Climate Change over the Past 20,000 Years in Australian and Antarctica

To refine the history of climate over the past 20,000 years using high resolution records from natural archives; to refine the history of potential external causes of climatic change; to attempt to

explain the variability and cause of past climate change; to assist understanding of mechanisms that control climate; to improve prediction of future change; and to improve the modeling of palaeoclimatic change.

(6) **Past Response of Vegetation and Surface Water to Australian Climates**

To test understanding of processes controlling vegetation change during rapid warming, by establishing the exact time sequence of past events.

(7) **Circulation, Heat Transport and Sea Ice Changes in the Southern Ocean**

(8) **Eastern Indian Ocean Circulation and Process Studies**

To observe and determine large-scale transport and storage of heat in the oceans surrounding Australia; to determine air-sea fluxes of heat and greenhouse gases; to understand the effect of ocean circulations on the C cycle; and to develop and validate ocean models assisting prediction of climate change.

(9) **Carbon Fluxes in the Subtropical Convergence and the Southern Ocean**

To resolve mesoscale, latitudinal and seasonal variation in $p\text{CO}_2$ in surface waters between Australia and Antarctica; to quantify regional C fluxes from surface to deep waters; to identify and model the physical, chemical and biological interactions controlling C transformations within the upper ocean; and to establish a Quaternary history of water column properties and fluxes in the northern part of the region.

(10) **The Carbon Cycle in the Monsoonal Marine Tropics**

To improve estimation of air-sea CO_2 fluxes in the monsoonal tropics; to quantify C pools and fluxes, and their seasonal and interannual variability, in Australasian shelf seas and in the western equatorial Pacific; and to establish a historical and geological record of seasonal and interannual variability in monsoonal activity and the circulation of the atmosphere and ocean north of Australia.

A summary of project requirements, including both an average cost per year and a 5-year total cost (in \$A), is given in Table 15 of "Global Change: A Research Strategy for Australia 1992 - 1996", and is reprinted here. In most cases the participating institutions are committing a similar amount of existing resources to the project.

3. Current Status

A proposal for funding a global change research package, including the 10 IGBP projects, was put forward by DASET to the Australian government in early 1992. Unfortunately, due to the recession and the consequent budget constraints, the proposal was not funded and thus no new resources were provided for the projects. However, the proposal was viewed favourably and was only dropped from consideration near the end of the budget deliberations. DASET has been asked to resubmit the global change package for consideration in the next financial year.

Despite the failure to secure funding for the 1992 - 1993 financial year, some research within the 10 IGBP projects is already underway, financed by the re-allocation of existing resources by some of the institutions involved in the projects.

4. New Initiatives

The National Committee for the IGBP has undertaken two new initiatives during 1992:

START Office

Resources have been secured to establish a START coordinating office for Australia. This office will identify Australian researchers and institutions involved in IGBP-related research, both for national needs and for interaction with international IGBP activities. The Australian START coordinating office will be located at the GCTE Core Project Office in Canberra, to take advantage of the GCTE CPO's established international connections. With the formation of the START network for the Tropical Asian Monsoon (TAM) region, a high priority for the Australian START coordinating office will be the identification of potential Australian contributions to TAM and opportunities for collaborative research between Australian and Southeast Asian scientists.

National Conference

A conference on "Land Use and Land Cover: The Cutting Edge of Global Change", sponsored jointly by the Academies of Science, Social Sciences, and Technological Sciences and Engineering, and the Institute of Agricultural Science, is being planned for mid-1993. The meeting will be based around three themes:

- (i) the present capacity to predict change in land use/cover;
- (ii) an examination of past land use change, particularly of the driving forces which led to them; and
- (iii) choices for future land use in Australia.

5. Relevance for Asia

The northern rim of Australia is biogeographically and climatically linked to Southeast Asia. This fact is recognized within START by the inclusion of the area in the TAM region. Six of the 10 Australian IGBP projects are based, or include major components, in tropical northern Australia or its surrounding oceans, and are thus of direct relevance to Southeast Asia. There are:

Project 1 - Northern Australia Tropical Transect:

The biogeochemistry and atmospheric chemistry of tropical northern Australia are closely linked through the monsoonal air flow to those of Southeast Asia.

Project 4 - Effects of UV-B on Plants:

The effects of enhanced UV-B radiation on the photosynthesis, growth and structure of rice will be studied.

Project 5 - Climate Change over Past 20,000 Years:

The study of Australasia's palaeoenvironmental and climatic record will include coral sclerochronology from the tropical Australasian region and dendrochronology from Indonesia and the Kimberley.

Project 6 - Past Response to Climate of Vegetation and Surface Water:

This project includes the construction of a high-resolution vegetation change record along a transect from New Guinea to Tasmania; and the derivation of a drought history for the Australasian region over the past 2,000 years.

Project 8 - Eastern Indian Ocean Circulation:

The role of the ocean to the northwest of Australia in transporting heat poleward will be studied. Also, the Pacific-Indian Ocean through flow between Australia and Java will be investigated.

Project 10 - Carbon Cycle in the Monsoonal Marine Tropics:

This work will concentrate in the western equatorial Pacific Ocean, where the Australian oceanographic vessel R.V. Franklin is participating with ships from Canada, U.S., Japan, Korea, China, France and Russia in a large JGOFS study.

In addition to these studies, Projects 7 and 9, on the heat and water transport dynamics and carbon transport dynamics of the Southern Ocean, may be useful as companion studies to similar work in the north Pacific.

There are likely more Australian studies of interest to global change research in the region. A major role of the Australian START coordinating office is to identify this research, and promote links between it and similar work in Asia.

Australian Global Change Programme: Budget Summary for All Projects*

* The figures throughout the report are in 1991 Australian dollars. Forward funding will need to take inflation into account so that each project can be accomplished effectively.

Project No.	International Projects**	Average Cost/Year (000's)	5 Year Total Cost (000's)
1. Atmospheric Chemistry, Biogeochemical Cycling, and Ecosystem Dynamics in Tropical Northern Australia	IGAC, GCTE	973	4,865
2. <i>Energy and Water Exchanges between Atmosphere and Land Surface at Different Scales</i>	GEWEX, BAHC	590	2,950
3. Impact of CO ₂ Climate and Land Use Changes on Agricultural Systems and Carbon Storage	GCTE	2,056	10,280
4. Ozone Depletion and the Impact of UV-B Radiation on Terrestrial and Marine Plants	(STIB)	1,138	5,690
5. Climate Change over the past 20,000 years in Australia and Antarctica - nature, causes and use of model testing	PAGES	1,552	7,760
6. Response of Vegetation and Hydrologic Systems to Past Climate in Australia and Adjoining Regions	PAGES, BAHC, GCTE	2,398	11,990
7. Circulation, Heat Transport and Sea Ice Dynamics of the Southern Ocean	WOCE	410	2,050
8. Eastern Indian Ocean Circulation and Process Studies	WOCE, TOGA	1,968	9,840
9. Carbon Transport Fluxes in the Subtropical Convergence and the Southern Ocean	JGOFS, WOCE	1,618	9,090
10. The Carbon Cycle in the Monsoonal Marine Tropics	JGOFS, TOGA	1,435	7,173
Total		14,138	71,688

** This column shows the link between the Australian Projects listed and international programmes, including the World Climate Research Programme and core projects of the International Geosphere-Biosphere Programme.

BAHC: Biospheric Aspects of the Hydrological Cycle (IGBP)
GCTE: Global Change and Terrestrial Ecosystems (IGBP)
GEWEX: Global Energy and Water Cycle Experiment (WCRP)
IGAC: International Global Atmospheric Chemistry Project (IGBP)
JGOFS: Joint Global Ocean Flux Study (IGBP)
PAGES: Past Global Changes (IGBP)
STIB: Stratosphere-Troposphere Interactions and the Biosphere (IGBP) [proposed; not established]
TOGA: Tropical Ocean and Global Atmosphere (WCRP)
WOCE: World Ocean Circulation Experiment (WCRP)