Co-operative National Oceanographic Programme

SANCOR

Programme developed by the South African
National Committee for Oceanographic Research

SOUTH AFRICAN NATIONAL SCIENTIFIC PROGRAMMES REPORT NO

22

JANUARY 1978

Issued by
Cooperative Scientific Programmes
Council for Scientific and Idustrial Research
P 0 Box 395
PRETORIA
0001
Copies of reports in this series can be ordered from this address

Printed 1977 in the Republic of South Africa
by the Graphic Arts Division of the CSIR

ISBN 0 7988 1280 X

SANCOR
Marine and Earth Sciences Unit
CSIR
Pretoria

TITLES IN THIS SERIES

1. A description of the Savanna Ecosystem Project, Nylsvley, South Africa. December 1975. 24 pp.

2. Sensitivity analysis of a simple linear model of a savanna ecosystem at Nylsvley. W M Getz and A M Starfield. December 1975. 18 pp.

3. Savanna Ecosystem Project - Progress report 1974/1975. S M Hirst. December 1975. 27 pp.

4. Solid wastes research in South Africa. R C Noble. June 1976. 13 pp.

5. Bibliography on marine pollution in South Africa. D A Darracott and C E Cloete. June 1976. 131 pp.

6. Recycling and disposal of plastics waste in South Africa. R H Nurse, N C Symington, G R de V Brooks and L J Heyl. June 1976. 35 pp.

7. South African Red Data Book - Aves. W R Siegfried, P G H Frost, J Cooper and A C Kemp. June 1976. 108 pp.

8. South African marine pollution survey report 1974-1975. C E Cloete and W D Oliff (editors). September 1976. 60 pp.

9. Modelling of the flow of stable air over a complex region. M T Scholtz and C J Brouckaert. September 1976. 42 pp.

10. Methods and machinery for pulverising solid wastes. M J Simpkins. October 1976. 29 pp.

11. South African Red Data Book - Small mammals. J A J Meester. November 1976. 59 pp.

12. Savanna Ecosystem Project - Progress report 1975/1976. B J Huntley. March 1977. 41 pp.

13. Disposal and recovery of waste paper in South Africa. G R de V Brooks. April 1977. 35 pp.

14. South African Red Data Book - Fishes. P H Skelton. July 1977. 39 pp.

15. A checklist of the birds of the Nylsvley Nature Reserve. W R Tarboton. September 1977. 14 pp.

16. Grondsoorte van die Nylsvley-natuurreservaat. H J von M Harmse. September 1977. 64 pp.

17. Description and manual for the use of DRIVER - an interactive modelling aid. P R Furniss. September 1977. 23 pp.

18. South African Red Data Book - Large mammals. J D Skinner, N Fairall and J du P Bothma. November 1977. 29 pp.

19. Introducing you to satellite operated Data Collection Platforms (DCP's). C C Stavropoulos. September 1977. 9 pp.

20. A phytosociological classification of the Nylsvley Nature Reserve. B J Coetzee, F van der Meulen, S Zwanziger, P Gonsalves and P J Weisser. December 1977. 31 pp.

21. An annotated checklist of the amphibians, reptiles and mammals of the Nylsvley Nature Reserve. N H G Jacobsen. December 1977. 65 pp.

22. Cooperative National Oceanographic Programme. SANCOR. January 1978. 19 pp.

TABLE OF CONTENTS

JJECTIVE OF COOPERATIVE NATIONAL OCEANOGRAPHIC PROGRAMME

le overall objective is to gain scientific knowledge of the basic :ructures, processes and relationships in the ocean and on the se< »d around Southern Africa to facilitate

the efficient exploration, exploitation and conservation of marine resources

the judicious development, management and conservation of the coastal zone

- improved weather forecasting and the fuller understanding of climate

- improved safety and economy in navigation

INTRODUCTION

With the ever-increasing demands on the resources of our planet, man's attention during recent years has turned more and more to the resources of the ocean and it is being increasingly recognised that the proper exploitation and conservation of these resources require a thorough understanding of the physical, chemical and biological processes occurring in the oceans and of the geological and climatological conditions pre= vailing. *lir* is also clear that as far as the renewable resources are concerned there is a considerable degree of urgency to ensure that irre= parable damage by over-exploitation is avoided.

Recognising no man-made territorial boundaries, oceanography is essentially international in character and progress on a global scale depends very much on cooperative research undertaken by the many nations of the world that have an interest in the sea. South Africa has its own specific interests in the oceans to the west, south and east - quite apart from any contribution to the global picture. Practical incentives are the efficient exploration and exploitation of the marine resources accessible to us and in particular the conservation of the biological resources, not only within our territorial waters but also in the oceans around us; the judicious development, management and conservation of the coastal zone; improved weather forecasting and a fuller understanding of climate, and improved safety and economy in navigation.

In the post-war years a number of mainly uncoordinated South African research projects were initiated to meet *ad hoc* needs or interests. Some fifteen years ago the South African National Committee for Oceanographic Research (SANCOR) was established by the CSIR to stimulate and coordinate these projects and to develop oceanographic research in South Africa into one integrated programme with one common overall objective. The programme which has been developed is a cooperative one involving governmental and provincial agencies, national laboratories, universities, museums and to some extent the private sector. The research is multidisciplinary, involving the basic disciplines of physics, chemistry, geology and biology supported by a wide range of specialised subdisciplines and various engineering sciences. SANCOR, by recognising national as well as international needs focuses attention on areas where the greatest need for research exists and - because it has of necessity to take cognisance of the availability of trained oceanographic manpower - also on education and training needs. It provides, within the limitations of its budget, funds for research to meet these needs where the resources of the organisations concerned are inadequate. It thus determines priorities and coordinates the national programme and South Africa's contri= butions to international projects.

By facilitating cooperation and the voluntary coordination of South Africa's oceanographic research effort SANCOR ensures that the optimum use of our resources in scientific manpower, facilities and finance is made in the national interest.

Internationally also, despite the limitations within which they have to operate, South African oceanographers have made significant contributions to global projects, establishing a reputation for the quality of their work and justifying their participation in the planning and execution of international oceanographic projects.

This document sets out the cooperative national programme of oceanographic research as approved by SANCOR.

The Document

There are two sections and an addendum. The first section sets out the longer term research needs in each of the oceanographic disciplines. The disciplinary objectives are in most cases specific to the disciplines concerned. However it is recognised that the needs of one discipline may require supporting projects within another which do not themselves support the objectives of the disciplines in which they are placed. The second section is a plan of action for the period 1978 - 1982, formulated to meet most of the immediate research requirements but recognising that limited facilities may make it impossible to do all that is visualised.

On the open sea where ship's time is usually the major expense in oceano= graphic research it is desirable to provide for as many disciplines as possible on each cruise. All oceanographic cruises cannot be completely multidisciplinary but there are nevertheless many cases in which inter= disciplinary assistance can be given by collecting data or by providing the means to collect data. The addendum indicates interdisciplinary data requirements; not all are equally important but the list is complete enough to assist oceanographers planning cruises to provide for as many interests as possible in consultation with their colleagues.

Oceanography is a fast developing science and it cannot be expected that the programme outlined will remain static. Most of the changes in years to come will occur in the plan of action, which will be adapted from time to time.

SECTION I - LONG-TERM RESEARCH NEEDS AND OBJECTIVES

PHYSICAL OCEANOGRAPHY

Objective

To gain scientific knowledge of the distribution and variation with time of physical quantities in the ocean around South Africa with particular emphasis on water movements, and of the interaction of the ocean and the atmosphere, to facilitate

- improved safety and economy in navigation
- improved weather forecasting and a fuller understanding of climate

Scientific Problems

Agulhas Current

This is one of the major western boundary currents of the world and a sound knowledge of the Agulhas will contribute to an understanding of the phenomenon. Because of the vast quantity of water transported along the South African east coast the Agulhas Current is also a dominant influence on the marine environment and the climate of the land areas adjacent to the south and east coasts of the country.

Benguela System

The eastern margin of the South Atlantic is characterized by upwelling within what is known to be a complex circulation system. Apart from the scientific interest of this problem, a full understanding of the mechanisms of the Benguela System and its upwelling waters and their influence on the marine food web is necessary for successful management of the fishing industry.

Agulhas Interaction Area

The intrusion of warm, fast-flowing water into the area to the south of the Republic, which might be expected to be dominated by colder surface water, gives rise to a variety of interactions such as the intensification and southward displacement of the Subtropical Convergence and air-sea interactions which are quite different from those that occur elsewhere at similar latitudes. It is also suggested that variations in this intrusion of Agulhas water affects the quality and quantity of equatorward flow in the Benguela System.

Southern Ocean

The Southern Ocean is of special interest because of its biological productivity and its influence on the weather and climate of the Southern Hemisphere.

Inshore Circulation

Apart from its scientific interest, knowledge of the very complex in= shore circulation is necessary for the effective management and development of harbour and recreational facilities, for an understanding of the be= haviour of pollutants in the sea, for an understanding of the inshore biological environment and for upwelling studies, especially off the west coast.

Sea Level

There is a recognised international need for long-term sea-level data on a global scale for monitoring climatic change and large-scale circulation. Coastal engineers also require information on the variability of sea-level for use in their designs of coastal structures.

Waves

Studies of the generation, travel and decay of waves in the open sea, their interaction with atmospheric circulation and their modification by currents and bottom topography as they approach the continental shelf, are essential for planning coastal development and wave energy extraction and for ensuring safety in navigation.

MARINE CHEMISTRY

Objective

To identify and describe the chemical components of the waters around Southern Africa, the bottom sediments, the marine biota and the interactions that take place between these chemical components with a view to furthering our understanding and hence the judicious use of our oceans, the life within them and the sea floor beneath them.

Scientific Problems

The Agulhas System

The Agulhas Current has a large transport and is a major contributor to the chemical budget of the Southern Indian Ocean. Measurements of the chemical flux, both particulate and dissolved, of this major current, its sediment transport, interaction with the sea floor and dispersion capability, are of interest.

The Benguela System

As one of the major upwelling regions of the world, study of the chemistry of the Benguela System is of considerable global importance, apart from the national interest generated through the large commercial fishery supported by this highly productive region. Due to the very high primary productivity, the organic chemistry of the water, organisms and sediments is of special scientific interest.

Agulhas Interaction Area

The Subtropical Convergence Zone is noted for an increase in trace element concentration and this area is considered to be a source for the water upwelling along the west coast which supports South Africa's major fisherie The use of chemical tracers to delineate penetration of Agulhas water into the Atlantic has already been demonstrated and should be of assistance in understanding this complex region.

Laboratory Studies

It is recognised that the forms in which elements exist in the sea are extremely complex and exert a considerable influence on their reactions. It is suggested that both theoretical and laboratory studies of this problei be strongly encouraged.

Sampling and Methodology

Chemical techniques should be developed or adapted as far as possible for use *in situ* or on board ship in order to minimize unpredictable storage changes and to facilitate on-voyage data assessment.

MARINE BIOLOGY

Objective

To gain scientific knowledge of life in the oceans around South Africa to facilitate the effective management of the living resources of the sea, the judicious development and management of the coastal zone and the conservatii of the marine and coastal environment. To this end an understanding of thi structure and functioning of the major types of ecosystem found in the Souti African marine environment is required.

Soi&ntific Problems

Estuaries

In addition to the study of severely disturbed estuaries, it is important to direct research effort in those estuaries where ecological disruption is minimal. By so doing our understanding of the nearly natural physico-chemical and biological events which occur in the Republic's estuaries can be assessed and used to interpret the magnitude of existing or proposed

man-made changes, and thus provide a foundation upon which sound manage= ment or conservation strategies can be based.

The Inter- and Infratidal Zone

Man makes his most immediate contact with the sea in the areas most accessible to him, namely the inter- and infratidal zones. These areas are exposed to conflicting uses such as food collecting, recreation and waste disposal. Scientifically-based information is needed in order to solve the problems associated with these conflicting uses.

The Continental Shelf and Slope

The continental shelf and slope is the area where exploitation of living resources on commercial scale takes place with the greatest intensity. Research aimed at stock assessment and the determination of maximum sus= tainable yields is, therefore, of the greatest importance.

The Abyssal Region

To date, the abyssal region has received relatively little attention in terms of biological research mainly because the problems outlined above proved more pressing and because research at great depths is expensive. Abyssal organisms are, however, often more vulnerable to disturbance of their environment, e.g. through pollution, than those in shallower water because of their great degree of specialization. Research is necessary because of an increasing tendency to dump harmful waste products in deep water, and also to establish more precisely the physical, chemical and biological interaction between abyssal regions and the water masses above.

The Southern Ocean

The high biological productivity of the Southern Ocean is expected to lead to exploitation at secondary stages in the food-chain, e.g. krill. Research is therefore needed to avoid ecological disruption of the structure of the comparatively simple trophic web within the pelagic invertebrate and verte= brate fauna of this great oceanic mass.

MARINE GEOSCIENCE

Objective

To gain an understanding of the geology, in its broad context of the area from the inshore coastal region to Madagascar, the Madagascar Ridge, the South West Indian Ridge, the Atlantic-Indian Ridge, the southern Mid-Atlantic Ridge and the Walvis Ridge. The following are the main aims :

(a) The unravelling of the history of the plate tectonic development of the South East Atlantic and South West Indian Ocean area. The aim is to establish firm constraints on the original configuration

of Southern Africa, South America, Antarctica and Madagascar within the supercontinent of Gondwanaland and the development of the ocean basins which now seperate them.

(b) The understanding of the geological history of the continental margin of Southern Africa - its development within the frame= work of plate tectonics and its tectonic and sedimentary history from its origin to the present time.

The second aim is clearly related to the first by the fact that the continental margin was created at the time of the break-up of Gondwanaland.

(c) Reconnaissance studies of selected phenomena of potential economic importance.

Scientific Problems

The oceans around Southern Africa contain many keys to the detailed understanding of the mechanism of plate tectonics and offer researchers an opportunity to contribute significantly to the current revolution in geological thinking. The geographic area of interest is large and contains numerous specific problems of global tectonic importance. The following are the most readily identifiable :

(a) The structure and evolution of the southern Mid-Atlantic Ridge between Tristan and Bouvet.

(b) The structure and evolution of the Atlantic-Indian Ridge and its flanking ocean basins, including the opposed continental margins of Africa and Antarctica and the apparently anomalous Agulhas Plateau separating the Agulhas and Transkei Basins.

(c) The definition of the spreading history of the south-western branch of the Mid-Indian Ridge north and south of the Prince Edward Island Group for which an abnormally slow spreading rate has been calculated.

(d) The origin and development of the Agulhas Fracture Zone which controls the character of the south-eastern continental margin, is known to pass through the Cape Rise and is presumed to be related to the northern scarp of the Falkland Plateau.

(e) The essential criteria which serve to characterize sheared and rifted continental margins as exemplified by the Indian and Atlantic margins of Southern Africa.

(f) The origin and structure of the Walvis Ridge with particular reference to its relationship to the continental margin, the Mid-Atlantic Ridge and the Cape and Angola Basins.

(g) The apparently anomalous structure of the ocean floor between Madagascar and Africa, including the Mozambique Channel and Basin, the flanking Madagascar and Mozambique Ridges and the Natal Valley.

(h) The structure and sedimentary history of the continental margin and the adjacent ocean basins as additional sources of information relating to the development of a model of continental drift, and likely to be of particular importance in deciphering the earliest phases of continental break-up and separation.

(i) The geology of the continental margin which is of interest in its own right in that it forms an extension of the geology of the continent and is of direct relevance to the search for oil and other potentially economic mineral accumulations.

OCEAN ENGINEERING

Ocean engineering is defined as the combined engineering effort to explore and judiciously use the ocean's resources. It is a relatively young field of engineering with the result that, in many cases, empirical rather than scientific methods are still used to solve ocean engineering problems.

Objectives

(a) To carry out research which will lead to a better understanding of coastal processes and will contribute to more scientifically-based design techniques.

(b) To carry out research into problems which are unique to Southern Africa and of particular importance to local coastal and ocean engineers.

Scientific Problems

Waves

Wave data representative of large ocean areas i.e. recorded in deep water, are urgently needed for the design and operation of coastal and ocean structures including energy extraction works, as well as for safety in navigation. The latter applies in particular to the east coast which, in view of the many shipping disasters caused by 'freak' waves, is internationally recognised as the main problem area.

Sediment Movements

Coastal as well as offshore structures normally disturb the natural sediment morphology and accurate predictions of possible changes are essential for safe, yet economic design. The prediction of longshore and normal to shore sediment movements, scour and possible liquefaction is still very approximate and requires further improvement by comparison with field measurements. Techniques to carry out these measurements should also be improved.

Numerical Modelling of Ocean Engineering Problems

Harbour resonances can cause considerable problems to shipping as well as to structures such as cooling water inlets. Various prediction techniques

are available which need to be checked against real cases. Boundary problems which can cause considerable errors need to be investigated.

The same applies to numerical dispersion models which also have to be adapted to local conditions.

Estuary Dynamics

Most of South Africa's estuaries are small by world standards. Their stability presents particular problems and known theories cannot be readily applied. Research is needed on the relationship between water and sediment movements.

Survey Techniques

Surfzone profiling techniques need to be further improved particularly in regard to accuracy. Surfzone seismic profiling techniques must be developed. Research in remote sensing techniques, particularly aerial photography, needs further development.

Small-craft Harbours

The combination of harbours for small craft with commercial harbours is considered undesirable and alternative sites must therefore be sought for the former. Since the South African coast offers little in the form of natural protection for small craft, approach, entry and mooring requirements need to be established.

Marine Building Materials

The marine environment is particularly harsh on building materials. For reasons of economy, building materials available near construction sites should be used in preference to 'imported' materials. Research into corrosion and abrasion as well as into the relative merits of using locally available materials will be encouraged.

SECTION II - PLAN OF ACTION 1978 - 1982

This section lists projects within each of the five disciplines which have been proposed to SANCOR by its disciplinary committees and have been accepted as qualifying for support in the period 1978 - 1982.

PHYSICAL OCEANOGRAPHY

Agulhas System

(a) Working up of existing hydrographic and current data and their presentation in the form of data reports, sections, time series and dynamic topographies.

(b) Organisation of an international workshop to review the state of knowledge about the Agulhas System.

(c) Making of new observations at stations to be occupied regularly along a line or lines of closely spaced deep stations across the current between Durban and East London.

(d) A multi-ship experiment which will enable the sources and outputs of the Agulhas Current to be determined more accurately than has been possible so far.

(e) Mathematical modelling of the Agulhas Current, on a collaborative basis, by the organisations engaged in this work.

(f) Measurements of bottom current velocities and pressure gradients.

(g) Bringing to bear on the problem such satellite and other new data as become available.

(h) Intensification of research in the nearshore zone (from the shore 500 m seawards) as far as water movement through wave or current action is of basic ecological importance.

Benguela System

(a) Completion of the working up of existing physical and chemical data and their presentation in the form of time series, sections of parameters and an atlas.

(b) Investigation of the Benguela System in the broader sense as part of the overall circulation in the South Atlantic Ocean in order to throw light on the likely sources of the various components of the system.

(c) Continuation of multidisciplinary research in the upwelling area in order to understand better the link between wind, upwelling, nutrient cycling processes and productivity.

(d) The mounting of an extensive current measuring programme in the system using both moored current meters and drogues to provide data on circulation and volume fluxes. This work must be linked with (c) and (e) in order to obtain maximum benefit. The possibility of studying the Benguela Jet by means of satellite-tracked buoys or land-tracked drogues should receive high priority, as should studies of the fate of upwelling plumes. The possible feedback of knowledge about circulation from biological studies should be kept in mind.

(e) Because the Benguela is primarily a wind-driven system, adequate attention should be given to the understanding of factors in= fluencing upwelling processes - e.g. the offshore windshear effect, diurnal wind fluctuations and their implications, empirical relations between wind and upwelling and the transfer of energy from atmosphere to ocean.

(f) Remote sensing - application of existing techniques (aerial, satellite, acoustic) for obtaining synoptic data on the surface layer and for studying changes taking place in both space and time. Cloud cover will present some difficulties.

Southern Ocean

Ships with the necessary capability are being planned and when these are available, interdisciplinary work in waters south of latitude 40 will be undertaken. This will, as far as possible, be undertaken as part of the international effort in the area.

Coastal Ct.Taulati.on

Information of this sort is often needed at short notice. The most satis-factory way of proceeding would be to carry out detailed investigations in selected areas around the coast, paying special attention to the influence of topography and the predominant weather patterns on inshore circulation. In this way, knowledge would be built up which would have local value as well as more general application. Studies of this nature will be encouraged, bearing in mind that initially experience in suitable techniques will have to be gained.

Sea Level

Sea level records are needed by coastal engineers, surveyors and earth scientists generally. If reliable and well-sited gauges could be tied in with the levelling system, they would provide the additional possibility of monitoring flow in major currents around South Africa.

Waves

The programme of wave study is directed partly towards providing statistical data on the state of the sea and partly towards gaining scientific knowledge of wave generation, travel and decay. It involves work on the east, south and west coasts and includes observation and prediction, wave modification,

wave modelling and the influence of topography, current systems and weather on wave behaviour.

Wave Data

Wave data are required for nearly all projects in marine and coastal engineering, for marine services and for the design and operation of ocean-going craft and equipment to be used at sea. They are required also for the planning and costing of operating schedules of ocean trans= port and other vessels.

It is important, therefore, that South Africa should possess reliable data on wave conditions in its waters. A representative collection of statistics on wave heights, frequencies, directions and speeds of travel is required. Long-period waves are of special interest on account of their high energy and their importance in coastal engineering design.

Modelling and Prediction of Waves

This part of the programme will be done on a collaborative basis. Initially use will be made of a simple wave prediction model developed for the Weather Bureau. It is expected that the model will be modified and improved as the programme proceeds.

Wave Modification

The programme should include studies of modification of waves passing from deep to shallow water by such processes as refraction, shoaling, diffraction, percolation and friction with the bottom. It includes a study of the effects of currents upon wave patterns and behaviour. This programme will be supported by model experiments in tanks and theoretical investigations.

MARINE CHEMISTRY

AguVhas System

(a) Working up of existing physical and chemical background data.

(b) Collecting samples at selected depth intervals (surface to deep water) in the water column on lines of stations perpendicular to the current for :

'particulate[1] and 'soluble[1] trace elements

organic carbon analysis, concentrating on the upper 300 m with some widely spaced samples from deep water

- nutrients, temperature, salinity and dissolved oxygen for correlating with physical data

- plankton analysis, using a noncontaminating net, for the determination of major and trace element content.

(c) Using physical data on the dynamics, generate an element budget and mass balance for the current system.

Benguela System

(a) Working up of existing physical and chemical background data, including the chemical aspects of upwelling.

(b) Collecting samples at selected depth intervals in the water column on lines of stations perpendicular to the current for :

- plankton analysis, using a noncontaminating net, for determination of major and trace element content, parti= cularly in the surface, thermocline and near-bottom regions

- particulate phase element analysis, especially in the surface, thermocline and near-bottom regions

- determination of the chemical flux in both directions through the shelf sediment/water interface, either by coring and expressing interstitial water by 'squeezing' or preferably by using an *in situ* probe of the Sayles design

- determinations of organic constituents and components of the sulphate/sulphide system in the uniquely organic rich sediments of the west coast

(c) Mathematical modelling of the chemical data within the established physical oceanography framework.

Sampling and Methodology

Analysis *in situ*

The possibility of *in situ* analysis using selective electrodes to yield continuous ocean depth profiles should be carefully studied under simulated natural conditions in the laboratory. Electrodes for investigation include those for dissolved oxygen, pH, ammonium, fluoride and sulphide.

On-board Analysis

Since changes occur between sample collection and analysis, rendering many previous data suspect, automated on-board analysis, adapted from present laboratory techniques, of ammonium, nitrate, silicate and phosphate (at least), should become routine on marine chemistry cruises. Capability to determine trace metals on board ship should be investigated, using atomic absorption spectrophotometry with electro-thermal atomization.

Chemistry of Carbon

Carbon Dioxide System

Instrumentation for investigating the carbon dioxide system should be adapted for routine use on marine chemistry cruises and the data related to productivity.

Organic Chemistry

Following a study of dissolved and parciculate carbon which will demarcate areas of high or low organic content (in the upper 300 m), on-board stripping techniques should be used to determine specific organic compounds, especially hydrocarbons (natural, petroleum-derived and halogenated), amino acids, proteinacious matter, carbohydrates, volatile organics (acetone, methane), sterols and lipids, particularly in the waters overlying the anoxic west coast sediments.

Surface Phenomena

Studies of marine aerosols, surface film and bubble processes should be initiated since these surface processes have an important bearing on climatological studies.

Marine Radio-act'tvi-ty

Studies of the natural and artifical radio-isotopes of U, Th, Po, Pb, C and H should be undertaken since such research throws light on the pathways these elements take through the marine environment and permits tracing and age determination of water masses to be made.

MARINE BIOLOGY

While existing research programmes fit neatly into an ecosystem approach, it is understood that such programmes are not the only ones which will receive sympathetic consideration for funds. It is recognised that with= out research on ecosystem components, it is unlikely that success will be achieved in any future systems analysis. Some of the programmes mentioned below have not yet begun and are meant to guide rather than dictate the type of work considered necessary.

Estuari-es

(a) Completion of existing survey studies on the Olifants, Breede, Umgazana and Natal estuaries and the detailed investigation into the zooplankton of South African estuaries.

(b) Microbiology of estuaries.

(c) Primary productivity in the open water of tidal and closed estuaries.

(d) Primary productiviy of estuarine macrophyte associations.

(e) Secondary production processes in estuarine zooplankton.

(f) The biology of estuarine benthos.

(g) The biology of the portunid crab *Scylla servatus* and its food resources.

(h) The qualitative and quantitative role of piscivorous birds in estuaries.

(i) The biology of the fishes *(Hlchristella^ Arribassis* and *Hyporhamphys* and gobies.

(j) Biology of *Mugil* and other fishes with economic potential and in particular resource subdivision between species.

Inter- and Infrat-Cdal Zone (to 50 m)

Intertidal Zone

Completion or, where necessary, further development or initiation of multidisciplinary and integrated investigations to obtain information also required for conservational and resource management purposes at various points along the coast of :

- standing crop and secondary productivity of sandy shore communities with detailed attention to animals such as the sand mussel *(Donax)*, the kelp eating amphipod *(Taloehestia)*, ghost crabs *(Ocypoda),* sea lice *{Eyppa* and *Emmevita)* and fish

- biological and ecological energetics of rocky shore communities with detailed attention to animals such as the barnacles *(Tetpacti-ta* and *Octomeris)*, limpets *{Patella),* mussels *(Choromyti-lus),* the kelp-eating isopod *(Ligia)* and various fishes.

Infratidal Zone

Completion or, where necessary, further development of multidisciplinary and integrated investigations to obtain information also needed for conservational and resource management purposes of :

ecological energetics of a kelp-bed community in the Western Cape with detailed attention to kelp *(Ecklon-ia* and *Laminaria),* mussels *{Aulacomya)*, sea-cucumbers *{Pentaota$_3$ Thy one),* rock lobster *(Jasus)$_3$* mysids *(Mysidopsis)* $_3$ isopods *(Cirolana)* and fish. (Energy input at detritus and bacterial levels is important.)

- ecological energetics of a reef community on the Natal coast with detailed attention to mussels *(Perna),* oysters *(Crassostrea)*> rock lobster *(Panul-irus)*, octopus *{0. vulgaris)* and inshore reef fish. (Energy input at detritus and bacterial levels is important.)

- biology and ecological energetics of nearshore communities on the south coast, to provide results comparable to those for the Western Cape and Natal coasts.

Continental Shelf and Slope

Pelagic Component

(a) the development of techniques and the measurement of primary pro= ductivity in the euphotic zone of coastal waters.

(b) Taxonomy of groups within the ichtyoplankton.

(c) Evaluation of the sport fisheries on the eastern and southern seaboard.

(d) Secondary productivity within important pelagic fish species, paying particular attention to measurements of energetics para= meters in laboratory systems.

(e) The influence of the changing patterns of pelagic fish dominance upon piscivorous bird distribution. These changing patterns are also likely to alter feeding patterns and therefore utilization.

Benthic Component

(a) The benthic fauna of the east coast with particular reference to the main foodweb components.

(b) The population structure, growth and reproduction of the rat tails *(Coelorhynakus).* The economic importance of these fishes to other nations and ourselves is increasing.

(c) Structure and standing crop of benthic organisms particularly in the deeper offshore waters.

Taxonomy

The following requires attention :

(a) The taxonomy of Porifera, Anthozoa, Polyzoa and ascidians, parti= cularly for the inter- and infratidal research groups.

(b) The collection and analysis of deep benthos and midwater pelagic fauna below 300 m, particularly off the Natal and Transkei coasts.

(c) The revision of the taxonomy of the Southern African marine ichthyofauna.

MARINE GEOSCIENCE

For the first few years, efforts will be concentrated in a strip about 500 km wide, extending south-south-west from South Africa's east coast, between Port Elizabeth and Ponta do Ouro to Antarctica, including the Natal Valley, the Transkei Basin, the Agulhas Plateau and parts of the Agulhas Basin, the Atlan= tic-Indian Ridge, the Africa-Antarctica Basin and the Antarctic Continental Margin. This is the area in which solutions to the most significant problems can be sought most efficiently and economically.

During this initial period, work will be undertaken in the larger area only when particularly favourable opportunities arise, especially opportunities for international collaborative efforts.

Every effort will be made to complete existing projects or to round them off as soon as possible. Much work has been done, many of the results have been published and more are in the process of publication. Unpublished results will be written up for publication or be made known to the marine geoscience community. Participants are urged-to collate their raw data for perusal by the scientific community.

To ensure the maximum contribution to the achievement of the objectives, each project will be designed to test critical aspects of a pre-defined theory or model. Future work will, to a large extent, be dictated by the model developed from the results obtained in the strip.

OCEAN ENGINEERING

Wave Research

A considerable amount of nearshore wave data has been collected over the past years. These data must be analysed and made available to coastal engineers involved in coastal design projects.

A deep sea wave-recording station operates off Slangkop at present. A special effort should be made to record deep sea waves on the east coast in the East London-Durban areas on a regular basis.

Further research must be directed towards improved wave direction recording and prediction techniques.

Numerical Modelling

Several computer models developed overseas, are presently being tested under local conditions and a programme of modifications to these models is under way.

Estuary Dynamics and Sediment Movements

Present research is aimed at improving sediment movement calculation techniques, Future efforts should also be directed towards monitoring actual sand move= ments and estuary changes in the field.

Small-craft Harbours and Surf zone Seismic Profiling

Work is progressing on these problems but concerted effort will be needed during the coming years to ensure sufficient progress.

----0000000-----

ADDENDUM

INTERDISCIPLINARY DATA REQUIREMENTS

Data required from / by	*Physical Oceanography*	*Marine Chemistry*
Physical Oceanography		Information on trace elements and other less common dissolved substances to assist in the determination of water mass movement and to study bottom water formation in the Southern Ocean
Marine Chemistry	Current direction and velocity throughout the water column both on shelf and in deep sea, particularly near-bottom currents. Temperature, salinity, dissolved oxygen and any nutrient data. A dynamic model of an upwelling system including 'jets' or under-currents, in order to interpret chemical element distribution. Information on physical processes at 'fronts', both offshore, e.g. Subtropical Convergence and inshore e.g. intense front separating cold upwelled water from warm offshore water. Data on precipitation (rain) and evaporation over ocean for calculation of chemical flux across air/sea interface	
Marine Biology	Estuaries: Water exchange mechanisms with sea, water input through river inflow and seepage, water loss through evaporation and outflow; salinity levels, scouring action and sedimentation resulting from interaction of above factors Inter- and infratidal zone: All aspects of water movement through nearshore currents, wave-action or any other factors. Indication of effects of such water movement as a source of energy input into reefs, inducement of sandscour and erosion of inter- and infratidal life leading to detritus formation. Also indication of eddy formation and upwelling resulting in nutrient concentration as basis for primary production processes Continental shelf and slope and other oceanic regions including the Southern Ocean: All aspects of water movement basic to sediment and nutrient transport, primary- and secondary production processes, transport of pelagic organisms Abyssal region: Indication of all water exchange mechanisms which may affect abyssal life and special attention to effects of dumping of wastes in deep water	Estuaries, inter- and infratidal zone, continental shelf and slope and, if possible, abyssal region: information on: Levels of nutrients and trace elements occuring naturally in sediment and water column above them, levels of nutrients and trace elements through artificial enrichment, levels of pollutants in both sediments and water column emanating from industrial-, domestic-, or agricultural run-off or the dumping of waste products in deep water Indication of progressive changes through man's activities in the chemical composition of the environment upon which living marine resources depend
Marine Geoscience	Currents: Velocity and direction variations with depth in Agulhas, Benguela and Mozambique Currents, including seasonal and weather-related changes. Details of current patterns associated with Mozambique, Walvis and Madagascar Ridges and Agulhas Plateau. Surface and sea floor current measurements inshore, particularly adjacent to river mouths. Velocity, direction data and suspended sediment load measurements from near river mouths and on adjacent open shelves to compare 'normal', 'storm' and 'river flood' conditions. Velocity and direction data on deep currents in any portion of the South West Indian Ocean but especially in Natal Valley, Transkei, Cape, Agulhas and Mozambique Basins and around Mozambique Ridge. Bottom photographs if possible. Suspended sediments from various depths down water column (see chemistry) Upwelling phenomena: Data relating to possible oceanic upwelling on the Walvis and Mozambique Ridges	Chemistry of suspended sediments, particularly from near river mouths and near the sea floor in the deep ocean basins (see physical oceanography and ocean engineering). Chemistry of interstitial waters in sediments: from deep ocean sediments and shelf areas rich in authigenic minerals or organic matter. Areas rich in manganese nodules could be singled out for special study
Ocean Engineering	Direction, heights and periods of waves analysed using standard spectral analysis techniques. Data on coastal circulation for use in numerical models and for nearshore sediment movement studies	Use of natural tracers to determine water and sediment movements. Corrosion information on marine building materials

Marine Biology	*Marine Geoscience*	*Ocean Engineering*
Information on plankton concentrations in the surface layers of the sea in order to assist in the interpretation of surface temperature maps acquired by means of satellites and used for water mass identification	Difference in sedimentation rates can be used to indicate variability in bottom currents and turbidity currents and long term climatological changes	Information on changes in inshore sediments can be used to determine average inshore water movements resulting from wind and waves
Species composition of both phyto- and zooplankton, collected for chemical analysis. Primary productivity measurements for chemical mass balance calculations. Information on life cycles of dominant planktonic organisms, i.e. life time, depth range, rate of growth and uptake of nutrients and trace metals from sea water, benthic burrowing animals which irrigate shelf and deep sea and profoundly alter chemical composition of upper layers of sediment relative to deeper layers. Rates of 'pumping', depth of penetration and population density of burrowing fauna. Information on marine bacteria	Mineralogy of sediment cores for interstitial water chemistry studies. Bottom topography and sedimentology of upper metre of ocean floor, i.e part of sediment which may influence the chemical composition of overlying water. Sedimentation rates, both inshore and in deep sea for recent sediments. Numerical models of inshore and estuarine hydro-dynamics for dispersion studies on elements introduced by rivers or from pollutant sources	Numerical models of inshore and estuarine hydrodynamics for dispersion studies on elements introduced by rivers or from pollutant sources
	Estuaries: Substrate-composition of estuaries in regard to process of sedimentation, scouring and water seepage. Of particular importance is information concerned with the dynamics and stability of estuary- and river mouths Inter- and infratidal zone: Sediment movement which may affect the morphology of the nearshore zone, the covering and uncovering of reefs and detritus formation through sandscour or other forms of erosion Continental shelf, slope and abyssal region: Sand and sediment movement which may affect benthic life Information on geological processes which influenced the evolution of marine life to its present form	Information related to man-induced coastal modification, particularly with regard to harbour or marina development. Also, advice as to the applicability of engineering techniques in the managment of estuarine systems which have been detrimentally affected by development in the catchment areas, e.g. through dam construction or argicultural practice
Biological productivity related to upwelling and surface current patterns. Data needed from along the west coast, Walvis Ridge and throughout the South West Indian Ocean Deep benthos: Scale of infaunal burrowing activity on the deep ocean floors - especially in the South West Indian Ocean - probably best monitored by bottom photographs, long cores and grab samples (see marine chemistry and physical oceanography). These data are to link with studies in sedimentaiton rates and degree of 'reworking' and 'mixing' between surface and underlying sediments		Current velocity and direction, sediment load, wave studies and surf zone seismics, e.g. in False, Saldanha and Algoa Bays
Effects of marine organisms on building materials. Use of biological tracers to determine sediment movement. Environmental tolerance limits of life in estuaries and lagoons are required where engineering techniques must be utilised to manage estuarine or lagoon systems modified by man. Information on estuary mouth conditions and tidal flow	Information on foundation conditions for marine structures. Origin of coastal sediments for planning coastal structures	