Intergovernmental Oceanographic Commission

Workshop Report No. 63

IOC/Westpac Workshop on Co-operative Study of the Continental Shelf Circulation in the Western Pacific

Bangkok, Thailand, 31 October - 3 November 1989

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IOC Workshop Reports

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No.	Title	Publishing Body	Languages
1	CCOP-IOC, 1974, Metallogenesis, Hydrocarbons and Tectonic Patterns in Eastern Asia (Report of the IDOE Workshop on); Bangkok, Thailand 24-29 September 1973 UNDP (CCOP), 138 pp.	Office of the Project Manager UNDP/CCOP c/o ESCAP Sala Santitham Bangkok 2, Thailand	English
2	CICAR Ichthyoplankton Workshop, Mexico City, 16-27 July 1974 (Unesco Technical Paper in Marine Sciences, No. 20).	Division of Marine Sciences, Unesco Place de Fontenoy 75700 Paris, France	English (out of stock) Spanish (out of stock)
3	Report of the IOC/GFCM/ICSEM International Workshop on Marine Pollution in the Mediterranean, Monte Carlo, 9-14 September 1974.	IOC, Unesco Place de Fontenoy 75700 Paris, France	English French Spanish (out of stock)
4	Report of the Workshop on the Phenomenon known as "El Niño", Guayaquil, Ecuador, 4-12 December 1974.	FAO Via delle Terme di Caracalla 00100 Rome, Italy	English (out of stock) Spanish (out of stock)
5	IDOE International Workshop on Marine Geology and Geophysics of the Caribbean Region and its Resources, Kingston, Jamaica, 17-22 February 1975.	IOC, Unesco Place de Fontenoy 75700 Paris, France	English (out of stock) Spanish
6	Report of the CCOP/SOPAC-IOC IDOE International Workshop on Geology, Mineral Resources and Geophysics of the South Pacific, Suva, Fiji, 1-6 September 1975.	IOC, Unesco Place de Fontenoy 75700 Paris, France	English
7	Report of the Scientific Workshop to Initiate Planning for a Co-operative Investigation in the North and Central Western Indian Ocean, organized within the IDOE under the sponsorship of IOC/FAO (IOFC)/Unesco/EAC, Nairobi, Kenya, 25 March-2 April 1976.	IOC, Unesco Place de Fontenoy 75700 Paris, France	English French Spanish Russian
8	Joint IOC/FAO (IPFC)/UNEP International Workshop on Marine Pollution in East Asian Waters, Penang, 7-13 April 1976.	IOC, Unesco Place de Fontenoy 75700 Paris, France	English (out of stock)
9	IOC/CMG/SCOR Second International Workshop on Marine Geoscience, Mauritius, 9-13 August 1976.	IOC, Unesco Place de Fontenoy 75700 Paris, France	English French Spanish Russian
10	IOC/WMO Second Workshop on Marine Pollution (Petroleum) Monitoring, Monaco, 14-18 June 1976.	IOC, Unesco Place de Fontenoy 75700 Paris, France	English French Spanish (out of stock) Russian
11	Report of the IOC/FAO/UNEP International Workshop on Marine Pollution in the Caribbean and Adjacent Regions, Port of Spain Trinidad, 13-17 December 1976.	IOC, Unesco Place de Fontenoy 75700 Paris, France	English Spanish (out of stock)
11 Suppl.	Collected contributions of invited lecturers and authors to the IOC/FAO/UNEP International Workshop on Marine Pollution in the Caribbean and Adjacent Regions, Port of Spain, Trinidad, 13-17 December 1976.	IOC, Unesco Place de Fontenoy 75700 Paris, France	English Spanish
12	Report of the IOCARIBE Interdisciplinary Workshop on Scientific Programmes in Support of Fisheries Projects, Fort-de-France, Martinique 28 November-2 December 1977.	IOC, Unesco Place de Fontenoy 75700 Paris, France	English French Spanish
13	Report of the IOCARIBE Workshop on Environmental Geology of the Caribbean Coastal Area, Port of Spain, Trinidad, 16-18 January 1978.	IOC, Unesco Place de Fontenoy 75700 Paris, France	English Spanish
14	IOC/FAO/WHO/UNEP International Workshop on Marine Pollution in the Gulf of Guinea and Adjacent Areas, Abidjan, Ivory Coast, 2-9 May 1978.	IOC, Unesco Place de Fontenoy 75700 Paris, France	English French
15	CPPS/FAO/IOC/UNEP International Workshop on Marine Pollution in the South-East Pacific, Santiago de Chile, 6-10 November 1978.	IOC, Unesco Place de Fontenoy 75700 Paris, France	English (out of stock)
16	Workshop on the Western Pacific, Tokyo, 19-20 February 1979.	IOC, Unesco Place de Fontenoy 75700 Paris, France	English French Russian
17	Joint IOC/WMO Workshop on Oceanographic Products and the IGOSS Data Processing and Services System (IDPSS), Moscow, 9-11 April 1979.	IOC, Unesco Place de Fontenoy 75700 Paris, France	English
17 Suppl.	Papers submitted to the Joint IOC/WMO Seminar on Oceanographic Products and the IGOSS Data Processing and Services System, Moscow, 2-6 April 1979.	IOC, Unesco Place de Fontenoy 75700 Paris, France	English
18	IOC/Unesco Workshop on Syllabus for Training Marine Technicians, Miami, 22-26 May 1978 (Unesco reports in marine sciences, No. 4)	Division of Marine Sciences, Unesco Place de Fontenoy 75700 Paris, France	English (out of stock) French Spanish (out of stock) Russian
19	IOC Workshop on Marine Science Syllabus for Secondary Schools, Llantwit Major, Wales, U.K., 5-9 June 1978 (Unesco reports in marine sciences, No. 5).	Division of Marine Sciences, Unesco Place de Fontenoy 75700 Paris, France	English French Spanish Russian Arabic
20	Second CCOP-IOC Workshop on IDOE Studies of East Asia Tectonics and Resources, Bandung, Indonesia, 17-21 October 1978.	IOC, Unesco Place de Fontenoy 75700 Paris, France	English
21	Second IDOE Symposium on Turbulence in the Ocean, Liège, Belgium, 7-18 May 1979.	IOC, Unesco Place de Fontenoy 75700 Paris, France	English French Spanish Russian
22	Third IOC/WMO Workshop on Marine Pollution Monitoring, New Delhi, 11-15 February 1980.	IOC, Unesco Place de Fontenoy 75700 Paris, France	English French Spanish Russian
23	WESTPAC Workshop on the Marine Geology and Geophysics of the North-West Pacific, Tokyo, 27-31 March 1980.	IOC, Unesco Place de Fontenoy 75700 Paris, France	English Russian
24	WESTPAC Workshop on Coastal Transport of Pollutants, Tokyo, 27-31 March 1980.	IOC, Unesco Place de Fontenoy 75700 Paris, France	English (out of stock)
25	Workshop on the Intercalibration of Sampling Procedures of the IOC/WMO UNEP Pilot Project on Monitoring Background Levels of Selected Pollutants in Open-Ocean Waters, Bermuda, 11-26 January 1980.	IOC, Unesco Place de Fontenoy 75700 Paris, France	English (superseded by IOC Technical Series No. 22)
26	IOC Workshop on Coastal Area Management in the Caribbean Region, Mexico City, 24 September-5 October 1979.	IOC, Unesco Place de Fontenoy 75700 Paris, France	English Spanish
27	CCOP/SOPAC-IOC Second International Workshop on Geology, Mineral Resources and Geophysics of the South Pacific, Nouméa, New Caledonia, 9-15 October 1980.	IOC, Unesco Place de Fontenoy 75700 Paris, France	English
28	FAO/IOC Workshop on the effects of environmental variation on the survival of larval pelagic fishes Lima, 20 April-5 May 1980.	IOC, Unesco Place de Fontenoy 75700 Paris, France	English
29	WESTPAC Workshop on Marine biological methodology Tokyo, 9-14 February 1981.	IOC, Unesco Place de Fontenoy 75700 Paris, France	English
30	International Workshop on Marine Pollution in the South-West Atlantic Montevideo, 10-14 November 1980.	IOC, Unesco Place de Fontenoy, 75700 Paris, France	English (out of stock) Spanish
31	Third International Workshop on Marine Geoscience Heidelberg, 19-24 July 1982	IOC, Unesco Place de Fontenoy 75700 Paris, France	English French Spanish
32	UNU/IOC/Unesco Workshop on International Co-operation in the Development of Marine Science and the Transfer of Technology in the context of the New Ocean Regime Paris, 27 September - 1 October 1982	IOC, Unesco Place de Fontenoy 75700 Paris, France	English French Spanish

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1. OPENING, WELCOME AND ADMINISTRATION

The Workshop was opened at 09:00 on 31 October 1989 with introductory remarks by Admiral Tavorn Pongspipatt who was overall chairman of the meeting.

Dr. Suvit Vibulsresth, Deputy Secretary-General of National Research Council of Thailand, and Professor Dr. Salag Dhabananadana welcomed the participants to the Workshop and stressed the importance of the project as a fundamental building block for other disciplines and particularly for assessing pollution problems in the northern Gulf of Thailand.

On behalf of the Secretary IOC, Mr. Yihang Jiang, Assistant Secretary IOC, expressed gratitude and appreciation to the Government of Thailand, the National Research Council and Chulalongkorn University for hosting the Workshop and to all institutions and individuals who have contributed to the Workshop, and welcomed all the participants.

The workshop elected Dr. Mahunnop Bunpapong as Chairman of the session on national statements, and Drs. Suphat Vongvisessomjai and Jan Backhaus as joint Co-chairmen for the session on discussion of the project. The Workshop also appointed Dr. John Church as rapporteur and adopted the Agenda (Annex I).

2. INTRODUCTION OF BACKGROUND INFORMATION

The Project Leader, Dr. M.Bunpapong and the Representative of IOC introduced the background information regarding the development of the project which was adopted by the IOC Regional Committee for the Western Pacific (WESTPAC) at its Fourth Session, Bangkok, Thailand, 22-26 June 1987. It aims to complete a comparative study of physical oceanography of the shallow seas in the WESTPAC region.

On the basis of the discussions and decisions of the WESTPAC-IV, the IOC Secretariat prepared a project outline and circulated it to Member States of WESTPAC. Several countries kindly provided their comments on this project and most responses expressed interest in the project and willingness to combine the related national projects with the IOC/WESTPAC project.

Mr. Jiang also introduced a new IOC international programme, adopted by the Fifteenth Session of the IOC Assembly (Paris, 4-17 July 1989) "An International Programme for the Dynamics and Oceanography of Coastal and Shelf Seas and Exchanges: Rationale and Elements" (Document IOC/INF-769), as the background information to the participants.

He stressed the need to develop an action and implementation plan that could be presented to the upcoming First Session of the WESTPAC Sub-commission, Hangzhou, China, 5-9 February 1990.

3. STATEMENTS BY THE PARTICIPANTS ON THE STATUS OF PHYSICAL OCEANOGRAPHY STUDY IN THE COUNTRIES

The participants presented brief status reports on physical oceanography study in their own countries with special references to the continental shelf and coastal zone.

Australia

Drs. J. Church and E. Wolanski presented some results from recent Australian work, including results from the Australian Coastal Experiment, studies in the Gulf of Carpentaria and new estimates of sea level rise resulting from the greenhouse effect. They emphasized the importance of "trapping", either in a coastal boundary layer or around reefs. In the Gulf of Carpentaria, freshwater can be trapped in coastal boundary layer for several months. They also discussed how estuaries may be affected by a rise in sea level and showed results from models for the Gulf of Carpentaria and the Gulf of Thailand.

China

Professor Zhouwen Yu presented a broad ranging review of recent work completed by his colleagues. Of particular importance for this project was the work on currents, tides, tidal currents, storm surges and air/sea interaction. He introduced the results from Seven-years Comprehensive Investigation on the Coastal Zone in China, and indicated that these results are very helpful to the project.

Indonesia

Mr. Sujatno Birowo presented a summary of the circulation in the Indonesian region and the response of this circulation to the monsoon winds. He stressed the need for long-term measurements of currents so that estimates of the Pacific/Indian ocean through flow could be improved. He also noted that they had recently acquired one new research vessel and were expecting two more. They have requirements for further training of students and more expertise.

Federal Republic of Germany

Dr. J Backhaus presented the result of a 12-level primitive equation model that has been applied to the Southeast Asian region. He also presented results of modelling of the North Sea Area. He stressed the need to address a variety of time scales and the interaction between various forcing mechanisms (such as wind and tide).

Malaysia

Mr. Kwong Lum Tuen described the study done in Malaysian EEZ and various data sources available for the Malaysian region including a number of tide gauges (one of which is on an offshore oil production platform). Some air/sea heat fluxes had been calculated for specific periods but these fluxes are not available on a routine basis.

Thailand

Cdr. Vichai Panpruk summarized a number of studies conducted in the Gulf of Thailand. As a result of significant freshwater inflow and air/sea exchanges, the hydrographic conditions are complex with different regions being stratified in different seasons. There are a number of permanent tide gauges around the Gulf. There are 2 oceanographic vessels- a coastal oceanographic research ship and a deep sea oceanographic research ship.

Japan

Dr. T. Yanagi presented some results for a wind-driven model of the Gulf of Thailand and surrounding areas. For the example shown there was reasonable agreement between the observed and predicted sea level.

Dr. H. Nakata presented some very interesting results from a detailed section across a front south of Japan. He showed estimates of the horizontal convergence and subsequent downwelling at the front. This convergence was confirmed by the large concentration of eggs and larvae at the front.

Philippines

Dr. M. Collins outlined the oceanographic capabilities and interests of the Philippines. There are plans to study oceanographic aspects of red tides which area problem in Philippine waters. She also discussed a study of seiches in Puerto Princes harbor, Pahlawan, which appear to be generated by internal waves formed by the interaction of the tide and the bottom topography.

Viet Nam

Dr. Nguyen Ngoc Thuy described Viet Nam's oceanographic capability. They have six permanent tide gauges, one of which is on an oil production platform. He showed estimates of tidal currents and estimates of surface waves during a typhoon. He also showed results from some surveys including a map of surface dynamic height.

4. DISCUSSION OF PROJECT

4.1 INTRODUCTION OF THE PRELIMINARY PLAN

The co-chairmen, Professor Dr. Suphat Vongvisessomjai and Dr. Jan Backhaus, invited the project leader, Dr. Mahunnop Bunpapong, to introduce the project.

The project leader presented the draft preliminary scientific plan to the Workshop, including the scientific objectives, the areas proposed to be involved in the project, and the parameters which should be measured in the study,as well as data management.

After introduction of the project, a drafting group was established for preparation of a scientific research plan for the project.

The group included:

Dr. Mahunnop Bunpapong
Dr. John Church
Dr. Jan Backhaus
Dr. Tetsuo Yanagi

The drafting group was responsible for the preparation of the report of the Workshop and the scientific research plan.

4.2 GENERAL DISCUSSION OF THE PLAN

For the implementation of the project, it was agreed that the area should be kept as wide as possible and described in a general way. Estuaries were not to be specifically included although it was recognized they were important.

The areas to be considered for the initial sub-projects include:

- Gulf of Thailand
- North west coast of Borneo and the island of Pahlawan
- Malacca Strait and the Andaman Sea
- Gulf of Tonkin
- Pacific/Indian Ocean through flow region
- East China Sea
- Sulu Sea

For a number of the areas listed above, one of the dominant processes will be the tide and wind-induced currents. For the north-west coast of Borneo, an investigation of the observed upwelling would be a valuable scientific investigation.

It was agreed that air/sea fluxes should be added to the list of parameters to be measured and that some regrouping of the parameters to be measured was necessary.

Following the discussion of the Workshop, the drafting group was requested to rewrite the introduction, the review of physical oceanographic conditions and the objectives, based on the preliminary draft of scientific plan. The group also considered the structure of the scientific plan, including a strategy for implementation of the project and the needs required to implement the project at different levels of complexity.

The Workshop then considered the work of the drafting group and agreed that the linkages with applied problems (biology, sediments transportation and climate, etc.) needed to be stressed. After some minor rewording the new introduction was adopted.

4.3 DISCUSSION OF SCIENTIFIC PLAN

The Co-chairman, Dr. J. Backhaus, suggested that considerable time should be devoted to discussions in the ad hoc groups in order to make optimal use of the time so as to cover all items in depth.

Three ad hoc groups was formed and the report from each of these three groups follows.

Group 1

Members: Dr. Twesukdi Piyakarnchana
Dr. Zhouwen Yu
Dr. Hideaki Nakata
Mr. Kwong Lum Tuen

This group was responsible for drafting the sections on numbers referring to the draft presented by the Secretariat.

2.0 (Scientific Objectives)
3.0 (Review of Physical Oceanographic Conditions
4.0 (General Plan/Strategy)

The group decided to redraft the original objectives as discussed earlier in this workshop. It opted to refer to the document IOC/INF-761 on the Project Outline circulated by the IOC Secretariat. The final results in this section is a summary of the section 2.1 (Immediate Objectives) and section 2.2 (Long-term Objectives) in the above-mentioned document. This was presented to the panel in this workshop and no questions were raised.

The group did not manage to proceed with section 3.0 as it felt that there was a need to rewrite the whole section. The chairman finally decided on a short note by the Rapporteur and that statements summarizing oceanographic conditions in the respective participants regions be placed in the Annex 5.

The group submitted a draft of general strategy for the implementation of the project.

Group 2

Members: Dr. Eric Wolanski
Dr. Suphat Vongvisessomjai
Dr. Nguyen Ngoc Thuy
Dr. Tetso Yanagi
Dr. Margaret Goud Collins

The group worked from the research and execution plan outlines introduced it to the general session. The research plan, focusing on developing expertise to study progressively more complex physical systems, was refined only slightly. A section was added, listing implications of the circulation, in order to emphasize the practical value of research in

coastal physical oceanography.

The outline of a generalized research project was likewise adopted with minor modification. The group stressed the importance of identifying a core group of scientists from the beginning of a project. It was agreed that the plan was to be general enough for application to any physical oceanographic project in order to provide a framework for scientists making proposals under this program.

Group 3

Members:
Dr. Jan Backhaus
Dr. Yihang Jiang
Dr. Nahunnop Bunpapong
CDR Vichai Panpruk RTN
Mr. Sujatno Birowo

Group 3 was assigned to discuss several aspects of the programme, namely the training, data management structure and organization, mutual assistance and partnership.

Referring to the points of discussion, group 3 drew up several suggestions and proposals.

Following the Group Rapporteur reports the completed plan was discussed. Sections 2, 3 and 4 were accepted with minor rewording. For section 5 and 6, it was agreed that some additional clarifications were required in order to illustrate the research plan in a clearer way. Section 8 was accepted with some minor rewording.

The Workshop discussed and adopted the completed Scientific Plan (Annex IV).

4.4 OTHER MATTERS RELATED TO THE SCIENTIFIC PLAN

(i) The workshop felt unable at this stage to identify potential national contributions.

(ii) The workshop recommends a further meeting within six months of the closing of this workshop with the objective of implementing the first stages of implementation of the sub-projects in the region.

(iii) The workshop recognized the importance of necessary training in field observation, data analysis and modelling technique and suggested the IOC to organize relevant training activities ensuring the success of the project.

The Workshop adopted the Recommendations (Annex II).

5. ESTABLISHMENT OF A SCIENTIFIC STEERING GROUP (SSG)

The Workshop established a Scientific Steering Group (SSG) for the

implementation of the project. The members of the SSG are:

- Dr. Mahunnop Bunpapong
- Dr. Eric Wolanski
- Prof. Zhouwen Yu
- Dr. Tetsuo Yanagi
- Mr. Tuen Kwang Lum
- and the IOC Secretariat representative, for the time being Dr. Y. Jiang.

6. CLOSURE

The Co-chairman expressed appreciation to the participants for their strong involvement and excellent work during the Workshop. The Representative of IOC, on behalf of the Secretary IOC, thanked all participants for their work and expressed appreciation to the hosting institution, Chulalongkorn University and the members of secretariat of the Workshop.

The Co-chairman closed the Workshop at 17.00 hrs on Friday 3 November 1989.

ANNEX I

AGENDA

1. OPENING, WELCOME AND ADMINISTRATION

2. BACKGROUND INFORMATION

3. STATEMENTS BY THE PARTICIPANTS ON THE STATUS OF PHYSICAL OCEANOGRAPHY STUDY IN THEIR OWN COUNTRIES

4. DISCUSSION OF THE PROJECT

5. ADOPTION OF THE REPORT AND FINALIZATION OF THE SCIENTIFIC PLAN

ANNEX II

RECOMMENDATIONS

Recommendation 1

The Workshop, recognizing the importance of the field observations, data analysis and modeling techniques for the success of the project, recommends that IOC and SC-WESTPAC organize relevant training courses in the above-mentioned aspects in the region.

Recommendation 2

The Workshop, considering the necessity of financial support for the successful implementation of the project, recommends that IOC identifies extra-budgetary funding from other agencies and institutions.

Recommendation 3

The Workshop, noting the needs for developing further implementational and observational plans, suggests that IOC and WESTPAC organize another Workshop for the preparation of the plan for the sub-regional project.

ANNEX III

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ANNEX IV

SCIENTIFIC PLAN

1. INTRODUCTION

World wide the sea is used as a valuable source of protein, oil and gas and as a sink for wastes. This in particular applies to shelf and coastal seas. In view of the demands of a rapidly growing world population, these areas deserve special attention and a better understanding of the marine environment is required. The circulation provides the transport means for living and non-living material within the sea and therefore plays a key role.

On the other hand, the dynamical phenomena in these shallow sea areas are specially complicated compared with that in the deep ocean owing to the existence of lateral boundary, shallow depth, and river discharge. A cooperative study of the circulation on these areas will lead to a better understanding of the dynamical phenomena, and an advancement of physical oceanography.

The high population density in the WESTPAC region demands the placement of a special weight on a joint cooperative study devoted to the understanding of the circulation in Western Pacific shelf and coastal seas, with emphasis on Southeast Asian seas. In particular the main driving forces of the circulation and its variability and energetics shall be studied on different levels of complexity.

2. SCIENTIFIC OBJECTIVES

(i) Understanding of the major features of the circulation, its associated energetics and variability. These include the main characteristics of river discharges, density flow, tidal currents, wind driven currents and other factors which contribute to this circulation.

(ii) Identification and understanding of the fundamental mechanisms of the circulation and their variabilities.

(iii) Development of circulation models for shelf sea areas.

(iv) Identification and quantification of implications of the circulation for the distribution of biological, chemical and sedimentological properties to provide better understanding of processes important for the transport of pollutants.

(v) Establishment of a network of observation systems for physical oceanographic parameters in the coastal and continental shelf seas.

3. REVIEW OF PHYSICAL OCEANOGRAPHIC CONDITIONS

Based on the relevant literature and the presentations of the IOC Workshop, a number of gaps in the existing knowledge were identified. Rather than present a complete review here, one page abstracts which summarize recent progress in physical oceanographic studies in the region are attached.

The results of the Workshop discussion is the research plan presented in sections 5 and 6.

4. GENERAL OUTLINE OF STRATEGY

In order to achieve the objectives outlined in section 2 above and based on the reports on the state of development of oceanographic studies undertaken by various member states of the WESTPAC, the following is the proposed strategy for the study of the continental shelf seas and coastal waters.

(i) The development of an implementation plan based on the research plan and the commitments given by the participants.

(ii) The establishment of a Scientific Steering Group (SSG) to monitor and to provide guidance for the implementation of the research plan.

(iii) The identification of a data centre for this programme. This centre should be responsible for the collection of data from and dissemination to participating nations, institutions and individuals.

(iv) The conduct of training courses for the handling of equipment, data processing and modeling.

(v) The holding of academic seminars and workshops to exchange experience, research results, etc.

(vi) The seeking of the necessary resources (financial support, ship time, instruments, etc.) from organizations for the implementation of the project.

5. RESEARCH PLAN (PROCESS ORIENTED)

The research plan outlined in this section is meant as a guide for progressive development of a comprehensive physical oceanography research programme in shelf and coastal seas regions. The first three main sections reflect increasing levels of complexity and, therefore, increasing scientific sophistication in their study. The final section lists some of the practical considerations which motivate interest in coastal physical oceanography in the WESTPAC region. For example, understanding of many aspects of fisheries ecology, pollutant transport, or red tide cycles depends on physical oceanography as well as does better prediction of storm surges and regional sea level changes possibly induced by global climatic

changes. In order to attack these problems a local expertise and data base, beginning with the simplest barotropic processes and progressing along the lines outlined, must be developed.

5.1 BAROTROPIC PROCESSES

Several important features of the ocean circulation are largely insensitive to any density differences in the water masses. These barotropic processes should be the first to be studied, as they refer to the most obvious features of the circulation, including the effects of tides and winds.

5.1.1 **Tidal effects**

- Tidal sea levels
- Tidal currents
- Tide-induced residual circulation

5.1.2 **Wind effects**

- Monsoon-induced circulation
- Tropical storm effects (e.g. storm surges, mixing)

5.1.3 **Barotropic instability**

5.2 BAROCLINIC PROCESSES

Baroclinic currents are controlled by the density differences in the water masses, which are caused by differences in temperature and/or salinity. They are usually important near the coast and at the shelf break, and can be significant in the practical implications listed below.

5.2.1 **The general circulation (geostrophic flow)**

5.2.2 **Local dynamics**

- River inputs
- Eddies
- Fronts
- Upwelling

5.2.3 **Buoyancy fluxes**

- Heat
- Horizontal mass fluxes (freshwater/salt)
- Vertical mass fluxes (evaporation/precipitation)

5.2.4 **Baroclinic instability**

5.3 INTERACTIONS OF PROCESSES

In many cases, various currents (tidal, induced by winds, internal circulation) interact with each other and with the topography to generate a

net circulation. This net circulation may be very different from the sum of the different forcing currents, and has important practical implications:

- Net circulation driven by winds, tides and buoyancy (e.g. coastal boundary layer, etc.)
- Tidal eddies (island wakes, flows within embayments)
- Cross shelf transport (advection and mixing)

5.4 IMPLICATIONS OF THE CIRCULATION

A proper understanding of the water circulation is necessary for several applications which lead to understanding of chemical, biological and sedimentological processes. Although the level of scientific sophistication necessay will vary from site to site, key implications of the circulation include the following processes:

- Suspended sediment transport
- Transport of dissolved and particulate pollutants
- Ecology and dispersal of red tide organisms
- Distribution of larvae and eggs
- Spawning conditions and related triggering mechanisms.

5.5 PARAMETERS TO BE MEASURED INCLUDE

- Temperature, Salinity
- Sea level
- Currents
- Dissolved oxygen, Nutrients, pH
- Air/sea fluxes (heat, freshwater, momentum)
- Air pressure, wind velocity
- Lateral fluxes (river discharge, heat)
- Turbidity
- Bathymetry

6. IMPLEMENTATION PLAN

This section outlines the steps necessary for implementation of any projects defined in Section 5. The success of this project depends critically on identifying scientists with sufficient interest to acquire the necessary resources. The background research, field program and modeling can then proceed within the framework defined below.

6.1 DETERMINATION OF CORE GROUP OF SCIENTISTS

These scientists are to act as principle investigators, with actual responsibility for completion of the project.

6.2 INITIAL PHASE OF RESEARCH

This is the scientific planning effort.

6.2.1 **Analysis, exchange and synthesis of historical data**

6.2.2 **Identify gaps in data**

6.2.3 **Preliminary modeling based upon historical data**

6.2.4 **Development of field strategy from synthesis of 6.2.1-3.**

6.3 EXECUTION OF RESEARCH STRATEGY

This stage builds on the existing knowledge with the collection of new data and the synthesis of these data with efforts in modeling.

6.3.1 **Joint field exercises**

6.3.2 **Data analysis**

6.3.3 **Comprehensive modeling, based on field and historical data**

6.3.4 **Model verification**

6.3.5 **Application of model for forecasting and practical needs (e.g. pollutant and larval transport, etc.)**

6.3.6 **Formulation of new hypotheses based on model**

6.4 PUBLICATION AND DISSEMINATION OF RESULTS

This step is essential for scientists to maintain interest in these projects.

6.5 **Archiving of observed and modeled data in data center (see section 8).**

General scientific access in the WESTPAC region to these data is essential for successful continuation of research programmes.

7. **TRAINING**

7.1 AREAS COVERED

Three areas of training are identified as necessary for the implementation of the research plan. These include:

- Field survey (including navigation, technical and practical use of instruments)
- Analysis of Data
- Modeling techniques.

These training courses will be conducted separately and with a suitable period for each.

7.2 SELECTION CRITERIA

The national co-ordinator shall forward the list of scientists

with experience in the respective areas of training to the training institutions. The list should not contain more than 3 candidates for each area of training. The training institute will make the final selection of the successful candidate.

The candidates who have completed their training courses are expected to be involved directly in the research outlined in section 5 to ensure the successful implementation of the scientific objective in their national maritime areas.

8. DATA MANAGEMENT AND EXCHANGE

The IODE format (GF3) is to be used as a standard format.

The Responsible National Oceanographic Data Center for Western Pacific (RNODC-WESTPAC) is selected as a center for data exchange network.

The data obtained through this project will be available to the community at large two years after initial processing of the data.

To ensure compatibility of exchanged data, an IBM compatible microcomputer floppy diskette (1.2 MB) should be used for data storage and exchange.

9. STRUCTURE AND ORGANIZATION

A Scientific Steering Group (SSG) has been established. The responsibilities of the SSG are to monitor the progress of research project, to give advice and guidance.

10. MUTUAL ASSISTANCE

Mutual assistance among WESTPAC members is encouraged. Co-operation between non-member and member states to carry out research relevant to this research plan within WESTPAC region is also desirable.

ANNEX V

ABSTRACTS OF THE PRESENTATIONS

PHYSICAL OCEANOGRAPHY IN P.R. CHINA

Prof. Zhouwen Yu

1. **OBSERVATIONAL AND MONITORING SYSTEM ESTABLISHED**

   (i) Research Vessel: More than 60 (Tonnage > 10000 ton,3; Tonnage > 3000 ton,9)
   (ii) Buoy = 12
   (iii) Research airplane = 2
   (iv) Coastal monitoring station = 58

2. **OCEANIC SERVICE SYSTEM**

Marine Environment Forecast Center (with more than 150 scientists and two advanced computers)

National Oceanography Data Center (with more than 200 scientists and one advanced computer)

World Oceanography Data Center D (in Tian Jin)

3. **SUBJECTS RECEIVING INTENSIVE STUDY**

   (i) Hydrology condition (Distribution of S, T, DO. pH (in the seas near China)
   (ii) Plumes
   (iii) Ocean circulation and currents in the coastal zone
   (iv) Wind waves and swell
   (v) Tides and Tidal currents
   (vi) Storm Surges
   (vii) Air-Sea Interaction.

4. **LARGE-SCALE FIELD INVESTIGATIONS CARRIED OUT OR BEING CARRIED OUT**

   (i) National Comprehensive Investigation (1958-1962, more than 50 R/Vs. were used, more than 400 stations were selected).
   (ii) Comprehensive Investigation in coastal zone (coastal area investigation about 360 000 km^2, involved about 1500 person. Data and report were published in 300 volumes)
   (iii) Scientific Investigation on West Pacific (1983-1986, 2 R/Vs used, total observing days about 110 days)
   (iv) China-US co-operative investigation of Air-Sea Interaction in the Tropical West Pacific (2 cruises/year, 60 days/cruise, 1985-1990, total cruises = 8)
   (v) China-Japan co-operative Investigation of Kuroshio (1986-1992, 2 cruises/year, 3-4 R/Vs/cruise, 60 days/cruise)
   (vi) There were some other large-scale Investigations, but the above-mentioned are specially related to physical oceanography.

CIRCULATION IN THE INDONESIAN WATERS

S. Birowo

The Indonesian archipelago is situated between Asia and Australia and between the Pacific and the Indian Ocean. Its waters form a geographical unit with complex structures and characteristics the numerous large and small islands separate its many seas, which are connected by channels and passages of varying widths and depths. Almost all types of bottom topography are found in the Indonesian waters including continental shelf (Sunda shelf in the west and Sahul shelf in the east) and deep basins (basins and troughs) in between.

In Oceanographic terms most of Indonesia's seas are part of the Pacific ocean which is separated from the Indian ocean by the islands of Sumatra, Java, Bali, Lombok, Sumbawa, Semba, Timor and Melville. Both accessibility to the Pacific ocean and dynamic conditions seem to be the cause of this phenomenon. The Indonesia's seas are also under the strong influence of the monsoon blowing between Asia and Australia. The effect of the monsoon on the oceanographic characteristics of the Indonesian waters can be clearly seen, especially in the upper layer. From October to March the so-called northwest monsoon blows mainly from west to east in most part of Indonesia. From April to September the southeast monsoon blows from east to west.

Because of their constancy and regularity, the monsoons are capable of generating and sustaining surface current. The geographic lay out of most of Indonesia's seas favour this development since the line connecting seas (South China Sea, Java Sea, Flores Sea, Arafura Sea and Banda Sea) is parallel to the axis of the monsoon. Thus, as the monsoon change direction twice a year, the surface water circulation is also reversed over a large area. The Sunda shelf, including the Southern China Sea, the Gulf of Thailand and the Java sea in particular is excellent site for further study the effect of monsoon on water circulation.

The Pacific ocean water spreads through the eastern Indonesia's seas into the Indian ocean. A number of investigators have estimated the magnitude of the Pacific to Indian transport. The average of all estimates is about 9.2 Sv (1 So = $10^6 m^3 s^{-1}$). It seems that all investigators agree about the direction of through flow, but there is a wide range of estimates of its magnitude. More investigation is needed.

Reportedly, upwelling occur in the Indonesia's seas such as the Banda and Arafura Seas, Molluca and Halmahena Seas and in the Indonesia's Exclusive Economic Zone such as south of Java-Husa Tenggara and north of Irian Jaya. Upwelling is important from an oceanographic as well as biological point of view.

Marine research activities in Indonesia are mostly carried out by government research institutions, agencies and universities.

The Center for Oceanological Research and Development of LIPI, is engaged in several marine research programs including physical oceanographic research.

The Hydro-oceanographic services of the Navy is engaged in bathymetric mapping and studying tides, current, sea level and hydrological parameters.

The Marine Fisheries Research Institute of the Ministry of Agriculture is engaged in fisheries research, including biological aspect, marine culture and stock assessment of commercially interesting marine biotas.

The Meteorological and Geophysical Agency of the Ministry of Communication is interested in studying the physical properties of the sea, especially in the surface layer.

The Indonesian National Institute of Aeronautics and Space is conducting research in the application of remote sensing technique using satellite images in the studies of the upper sea surface layer.

Universities such as Bogor Agricultural University, University of Diponegoro are also conducting research in biology, fishery and oceanography.

PHYSICAL OCEANOGRAPHIC CONDITION IN JAPAN

T. Yanagi and H. Nakata

At about 60 tide gauge stations we are measuring sea level every hour around Japan and the oldest 10 stations have worked successively in about 100 years.

Recently long-term (months) current meter measurements have been carried out at many stations in coastal and shelf seas around Japan and in the East China Sea in order to clarify the long-term variability of the coastal and shelf sea circulations. These data are also used to verify the numerical model which has been developed to estimate the material transport including living ones such as fish eggs and larvae in the coastal and shelf seas. Moreover the ADCP (Acoustic Doppler Current Profiler) has began to be used in order to clarify the detailed current distributions around coastal fronts and eddies.

The remote sensing measurements using satellites have become valuable for detection of temporal and spatial variabilities of coastal circulations including fronts and eddies.

About 300 physical oceanographers are working in 15 universities and 20 governmental institutes which carry out studies of physical oceanography. All the observations of water temperature are gathered in JMA (Japan Meteorological Agency) in real time and JMA publishes the chart of horizontal water temperature at several depths around Japan every 10 days. Moreover charts of all oceanographic data including water temperture, salinity, current, DO, and nutrients have been complied at JODC (Japan Oceanographic Data Center) for general use.

AN OVERVIEW OF PHYSICAL OCEANOGRAPHY STUDIES UNDERTAKEN IN MALAYSIA

Kwong Lum Tuen

The declaration of the Malaysian Exclusive Economic Zone (EEZ) in 1980 has bestowed upon the Nation the sovereign rights to explore, exploit, conserve and manage the marine resources within a maritime area equivalent to 4 times her land area. A good data set on marine meteorology and oceanography is required to support the above mentioned activities. In an effort to build a good data base, the Malaysian Meteorological Service (MMS) has initiated a data acquisition programme for the acquisition of marine meteorological and oceanographic data in the coastal as well as the continental shelf seas of the EEZ, while the Malaysian Department of Survey and Mapping has set up a network of tidal stations to monitor sea level along the coast of Peninsular Malaysia. The Royal Malaysian Navy is presently maintaining 5 tidal stations in the coastal water under the ASEAN-Australia Cooperative programme of Tides and Tidal Phenomena. The University of Agriculture Malaysia and the Department of Fishery have carried out scientific expeditions in the coastal and continental shelf waters of the EEZ to investigate physical oceanography, chemical oceanography and pollution, biological oceanography, and biology as well as the living resources. It is recognized that the present data set complied by the MMS and other agencies is still inadequate and more effort is required to ensure that meaningful investigation on the near shore processes could be conducted in the Malaysian EEZ.

THE PHYSICAL OCEANOGRAPHIC STUDY IN THE GULF OF THAILAND

CDR. Vichai Panpruk, RTN.

The physical oceanography conditions in Thailand are observed and analyzed by the Hydrographic Department, Royal Thai Navy, and other Thai agencies and organizations. The data as well as reports are obtainable on request to the Government agencies in Thailand and abroad. The circulation, mass transport and currents in the Gulf are as well as the distribution of temperature, salinity, density and current measurements. These indicated that there occur a complex mixtures of tides, wind and density driven currents at a localized rather than a large scale. In the upper Gulf and all the coastal region, where land-based pollution is discharged to the sea, the knowledge of circulation, of mass transport and current processes are important in studying pollutant transport as well as in the whole Gulf.

REPORT ON AUSTRALIAN CONTINENTAL SHELF OCEANOGRAPHIC RESEARCH

J. Church and E. Wolanski

There have been detailed process-oriented field, analytical and numerical investigations of the water circulation around several continental shelves, primarily the North-West shelf, the South Australian Gulf, the South-East Australian coast, Bass Strait, Torres strait, the Great Barrier

Reef and the Gulf of Carpentaria. These studies have concentrated on barotropic and baroclinic tides and the wind-driven criculation. Important spin-offs of major oceanographic experiments, such as ACE, have been a sound understanding of dynamics of continental shelf waves, including their generation and propagation, and a better understanding of density flows and the interaction between the deep ocean and the shelf. Coastal oceanography research has emphasized the water circulation around islands, reefs and headlands, the coastal boundary layer trapping effects, the role of mangrove swamps, and fluidization of mud. Oceanographic research often focuses on multi-disciplinary topics, such as the influence of the water circulation on Penaeid prawn ecology in the Gulf of Carpentaria, and on the fate of coral eggs in the Great Barrier Reef.

ANNEX VI

TERMS OF REFERENCE OF THE SCIENTIFIC STEERING GROUP (SSG) FOR THE PROJECT ON CO-OPERATIVE STUDY OF THE CONTINENTAL SHELF CIRCULATION IN WESTERN PACIFIC

1. FUNCTION

1.1 Identify regional and sub-regional problems of the continental shelf circulation and prepare appropriate project proposals and scientific plans for their study in consultation with the Member States concerned;

1.2 Prepare relevant guidelines for the implementation of the programme and related projects in the region, including for field observation programmes, data quality assurance, analysis and exchange and modeling techniques;

1.3 Assist with the identification of training, education and mutual assistance needs as well as equipment requirements, and provide related scientific and technical advice;

1.4 Co-ordinate the implementation of the regional and sub-regional projects and, in consultation with the Chairman of the IOC Sub-commission for WESTPAC and IOC Regional Secretariat for WESTPAC, organize scientific seminar to summarize the results of the programme;

1.5 Report, through the Project Leader, to the Sub-commission for the Western Pacific on the progress of the project including implementation, results and experiences; and

1.6 Assist Member States and the Secretariat in providing interpretation of the results for the use by Member States in relation to resource and marine environment protection oriented activities and decision making.

2. SCIENTIFIC AND TECHNICAL ADVICE

In discharging its tasks, the Group will be guided by the overall scientific objectives and research strategy formulate by the Workshop on the project, with support of the Secretariat.

3. COMPOSITION

The SSG will be composed of specialists from the region, selected in their personal capacity for their scientific of technical expertise.

No.	Title	Publishing Body	Languages
32 Suppl.	Papers submitted to the UNU/IOC/Unesco Workshop on International Co-operation in the Development of Marine Science and the Transfer of Technology in the Context of the New Ocean Regime Paris, 27 September-1 October 1982	IOC, Unesco Place de Fontenoy 75700 Paris, France	English
33	Workshop on the IREP Component of the IOC Programme on Ocean Science in Relation to Living Resources (OSLR) Halifax, 26-30 September 1983	IOC, Unesco Place de Fontenoy 75700 Paris, France	English
34	IOC Workshop on Regional Co-operation in Marine Science in the Central Eastern Atlantic (Western Africa) Tenerife 12-17 December 1983	IOC, Unesco Place de Fontenoy 75700 Paris, France	English French Spanish
35	CCOP/SOPAC-IOC-UNU Workshop on Basic Geo-scientific Marine Research Required for Assessment of Minerals and Hydrocarbons in the South Pacific Suva, Fiji, 3-7 October 1983	IOC, Unesco Place de Fontenoy 75700 Paris, France	English
36	IOC/FAO Workshop on the Improved Uses of Research Vessels Lisbon, 28 May - 2 June 1984	IOC, Unesco Place de Fontenoy 75700 Paris, France	English
36 Suppl.	Papers submitted to the IOC-FAO Workshop on Inproved Uses of Research Vessels Lisbon, 28 May-2 June 1984	IOC, Unesco Place de Fontenoy 75700 Paris, France	English
37	IOC/Unesco Workshop on Regional Co-operation in Marine Science in the Central Indian Ocean and Adjacent Seas and Gulfs Colombo, 8-13 July 1985	IOC, Unesco Place de Fontenoy 75700 Paris, France	English
37 Suppl.	Papers submitted to the IOC/Unesco Workshop on Regional Co-operation in Marine Science in the Central Indian Ocean and Adjacent Seas and Gulfs Colombo, 8-13 July 1985	IOC, Unesco Place de Fontenoy 75700 Paris, France	English
38	IOC/ROPME/UNEP Symposium on Fate and Fluxes of Oil Pollutants in the Kuwait Action Plan Region Basrah, Iraq, 8-12 January 1984	IOC, Unesco Place de Fontenoy 75700 Paris, France	English
39	CCOP (SOPAC)-IOC-IFREMER-ORSTOM Workshop on the Uses of Submersibles and Remotely Operated Vehicles in the South Pacific Suva, Fiji, 24-29 September 1985	IOC, Unesco Place de Fontenoy 75700 Paris, France	English
40	IOC Workshop on the Technical Aspects of Tsunami Analyses, Prediction and Communications Sidney, B.C., Canada, 29-31 July 1985	IOC, Unesco Place de Fontenoy 75700 Paris, France	English
40 Suppl.	IOC Workshop on the Technical Aspects of Tsunami Analyses, Prediction and Communications *Submitted Papers* Sidney, B.C., Canada, 29-31 July 1985	IOC, Unesco Place de Fontenoy 75700 Paris, France	English
41	*First Workshop of Participants in the Joint* FAO/IOC/WHO/IAEA/UNEP Project on Monitoring of Pollution in the Marine Environment of the West and Central African Region (WACAF/2) Dakar, Senegal, 28 October - 1 November 1985	*IOC, Unesco* Place de Fontenoy 75700 Paris, France	*English*
42	IOC/UNEP Intercalibration Workshop on Dissolved/Dispersed Hydrocarbons in Seawater Bermuda, USA, 3-14 December 1984 (in press)	IOC, Unesco Place de Fontenoy 75700 Paris, France	English
43	*IOC Workshop on the Results of MEDALPEX* and Future Oceanographic Programmes in the Western Mediterranean Venice, Italy, 23-25 October 1985	*IOC, Unesco* Place de Fontenoy 75700 Paris, France	*English*
44	IOC/FAO Workshop on Recruitment in Tropical Coastal Demersal Communities Ciudad del Carmen, Campeche, Mexico, 21-25 April 1986	IOC, Unesco Place de Fontenoy 75700 Paris, France	English (out of stock) Spanish
44 Suppl.	IOC/FAO Workshop on Recruitment in Tropical Coastal Demersal Communities - *Submitted Papers* Ciudad del Carmen, Campeche, Mexico, 21-25 April 1986	IOC, Unesco Place de Fontenoy 75700 Paris, France	English
45	IOCARIBE Workshop on Physical Oceanography and Climate Cartagena, Colombia, 19-22 August 1986	IOC, Unesco Place de Fontenoy 75700 Paris, France	English
46	Reunión de Trabajo para Desarrollo del Programa «Ciencia Oceanica en Relación a los Recursos No vivos en la Región del Atlantico Sudoccidental Porto Alegre, Brazil 7-11 de Abril de 1986	IOC, Unesco Place de Fontenoy 75700 Paris, France	Spanish
47	IOC Symposium on Marine Science in the Western Pacific: The Indo-Pacific Convergence Townsville, 1-6 December 1986	IOC, Unesco Place de Fontenoy 75700 Paris, France	English
48	IOCARIBE Mini-Symposium for the Regional Development of the IOC-UN (OETB) Programme on "Ocean Science in Relation to Non-Living Resources (OSNLR)"	IOC, Unesco Place de Fontenoy 75700 Paris, France	English Spanish
49	AGU-IOC-WMO-CPPS Chapman Conference: An International Symposium on "El Niño" Guyaquil, Ecuador, 27-31 October 1986	IOC, Unesco Place de Fontenoy 75700 Paris, France	English
50	*CCAMLR-IOC Scientific Seminar* on Antarctic Ocean Variability and its Influence on Marine Living Resources, particularly Krill (organized in collaboration with SCAR and SCOR) Paris, France, 2-6 June 1987	*IOC, Unesco* Place de Fontenoy 75700 Paris, France	*English*
51	CCOP/SOPAC-IOC Workshop on Coastal Processes in the South Pacific Island Nations, Lae, Papua-New Guinea, 1-8 October 1987	IOC, Unesco Place de Fontenoy 75700 Paris, France	English
52	SCOR-IOC-Unesco Symposium on Vertical Motion in the Equatorial Upper Ocean and its Effects upon Living Resources and the Atmosphere Paris, 6-10 May 1985	IOC, Unesco Place de Fontenoy 75700 Paris, France	English
53	IOC Workshop on the Biological Effects of Pollutants Oslo, 11-29 August 1986	IOC, Unesco Place de Fontenoy 75700 Paris, France	English
54	Workshop on Sea-level Measurements in Hostile Conditions Bidston, UK, 28-31 March 1988	*IOC, Unesco* Place de Fontenoy 75700 Paris, France	*English*
55	IBCCA Workshop on Data Sources and Compilation Boulder, Colorado, 18-19 July 1988	IOC, Unesco Place de Fontenoy 75700 Paris, France	English
56	IOC/FAO Workshop on Recruitment of Penaeid Prawns in the Indo-West Pacific Region (PREP) Cleveland, Australia, 24-30 July 1988	IOC, Unesco Place de Fontenoy 75700 Paris, France	English
57	IOC Workshop on International Co-operation in the Study of Red Tides and Ocean Blooms Takamatsu, Japan, 16-17 November 1987	IOC, Unesco Place de Fontenoy 75700 Paris, France	English