# ABSTRACTS BOOK

# International Conference on the International Oceanographic Data & Information Exchange in the Western Pacific (IODE-WESTPAC) 1999,

## ICIWP '99

*"The needs of scientific research programmes for oceanographic and coastal data"*

**Date : 1st – 4th November 1999**
**Venue : Pelangi Beach Resort, Langkawi, Malaysia**

***Organised by***

Intergovernmental Oceanographic Commission (IOC), UNESCO

***In collaboration with***

Japan Oceanographic Data Center (JODC), Hydrographic Department, MSA, Japan
Oceanographic Research Coordination Committee of Malaysia

***With support from***

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Marine Information Research Center (MIRC), Japan
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# INDEX

## SEMINAR ON "OCEANOGRAPHY AND MARINE SCIENCE"


| | | *Page* |
|---|---|---|
| **SESSION 1;** | **Coastal Environment** - ***Data Requirements, Needs & Products*** | *1* |
| **Keynote:** | **Ocean Circulation in the Asian Waters**<br>*Prof. Dr. Tetsuo Yanagi, Research Institute for Applied Mechanics, Kyushu University, Japan* | *3* |
| **CE01:** | **Tidal Dynamic in Malacca Straits**<br>*Lcdr. Drs. Dede Yuliadi, Indonesian Navy* | *4* |
| **CE02:** | **Potential use of Satellite Altimeter Data for the Determination of the Leading Tidal Constituents for the Marine Region of Peninsular Malaysia**<br>*Muhammad Nur JP Vella, Centre for Geodetic and GPS Studies (CGGS), Faculty of Geoinformation Science & Engineering, UTM, Malaysia* | *5* |
| **CE03:** | **Contribution of National Tidal Data Centre in Research and Development Activities in Indonesia**<br>*First Admiral Mohamad Makmur Sulaeman, Indonesian Navy Dishidors TNI-AL, Indonesia* | *6* |
| **CE04:** | **Characteristic Scales in Coastal and Limnological Processes: Implications in Data Sparse Environment**<br>*Dr. Koh Hock Lye, School of Mathematical Science, Universiti Sains Malaysia, Malaysia* | *7* |
| **CE05:** | **The National Environment and Resource Information Center (NERIC) and Coastal Zone Management in Vietnam**<br>*Prof. Dr. Bui Cong Que, Vietnam National Oceanographic Data Center, Vietnam* | *8* |
| **CE06:** | **Straits of Malacca Management Compliance and Information System (SOMMACIS)**<br>*Prof. Mohd Ibrahim Mohammed, Dept. of Environmental Science, Faculty of Science & Environmental Studies, Universiti Putra Malaysia, Malaysia* | *9* |
| **CE07:** | **Research and Data Needs in Managing Coastal Erosion**<br>*Assoc. Prof. Hadibah Ismail, Coastal & Offshore Engineering Institute, Universiti Teknologi Malaysia, Malaysia* | *10* |
| **CE08:** | **Seasonal Shoreline Characteristics of the Open Muddy Beach of the Pantai Punggur, Malaysia**<br>*Assoc. Prof. Dr. Ahmad Khairi Abd. Wahab, Hydraulic & Hydrology Department, Faculty of Civil Engineering, Universiti Teknologi Malaysia, Malaysia* | *11* |
| **CE09:** | **Some Behaviours of Strongest Short-term Coastal Change Induced by Cross-shore Wave Energy Flow and Corresponding Theoretical Consideration**<br>*Dr. Le Phuoc Trinh, Institute of Oceanography of Vietnam, Vietnam* | *12* |
| **CE10:** | **Restoration of the Breakwater of Fishing Harbour in Thangassery, Kerala**<br>*Mr. K.K.Raveerdran, Harbour Engineering Department, India* | *13* |
| **CE11:** | **Rapid Reef Mapping- An Attempt with Hydroacoustic Method**<br>*Lee Yew Jin, Elcee Instrumentation Sdn Bhd, Malaysia* | *14* |
| **CE12:** | **The Role of International Organizations in the Study of Rivers & Sea Coastal Area Interaction**<br>*Dr. I.Oliounine, IOC/UNESCO, France* | *15* |
| **CE13:** | **Real-Time Information System for Sustainable Management of Shared Coastal Waters: Gulf of Thailand as a Demonstration Site**<br>*Dr. Anond Snidvongs, Marine Science Dept., Chulalongkorn University, Thailand* | *16* |

*Page*

**CE14:** **Role and Contribution of Oceanographic Research in Maritime Policy Making in Malaysia** *18*
*Mr. Mohd. Nizam Basiron, Center for Marine and Coastal Environment, Maritime Institute of Malaysia, Malaysia*

**CE15:** **Data Necessary for an Effective Hydraulic Study: The Malaysian Scenario** *19*
*Iwan Tan bin Sofian Tan, Hydec Engineering Sdn Bhd, Malaysia*

**CE16:** **Effective Coastal Management Strategies in the Era of Hydroinformatics - A UTM Focus** *20*
*Faridah Jaffar Sidek, Coastal & Offshore Engineering Institute, Universiti Teknologi Malaysia, Malaysia*

**SESSION 2; Data Management Activities and Technical Developments** *21*

**Keynote:** **Technical Developments in Marine Data Management** *23*
*Mr. Ben Searle, Chairman, IODE Committee of IOC, Head of Australian Oceanographic Data Center, Australia*

**DM01:** **The Use of Autonomous Solar Electric Research Vessel to obtain Oceanographic Data** *24*
*Peter Thomas, Dept. of Software & Electronic Eng, Central Institute of Technology, New Zealand*

**DM02:** **Digital Marine Mapping of Indonesian Waters** *25*
*Mr. Suharto Widjojo, National Coordination Agency for Surveys & Mapping (BAKOSURTANAL), Indonesia*

**DM03:** **An Internet Server for the Visualisation of Gridded Oceanographic Data** *26*
*Dr. Greg Reed, Australian Oceanographic Data Center, Australia*

**DM04:** **VODC for PC 2.0 (the Software for Integrated Oceanographic Data Management)** *27*
*Tac Van Vu, Institute of Oceanography, Nha Trang, Vietnam, Vietnam*

**DM05:** **Quality Control Software which is easily applicable to Oceanographic Data Processing in Data Originators** *28*
*Dr. Toru Suzuki, Marine Information Research Center, Japan*

**DM06:** **Marine Data and Information Management in Vietnam** *29*
*Dr. Van Moi Nguyen, Marine Hydrodynamic Research, Vietnam*

**SESSION 3; Living Marine Resources - *Data Requirements, Needs & Products*** *31*

**Keynote:** **Utilization of Biological Data for IODE system in the WESTPAC area** *33*
*Prof. Dr. Makoto Terazaki, Ocean Research Institute, University of Tokyo, Japan*

**LMR01:** **Distribution of Intertidal Meiobenthos in Langkawi Island Malaysia** *34*
*Dr. Idris Abdul Ghani, Dept. of Biology, Faculty of Science & Environmental Studies, Universiti Putra Malaysia, Malaysia*

**LMR02:** **Seagrass Ecosystem in Indonesia: A Case Study in Lombok Island** *35*
*Mr. Muhammad Husni Azkab, Research & Development Center for Oceanography, Indonesian Institute of Sciences, Indonesia*

**LMR03:** **Leaf Growth, Production and Ecosystem Dynamics of Toothed Seagrass *Cymodocea serrulata* (R. Br.) Aschers. et Magnus in Port Dickson, Malaysia** *36*
*Abu Hena M. Kamal, Dept. of Biology, FSAS, Universiti Putra Malaysia, Malaysia*

**LMR04:** **Some Observations on the Impacts of the Indo-Pacific Region 1998 SST Anomalies on Local Coral Communities** *37*
*Dr. Kushairi Mohd Rajuddin, Department of Fisheries, Southeast Asia Fisheries Development Center, Malaysia*

*Page*

**LMR05:** **Ecological Aspects of Oceanic Squid, *Stenoteuthis oualaniensis* (Lesson) in the South China Sea, West Coast of Philippines** *38*
*Dr. Somboon Siriraksophon, Geomatics Research Division Southeast Asian Fisheries Development Center, Thailand*

**LMR06:** **Coccolithophorids (Nanoplankton) of the South China Sea - its Mass Water Transport** *39*
*Prof. Dr. Lokman Shamsudin, Faculty of Applied Sciences and Technology, Universiti Putra Malaysia Terengganu, Malaysia*

**LMR07:** **Bio-prospecting, Research and Conservation of Deep-sea Resources within and beyond National Jurisdiction** *40*
*N. Syed-Ibrahim, Center for Marine and Coastal Studies, Universiti Sains Malaysia, Malaysia*

**LMR08:** **The Crustacean Associated in Seagrass Beds in Indonesia** *no received*
*Indra Aswandy, Research & Development Centre for Oceanology, Indonesia Institute of Science, Indonesia*

**SESSION 4; Global Climate Change and Regional Oceanography** *41*
***- Data Requirements, Needs & Products***

**Keynote:** **Global and Regional Ocean Climate Change on Interannual to Interdecadal Timescales: Outstanding Problems, Global Networks, and Products** *43*
*Dr. Warren B. White, Scripps Institution of Oceanography, University of California - San Diego, United States*

**GCC01:** **Long-term Variations of Surface and Intermediate Water Masses in the North Pacific and their Implications to Climate Change** *44*
*Assoc. Prof. Dr. Toshio Suga, Dept. of Geophysics, Graduate School of Science, Tohoku University, Japan*

**GCC02:** **Global Warming and Inter-Annual Variability** *45*
*Prof. Dr. Alejandro Livio Camerlengo, Faculty of Applied Science & Technology, Universiti Putra Malaysia Terengganu, Malaysia*

**GCC03:** **Low Frequency and Quasi-Biennial Oscillations in the Regional Precipitation Anomaly in Malaysia and their Relations to the Winds, SLP and SST in the Tropical Pacific and Indian Oceans** *46*
*Dr. Fredolin T. Tangang, Dept. of Marine Science, FSSA, Universiti Kebangsaan Malaysia, Malaysia*

**GCC04:** **Physical Characteristics of Water Mass in the South China Sea** *47*
*Dr. Mohd. Nasir Saadon, Faculty of Applied Science & Technology, Univ. Putra Malaysia Terengganu, Malaysia*

**GCC05:** **Properties of the Water near the Strait of Malacca using the World Ocean Database 1998 from NOAA** *48*
*Mr. Takaya Namba, Faculty of Science and Environmental Studies, Universiti Putra Malaysia, Malaysia*

**GCC06:** **The Regional Oceanographic Data Analysis and Simulation Modeling System for the South China Sea** *49*
*Prof. Dr. Dinh Van Uu, Marine Dynamic and Environment Research Center, Vietnam National University, Vietnam*

**GCC07:** **Long term Metocean Measurements in the South China Sea** *50*
*En. Rozlan bin Mohd Ramli, Petronas Carigali Sdn. Bhd., Malaysia*

**GCC08:** **Data Processing and Subsurface Thermal Structure in the South China Sea** *51*
*Prof. Youhai He, South China Sea Institute of Oceanography, Academia Sinica, China*

*Page*

**GCC09:** **SEAWATCH program in Indonesia** *52*
*Mr. Agus Setiaman, Agency for the Assessment & Application of Technology (BPP TEKLOGOI) SEA WATCH Indonesia Program, Indonesia*

**GCC10:** **Marine Research Activities and Oceanographic Data Management in Vietnam** *54*
*Prof. Dr. Dang Ngoc Thanh, National Center for Natural Science & Technology of Vietnam, Vietnam*

**GCC11:** **Oceanographic Observations and Coastal Environment Monitoring Programmes of Korea** *55*
*Dr. Kyu Kui Jung, Korea Oceanographic Data Center, South Korea*

**GCC12:** **Ocenographic Data Management - Malaysian Experience** *56*
*Cdr. Zainal bin Aziz, Hydrographic Department, Royal Malaysian Navy, Malaysia*

**SESSION 5; Marine Pollution -** ***Data Requirements, Needs & Products*** *57*

**Keynote:** **Exchanging Data and Information on Marine Pollution - Challenges and Issues** *59*
*Prof. Dr. Gil S. Jacinto, Marine Science Institute, University of the Philippines, Philippines*

**MP01:** **Coastal Resource Sensitivity of Oil Spill Pollution using Remote Sensing and Geographic Information System** *60*
*Mazlani Muhammad, MACRES, Malaysia*

**MP02:** **The Straits of Malacca Environmental Information System (SMEIS)** *61*
*Prof. Kum Sang Low, Institute of Postgraduate Studies & Research, University of Malaya, Malaysia*

**MP03:** **Marine Toxicology - Its Nature and Significance in Malaysia** *62*
*Assoc. Prof. Iekhsan Othman, Dept. of Bio-chemistry, University of Malaya, Malaysia*

**MP04:** **Bioconcentration and Availability of Organo-Chlorine Pesticides (OCP) in different, Compartments of the Food chain in the West Coast of Peninsular Malaysia** *64*
*Dr. Zubir bin Din, Centre for Marine & Coastal Studies Malaysia, Universiti Sains Malaysia, Malaysia*

**MP05:** **Polycyclic Aromatic Hydrocarbons in Mussels from Malaysian Coastal Waters** *65*
*Ali Mashinchian Moradi, Faculty of Science and Environmental Studies, Universiti Putra Malaysia, Malaysia*

**MP06:** **Distribution of Polynuclear Aromatic Hydrocarbons (PAH)s and Total Aliphatic Hydrocarbons (TAHs) in the bottom sediments of the Gulf of Thailand and the South China Sea** *67*
*Dr. Mohd Kamil Abdul Rashid, Fakulti Sains Gunaan & Teknologi, Universiti Putra Malaysia, Malaysia*

**MP07:** **Trend in Environmental Water Quality of Inner Jakarta Bay, Indonesia** *68*
*Melati Ferianita Fachrul, Dept. of Environmental Engineering,Faculty of Civil Engineering, Universiti Teknologi Malaysia, Malaysia*

**MP08:** **Dissolved Fraction of Metals in Malaysian Waters, Using an In-site Sampling and Extraction Techniques** *69*
*Shahunthala Devi Ramachandran, Institute Penyelidikan Perikana, Malaysia*

**MP09:** **Concentration of Heavy Metal Contamination in Marine Sediments off East Coast Peninsular Malaysia** *70*
*Dr. V.R. Vijayan, Mineral and Geoscience Department, Malaysia*

**MP10:** **Organic Contaminants in Sediments of Melaka Strait** *71*
*Dr. Ab. Khalik b. Hj. Wood, Malaysia Institute for Nuclear Technology Research, Malaysia*

**MP11:** **Monitoring Programme on Marine Pollution from a Coastal Power Plant into the Sea** *72*
*Assoc. Prof. Absornsuda Siripong, Marine Science Dept., Faculty of Science, Chulalongkorn University, Thailand*

*Page*

**POSTER SESSION** *73*

**P01:** **Oceanographic Chemical Data Set in the Northwestern Pacific** *75*
*Mr. Toru Hazama, Japan Oceanographic Data Center, Japan*

**P02:** **Distribution of *Ceratium* Species in Quarter Bay, Iran** *76*
*Majid Eshaghi, Faculty of Food Science & Biotechnology Universiti Putra Malaysi, Malaysia*

**P03:** **Monitoring of Trace Metals in Sediments and Flat Tree-Oysters from Sepang Rivers, Malaysia** *77*
*Miss. Katayon Saed, Faculty of Science & Environmental Studies, Universiti Putra Malaysia, Malaysia*

**P04:** **Identification of Fishing Areas in the Southeastern part of Samar Sea, Philippines** *78*
*Dr. Latip S. Abdurahman, Samar Regional School of Fisheries, Philippines*

**P05:** **Bio-Physical Characteristics of Maqueda Bay, Samar , Philippines** *79*
*Dr. Renato C. Diocton, Samar Regional School of Fisheries, Philippines*

**P06:** **Marine Data Collection by a Network of Moored Oceanographic Buoys in the Gulf of Thailand and Andaman Sea, and the applications of such data in various fields** *no received*
*Pitan Singhasaneh, SEAWATCH Thailand, NationalRresearch Council of Thailand, Thailand*

**P07:** **The First Step for an Oceanographic Database of the Vietnam Sea Region in the Gulf of Thailand** *80*
*Dr. Phan Van Hoac, Center for Hydrometeorology of South Vietnam, Vietnam*

**P08:** **State of Vietnam Coastal Erosion and Accretion and Environment Concerns** *81*
*Dr. Dinh Van Huy, Haiphong Institute of Oceanology, Vietnam*

**P09:** **Cooperative Projects in the Sea of Japan and the Sea of Okhotsk: New Oceanographic Data for International Community** *82*
*Dr. Alexander N. Man'ko, Far Eastern Regional Hydrometeorological Research Institute, Russia*

**P10:** **Measurement of Wave Height in the Gulf of Thailand** *83*
*Mr. Wattana Kanbua, Thai Meteorological Department, Thailand*

**P11:** **Development of Molecular Markers for Sea Cucumber (Holothuroidea)** *84*
*Dr. Pathimah Ismail, Faculty of Medicine & Health Science, Universiti Putra Malaysia, Malaysia*

**P12:** **The National Environment and Resource information Centre (NERIC) and Coastal Zone Management in Vietnam** *85*
*Mr. Nguyen Tu Dan, Vietnam National Oceanographic Data Center, Vietnam*

**P13:** **International Cooperative Effort on Oceanography and Sustainable Development of the Gulf of Thailand** *86*
*Dr. Anond Snidvongs, Marine Science Dept., Chulalongkorn University, Thailand*

**P14:** **JICA/UPM Malacca Straits Expedition No2, Nitrogen and Phosphorous Distribution** *88*
*Prof. Dr. Law Ah Theem, Faculty of Applied Science & Technology, Univ. Putra Malaysia Terengganu, Malaysia*

**P15:** **Quantitation of Polycyclic Aromatic Hydrocarbons (PAHs) in Marine Environmental Samples by Silica Gel Column Chromatography and GC-MS** *88*
*Ali Mashinchian Moradi, Faculty of Science & Environmental Studies, Universiti Putra Malaysia, Malaysia*

**P16:** **Distribution of Ortho-phospate in the Straits of Malacca** *90*
*Tengku Rozaina binti Tengku Mohamad, Southeast Asian Fisheries Development Center, Malaysia*

**P17:** **Development of Sine-slab® for Coastal Erosion Control** *91*
*Assoc. Prof. Dr. Noraieni Hj Mokhtar, COEI, Universiti Teknologi Malaysia, Malaysia*

**P18:** **Screening for the Presence of Endoparasites in the Gastrointestinal Tract of Sea Cucumbers From Trengganu** *92*
*Hawa Ismail, Faculty of Allied Health Sciences, Universiti Kebangsaan Malaysia*

# SESSION 1

## Coastal Environment

*- Data Requirements, Needs & Products*

Keynote

## Ocean Circulation in the Asian Waters

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In order to realize the sustainable development in the coastal sea, it is essential to understand the current field there because thetransport of material such as oil spill, nutrients and fish larvae is mainly governed by the current. However it is very difficult to understand the current field only by the results of direct current measurements in the coastal sea where fishing activity is very high and it is impossible to maintain the mooring system with current meters in the long term at many stations.

The accumulated oceanographic data such as water temperature, salinity, sea surface wind and sea surface topography in the Oceanographic Data Center are very useful to estimate the current field in the coastal sea.

In the presentation, tidal phenomena in the South China Sea revealed by the analysis of tide gauge data along the coast and altimetric data from satellite, seasonal variation of three-dimensional circulation in the South China Sea revealed by the diagnostic numerical model will be introduced.

**CE01**

## Tidal Dynamic in Malacca Straits

***M. Makmur Sulaeman and Dede Yuliadi****
*Indonesian Navy*

Tidal dynamic study in a "intermediary waters" with narrow and heavy traffic condition such as Malacca Straits are very important and many scientists are interested in further research in the transit passage.

Many foreign and Indonesian scientists have studied the tidal dynamic in Malacca Straits, both either in modeling or direct measurement like joint survey between Indonesia, Malaysia, Singapore and Japan.

Several tidal modeling had been conducted by Wyrtki (1961), Pariwono (1985), Guoy (1988) and direct measurement was carried out by Indonesia, Malaysia, Singapore and Japan in 1978/1979 and 1997 in Malacca Straits namely the four nation joint resurvey of critical areas and investigation of dangerous inconfiring shoal and wrecks in the straits of Malacca and Singapore. Pattern of the tide both co-tidal and co-range show that the result's trend almost same, but if we compare more in detail between modeling and direct measurement, the amplitudes and phases rather different. This is depend on the data input when the modeling is running.

Tidal data used in modeling such as number, period of time and boundary conditions are very important because will effect the accuracy of the result of the modeling as well as detail bathymetric map and coastal conditions such as mangrove which its influence mainly to tidal movement.

From data and information collected shows that tide in Malacca Straits is mainly influenced by Indian Ocean dominantly by semi diurnal tide especially by $M_2$.

CE02

# Potential use of Satellite Altimeter Data for the Determination of the Leading Tidal Constituents for the Marine Region of Peninsular Malaysia

*Muhammad Nur JP Vella*[*1], *Shahrum Ses*[1], *Majid Kadir*[1] *and Koji Matsumoto*[2]

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The eight leading ocean tide, $M_2$, $S_2$, $N_2$, $K_2$, $K_1$, $O_1$, $P_1$ and $Q_1$ for peninsular Malaysia are developed using Satellite Altimeter and Tide Gauge data as a control, for the precision of the model. The Tide Gauge data (constituents) are being used as a control group (external) for the comparisons. TOPEX/POSEIDON merged geophysical data records are used as the satellite altimeter data. The cross track adjustment was carried out on the data, after the cross track adjustment only tracks suitable to this study were incorporated into the solving of the eight leading ocean tides. Tracks that were included in the study were grouped into cells of 30' by 30'. From each 30' cell, a set of eight tidal coefficients are derived, $M_2$, $S_2$, $N_2$, $K_2$, $K_1$, $O_1$, $P_1$ and $Q_1$, also a total of 17 Orthoweights including 6 Diurnal, 6 Semi-diurnal 4, for the long period tides Ssa, Sa and one constant value.

The time series of altimeter data and tide gauge data are analysed by the response method with orthotide functions so that harmonic constants for the eight leading tides are computed on 30' by 30' cells where corresponding data exist. The there are eight resulting maps describing the leading coefficients on a 30' by 30' grid commensurate with the grid size used to convolve the SSH's.

The notable feature of the response method is that it does not insist upon expressing the tides as sums of harmonic functions of specified tidal spectral line, but expressing the tides by admittance functions of each tidal species. This property of the response method shows some advantages especially when it is applied to satellite altimeter data. Another advantage of the response method is that by assuming a smooth admittance, one can obtain a full definition of tides with fewer parameters. The harmonic analysis needs 2jparameters to determine amplitude and phase of j constituents, while with the response method one needs only 4k+2 parameters per tidal frequency band, where limiting the lag K to 1 is usually sufficient.

TOPEX/POSEIDON satellite altimeter tracks are extracted for the test area, over the following region of the South China Sea, $\phi_N$ (0°, 8°) and $\lambda_E$(100°, 120°). Although this is a small test area and not representative of the full tidal dynamics of the South China Sea, the results from the research undertaken offer promising hopes for a larger area representative of the South China Sea.

Comparisons with global tidal models and the test area results are commensurate, but show that improvement is needed in the area of appropriate data distribution. It is envisaged that with the inclusion of more data such as bathymetry from satellite altimeter missions an improvement on the test model can be achieved.

**CE03**

# Contribution of National Tidal Data Centre in Research and Development Activities in Indonesia

***Mohamad Makmur Sulaeman* and Trismadi***
*Indonesian Navy Dishidors TNI-AL, Indonesia*

When National Workshop on Application of Tidal Data and Others that held onOctober 30 - November 1, 1990 in the Hydro Oceanographic Service Indonesian Navy (abbreviated by Dishidros) and attended many institutions had chosen Dishidros by acclamation as National Tidal Data Center. Dishidros find out this function is too heavy, because our territory is very large and several marine institutions involving in tidal data collection for their own purposes. From this commitment, Dishidoros build the internal concept in tidal data management.

A Database system is being developed at Dishidoros to manage tidal data (as primary data; tidal data survey, record of tide gauge, tidal constituents and secondary data from other institutions). At present, Dishidros has produced Tidal Data Constituent Catalogue. The tidal data have been computerised and planned to develop web site ininternet.

If tidal data have already stored on National Tidal Data Centre and easy to get, it become helpful to scientists and engineers in supporting research and other activities that needs tidal data. Finally we hope this function would be useful for many institution especially in Information Exchange ofOceanographic Data in the Western Pacific.

CE04

# Characteristic Scales in Coastal and Limnological Processes: Implications in Data Sparse Environment

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Some theoretical models are introduced to highlight the significance of characteristic length scales and time scales in considering models for coastal and limnological environments having several physical, chemical and biological processes with differing characteristic scales, particularly under data sparse conditions.

First, a tidal flow model such as DYNHYD5 or Aquasea applicable to estuarine waters involving, a priori, gravity, local acceleration, friction and viscosity is used to illustrate the dominance of gravity as the primary driving force. In such a case, simple tidal models such as Abadi are appropriate in lieu of more complicated models for first approximations. Next some coastal process models, such as WASP5, are introduced in which several processes have various characteristic scales and for which, in certain situations, simplification may by possible in order to facilitate proper conceptualization and characterization. Finally we show that such characterization is applicable to limnological and inland water environment with particular reference to a reservoir in Sabah for which a water quality model HEC-5Q is being currently developed to assist in the management of the dam.

**CE05**

# The National Environment and Resource Information Centre (NERIC) and Coastal Zone Management in Vietnam

***Bui Cong Que*, Nguyen Hong Phuong, Nguyen Ngoc Thach and Nguyen Tu Dan***
*Vietnam National Oceanographic Data Centre, Vietnam*

The National Environmental and Resource Information Centre (NERIC) was established as a part of Vietnam National Oceanographic Data Centre (VODC) for implementing the Coastal Zone Environmental and Resource Management Project (CZERMP) in Vietnam. One of the NERIC functions is to collect and identify all available data and sources on natural conditions, resources and environmental status of various areas along the coastline of Vietnam. NERIC encapsulates advanced computing facilities, image analysis capacity and GIS processing capability, which allow to conduct standardization for building the GIS databases, Metadata directories on Marine and Coastal Environment and resources. At. present NERIC is operated on the basis of a computer network connecting the VODC with collaborating research institutions and managing agencies within CZERMP.

The most important task of NERIC is data analysis and GIS processing with purpose to evaluate the status and to assess the environment impacts of economic development and human activities in coastal zones of Vietnam. During 1997-1999, aMetadata directory and GIS databases have been established for Van Phong Bay and Red River mouth area in Vietnam. The final results of study in these areas includeGIS products on Environmental Impact Assessment caused by tourism development, sea port construction, aquaculture development in Van Phong Bay area, as well as agriculture development and aquaculture exploitation in the Red river mouth area. GIS products have been transferred to managing agencies and decision makers for use in coastal environment and resource protection and sustainable development planning.

CE06

## Straits of Malacca Management Compliance and Information System (SOMMaCIS)

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The Straits of Malacca is one of the busiest waterways in the world. Its strategic location plays an important role for the shipping industry. Some 600 ships of all nations pass through the straits daily. For the littoral states of Malaysia, Indonesia, and Singapore, the Straits is a life support system to the millions of people that inhabit the towns and villages that dot the coastline from Langkawi to Tanjung Piai. Besides supporting more than 90% of the national trade, the Straits support industrial development, the tourism industry and the food fish production. The value of the marketable and non marketable resources have been estimated at US$ 5.6 Billion while the shipping value of the Straits are estimated at some US$ 600 million annually. The projected increase in shipping activities and rapid development along the vicinity of Malacca Straits has increased the risk of conflict among the stakeholders and seriously threatening its fragile ecosystem.

Development in the field of geographical information system (GIS) and GIS modeling is currently applied to address some of these issues. Based on spatial analysis, database management and information systems, resource managers obtain vital information, analyze, display results and apply scenario modeling to solve management issues. The application of remote sensing in ecological and environmental management have shown tremendous potentials for codifying and determining large scale phenomenon and synoptic data capture for oceanography, pollution and the environment. Remote sensing technology is currently being developed to give near real time solutions to issues of natural resources and the sustainable development.

This project employs remote sensing and GIS technology to mitigate the age-old problems of information availability and timeliness, data management, and synoptic inventory of natural resources. The use of modeling, spatial analysis, and near real-time systems can assist decision-makers to make better-informed judgements that will effect the governance and management of the Straits of Malacca.

The Straits of Malacca Management Compliance and Information system (SOMMaCIS) will be developed over five phases from the data acquisition to the operational stage where the information will be made available to users through the electronic media.

Key words: coastal zone management, Straits of Malacca environment, remote sensing, GIS, and information system.

CE07

# Research and Data Needs in Managing Coastal Erosion

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In the field of coastal engineering, the usual objectives are either to minimise flooding or to reduce erosion due to action of waves and tides. Therefore, coastal structures must be carefully conceived and designed in order to ensure that there can be appropriate level of confidence that they will achieve their design purpose. This paper identifies those aspects of the coastal environment that will particularly influence the design of coastal structures and outlines the data requirements in the development of solutions to coastal erosion problems. The paper also describes some of the research presently being carried out on coastal structures which will hopefully lead to improved management of sea defences.

Keywords: Coastal erosion management; coastal structures; coastal engineering research; data needs.

CE08

# Seasonal Shoreline Characteristics of the Open Muddy Beach of the Pantai Punggur, Malaysia

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A representation of seasonal shoreline changes of the open mud-dominated beach of Pantai Punggur was obtained from about quarterly periodic measurement of beach profile. The shoreline data were analyzed and the results were presented in terms of the variability of shoreline changes about the mean, the rate and direction of short-term changes. Longshore and cross-shore sediment transport components are interpreted using field observations and available data. It is suggested that the cycle of monsoon circulation had potent influences on the wave characteristics and the consequent sediment transport.

**CE09**

# Some Behaviours of Strongest Short-term Coastal Change Induced by Cross-shore Wave Energy Flow and Corresponding Theoretical Consideration

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There is a quantity of famous theoretical and experimental works oriented themselves to solving actual problem of coastal and nearshore topography changes under the versatile influence of oceanic wind waves. In this paper the author would like to give supplementary a few behaviours of such phenomena observed along the coasts of Vietnam, such as the coastal collapse and primitive on-the-spot accumulation, coastal material hurl, etc. Most simple theoretical explanation of them grounding on the second Newton's law has been presented.

CE10

## Restoration of the Breakwater of Fishing Harbour in Thangassery, Kerala

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The fishing harbour at Thangassery in Kerala west coast of India is formed by a breakwater of length 2.1 km. The breakwater is formed with armour layer of 3 T to 5 T quarry stones upto a water depth of 9 m, beyond which the armour layer consists of 8 T tetrapods. The breakwater had served effectively for two years after construction. The monsoon in the year 1998 lead to severe damage of the armour layer resulting in total displacement of armour units, wash away of the leeside of the breakwater especially at chainages 1612 m to 1622 m and 1642 m to 1652 m. A detailed study had to be taken up immediately to look into the methods for restoring the damaged portion of the breakwater.

The primary objective of determining the slope of the existing cross section as well as the percentage of damage was fulfilled by carrying out a survey. The average slope of the existing breakwater after damage was found to be 1:1.1 as against a slope of 1:2.5 as per design. Physical model tests were carried out initially to check the stability of the cross section as per design when it is subjected to a significant wave height of 3.75m occuring during the monsoons as reported by the harbour authorities. The stability tests were carried out for the two most frequently occuring wave periods of 8 and 10 sec. The damage of the section was found to be more than the permissible level to the extent of 6.15% for 8 sec wave and 17.4 % for 10 sec wave. The tests were followed up with suggestive measures of strengthening the armour layer. This consisted of provision of a berm at mean high water level of width of 4m by adopting the same size of rubble stones of 3T to 5 T. The tests were repeated and the section was found to be stable. The tests also covered qualitative assessment of overtopping in order to decide the option of raising the crest elevation. The details of the modelling, experimental procedure, results of the laboratory tests and adequacy of crest elevation are presented and discussed in detail in this paper.

**CE11**

## Rapid Reef Mapping - an Attempt with Hydroacoustic Method

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A new approach was applied to mapping out the reef substrate of the four islets of Pulau Payar Marine Park. A seabed classification system which harnessed the RoxAnn hydroacoustic signal processor, Differential GPS and a 200 kHz echosounder was able to translate the echo return into hardness and roughness indices which then exhibit unique characteristic for each bottom type recorded. The system was able to discriminate six major reef substrates i.e. the live coral, dead coral, soft coral, coral rubble, rock and sand. Live hard coral represents a total coverage of 19.30 % from the 157.68 km total length of transect recorded from Payar group of island. The four main growth forms found were the massive (10.11 %), branching (7.11 %), encrusting (1.51 %) and foliose (0.57 %). Table corals and columnar corals were also present but in a very small quantity (surface area) that the RoxAnn seabed classification system was not able to classify them as a separate group. As for Pulau Segantang group of island, soft coral was the dominant coral type contributing to 34.65 % of the total 4.12 km of track run. Live coral coverage at P. Segantang in this survey was negligible. It was also common to find small coral colonies growing on boulders surface in shallower water for both Payar and Segantang waters. They were grouped as a stand-alone coral substrate due to their unusual existence pattern. The real time track data were also interpolated using Surfer® 6.2 for thematic maps showing depth contour, 3D depth profile and bottom surface area. The results were satisfactory, in spite of the presence of data distortion. The use of hydroacoustic method for mapping of coral reef substrate is independent of water depth, visibility, light penetration and time. Hence hydroacoustic method shows strongly to be a better alternative to the conventional transect line method and satellite images in terms of time and cost spent and the results gained in return, especially for large scale survey.

CE12

# The Role of International Organizations in the Study of Rivers & Sea Coastal Area Interaction

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Agenda 21 adopted by the United Nations Conference on Environment & Development in June 1992 set out a number of concerns & "critical uncertainties". One of these concerns is the future of coastal zones & areas. UNESCO through its programmes IHP, MAB & IOC is trying to respond to these concerns. The programme ICAM (Integrated Coastal Area Management) gives a new perspective to creation of a comprehensive management system for coastal areas which incorporates scientific issues including the study of interaction between rivers & coastal areas, as well as social issues including the study of the influence of the human population & its behaviour. There is a need for coastal strategies based on a sound scientific database & integrated approach. One possible scenario of coastal management is given.

# Real-Time Information System for Sustainable Management of Shared Coastal Waters: Gulf of Thailand as a Demonstration Site

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Several coastal waters in WESTPAC region are under continuous stresses from pollution, especially from land-based source, overexploitation of fisheries resources, losing of aesthetic and tourism values, and conflict of resources utilization among user groups. Frequently, the lack of reliable information that had temporal and spatial scale as well as the content that relevant to the problem led to the delay or postponement for the solution. Problem would be further complicated for coastal water shared by more than one country which has different levels of data acquisition capabilities, data management and exchange policies.

Gulf of Thailand is an example of such case where open oceanographic data exchange and sharing among its four littoral countries are still in an infant stage. And while agreements for international cooperation have been progressed and reviewed by concerned agencies in each country, local as well as transboundary problems in the Gulf are very common. These problems cry for a regional data and information system that is independent of national politic and security concern. Such system would be used as an interim basis for making non-bias solutions and decisions.

The water of the Gulf is strongly influenced by input from land via rivers, stream and possibly groundwater. These paths bring in not only freshwater, but dissolved and suspended material that support coastal ecology and biological production. Algal bloom, coastal fisheries/aquaculture production and water quality in general along the coast of the Gulf are known to be related to the season and magnitude of terrestrial input. Stratification of the main body of the Gulf is also determined by the balance between freshwater input and tidal/Ekman stirring. The ability to forecast and estimate the extent of terrestrial input is therefore a key for management actions, such as warning and recommendation regarding water quality and algal bloom, coastal fisheries and aquaculture activities, tourism and other uses of coastal resources, etc.

Freshwater input (surface and subsurface) along every section of the coastline of the Gulf of Thailand can be estimated from the regional drainage basin model for Southeast Asia

developed by the Southeast Asia START Global Change Regional Center in collaboration with the University of Washington Department of Oceanography. Precipitation over the basin was estimated at near real-time from geostationary weather satellite (GMS-5) and TRMM. Correction for vegetation and other factors are done by other remote sensing information such as AVHRR-NDVI, and other geospatial data. This model had been successfully verified against the observed data from small and large rivers in the region.

Chemical loading will be estimated from geochemical weathering model for each basin. SeaWiFS data as well as delayed mode oceanographic station data are also used to verify the change in composition of coastal suspended constituents with those predicted by the model. Nested high resolution sub-models are also made for sub-regions with special interest or importance.

The Gulf of Thailand Sub-Regional Oceanographic Data Center (GoT-ODC) currently run the real-time model and make forecast for coastal water quality and distribution. However, it is planned that technology will be transferred to national and local agencies/administrations concerned with coastal and marine resource management. GoT-ODC also plan to continue near real-time data service to users and other partners of the project pending availability of funding. Delayed mode remote sensing and oceanographic station data for the Gulf of Thailand are also freely available on-line via Internet at http://www.start.or.th/westpac/

**CE14**

# Role and Contribution of Oceanographic Research in Maritime Policy Making in Malaysia

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The development of appropriate policies for the maritime sector in Malaysia depends partly on the availability of accurate, up-to-date and appropriately analysed data. Such data is needed at the problem definition and solution definition stages of policy development and analysis exercise. Given the myriad of activities in Malaysia's seas and coastal waters it could be assumed that data and information requirement are correspondingly large. This paper examines the role which oceanographic or marine science research played in, and its contribution to the development of maritime policy/policies in Malaysia. This is done by examining the present organisation of oceanographic research in Malaysia, particularly in terms of the linkages between the research community and government policy makers. In addition, area where contribution form the research community are needed are also identified. Presently, the link between the research community and the policy makers is at best tenuous. The situation is primarily because there is no institutionalised or formalised arrangement for information and analysis from the research community to be conveyed to policy makers. Secondarily, much of the research undertaken is for academic purposes and the information obtained are not tailored to the needs of the policy makers. Thirdly, and more conceptually, there has been no conscious attempt to integrate oceanographic research into the overall national development and policy making structure similar to that in Indonesia for example.

CE15

## Data Necessary for an Effective Hydraulic Study: The Malaysian Scenario

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A hydraulic study has become a tool for developments along the coast, reclamations and offshore dredging works. The accuracy of the outcome of any hydraulic study is dependent on the data pertinent to the study area. The data is usually divided into field data and recorded or historical data. Field data is usually collected between two weeks and up to a month due to the short duration given or the study. This provide a small window to the environmental conditions of the area. It is also important to study the effects of the monsoons which has a great impact on the Malaysian climate. Increasing reliance on data kept or archived by government departments and agencies and private companies has made it necessary to develop some form of cooperation. Most of the available data are land based. Marine data such as tides, currents, waves and winds need to be collected around Malaysia at more locations. Although the instrumentation required might be costly, a joint effort in terms of manpower and financing would be desirable in order to understand more of the water body surrounding Malaysia.

**CE16**

# Effective Coastal Management Strategies in the Era of Hydroinformatics – A UTM Focus

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Within the context of coastal management, it has been recognised that in order to institute viable management policies at specific locations it is necessary to have a wider understanding of the regional dynamics within the physical process environment and of the factors which influence them. The high interdependence between the physical character of the coastal environment and its response to forcing agents such as wave, wind and tidal climate require numerous variables to be examined to enable us to form this fuller understanding. Hydroinformatics provides a means of correlating those variables and such a methodology has been employed in a number of strategic coastal studies undertaken by the Coastal and Offshore Engineering Institute of UTM in order to provide guidance on coastal management and development. Thus this paper provides an overview ofhydroinformatics as a tool in decision support for coastal managers who require information relating to management priorities, physical processes and viable management techniques, and this is illustrated by examples from work undertaken within Malaysia by UTM.

# SESSION 2

## Data Management Activities and Technical Developments

Keynote

## Technical Developments in Marine Data Management

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The need for greater quantities of marine data to support a range of maritime activities including resource management, sustainable use, defence activities and policy development has been increasing rapidly over the past few years. This requirement is being partially driven by the requirements and obligations coastal states have under the United Nations Convention on the Law of the Sea (UNCLOS) and partially by human impact and resource conflict issues within coastal zones.

In addition to the increasing need for marine data and improved access to data and data products, recent technological advances in data collection processes have resulted in massive increases in the quantities of data now being collected. These factors are providing a greater pressure on managers of marine data to support larger volumes of data available and address the broader needs for data and data products coming from the marine community.

As a result of these pressures, and the increasing complexity of the task, marine data management is advancing to a point where it can now be considered a scientific activity in its own right. The increasing number of conferences devoted to marine data management and its technologies and the increase in publications relating to this topic support this view.

The paper will focus on developing internet technologies and capabilities that will support our future marine data management activities. These technologies cover a wide range of areas including databases capable of supporting spatial data and object data structures, data markup languages such as XML and the extensions of existing marine data management systems such as the electronic navigation chart (ECDIS). The use and integration of these technologies will be examined and a model proposed for future marine data systems.

**DM01**

## The Use of Autonomous Solar Electric Research Vessel to obtain Oceanographic Data

***Peter Thomas***
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This paper evaluates the potential for gathering oceanographic, environmental, and climatic data for ocean going autonomous solar powered research vessels. It outlines the requirement for a command and control centre and discusses the opportunities for data gathering made available by this technology.

DM02

# Digital Marine Mapping of Indonesian Waters

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The most distinctive features of the Indonesia country is characterized by the physical size of its sheer which coverage over 5,000 km from the west to the east (from Sumatera to the border of Indonesia and Papua New Guinea territory). The area of land and marine territory is about 7.7 million $km^2$ and is the largest maritime territory in the world. The coverage of land area is about 1.9 million $km^2$ dominated by five main islands namely Sumatera, Java, Kalimantan, Sulawesi and Irian Jaya.

In order to fulfil the requirements stated in UNCLOS'82 a project of Digital Marine Resource Mapping (DMRM) of Indonesian water has been established in the early 1996. Project activities which have been successfully completed including Verification of Basepoints and establishment of Baselines for determining the Territorial Water, the Contiguous Zone and the Economic Exclusive Zone (EEZ); Whereas the Bathymetric investigation of the Continental Shelf and Critical Areas in designated Sea Lanes as well as Institutional Development and Technology Transfer are on progress.

BAKOSURTANAL (The National Coordination Agency for Surveys and Mapping) is a non-ministerial Agency which reports to the Minister of Policy and Security directly and also to the Minister of State for Technology on technical matters. There are a number of Government and Private Institution in Indonesia which have their business and activities in marine area; Therefore, the need of bathymetric information is very essential. In the production of bathymetric map, BAKOSURTANAL takes an important part. In conjunction with that BAKOSURTANAL on behalf of the Government of Indonesia is responsible to do such activities as verification of base points, baseline, produce charts ofsealane, Territorial Sea, Economic Exclusive Zone (EEZ). This paper tries to discuss the activities of BAKOSURTANAL in mapping Indonesia territorial waters to fulfil the requirement of UNCLOS'82.

**DM03**

## An Internet Server for the Visualisation of Gridded Oceanographic Data

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One of the important roles of a National oceanographic Data Centre (NODC) is to publish data so that is it available to both the scientific community and the general public. Traditionally data has been published in hard-copy format but technology advances, such as the Internet and the World Wide Web, provide flexible tools that can handle a wide range of data presentation methods and are popular enough to reach a wide audience.

The Australian Oceanographic Data Centre has developed a web-based application to provide remote access to gridded oceanographic datasets. A data extraction and visualisation server allows users to interactively browse a database and spatially visualise the data. Different datasets can be selected and variables such as time, location and parameter can be specified. The application allows users to query and visualise data within an Internet browser environment thus providing rapid access to oceanographic data using a familiar environment. This paper describes the design of the application and outlines the benefits to an NODC of providing on-line access to datasets.

DM04

## VODC for PC 2.0 (*the Software for Integrated Oceanographic Data Management*)

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VODC for PC 2.0 is the software for Integrated Oceanographic Data Management designed for personal computer with 32-bit operating system, and the database management system is Microsoft Access 97. The program interface is designed very carefully and specifically to provide crucial functions in manipulation of database. VODC for PC enables to preserve the oceanographic data collected from different data sources.

Nowadays, VODC for PC has been used to store and mange data in many Vietnamese Oceanographic Agencies. During a long time of using, it is proved that VODC for PC is easy to use, fast to manipulate and preserve data in synthetic manner. Especially, it can interchange data with other softwares.

**DM05**

## Quality Control Software which is easily applicable to Oceanographic Data Processing in Data Originators

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The Marine Information Research Center (MIRC) developed a quality control (QC) software, which runs on Microsoft Windows. The results of quality check displayed graphically in various ways, and so erroneous data are easily found and corrected even by non-experts, such as part-time workers in local data-originating agencies. The POD (data format designed by Japan Fisheries Agency) formatted data of eachagency are re-arranged in time-serial data set, and then are dividedinto cruise data by identifying several days interval between stations. Header information and ship-track are displayed for each cruise, and erroneous information such as extraordinary ship speed areindicated with red colored tracks. The error data can be corrected in window directly. This procedure is very efficient to find errors in header information such as position, date, time and so on. Then, temperature, salinity and density profiles can be shown for selectedobservation point(s). Range and gradient checks and density inversion check can be easily made in this window: erroneous data detected by criterions set by Ocean Climate Laboratory of US-NODC are shown also with red colored curves automatically. The T-S diagram, horizontal and vertical quantity distributions are also obtainable through thissoftware. The quality control software will be demonstrated, and its usefulness will be shown from analysis of the data obtained by Wakayama Prefectural Fisheries Experimental Station from 1975 to 1995.

DM06

## Marine Data and Information Management in Vietnam

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As you known, the informatics have been developing rapidly, and follow it up, the GIS technology (Geographic Information System) has been wildly used in many scientific fields, especially it has called as real scientific field and technology in data management on the geographic information system. GIS has standard ways and tools of calculation. It allowed to carry out collection, management, processing and easy to get access into data and information. So that, the applying GIS in oceanographic data management is very necessary.

GIS for the oceanographic data management in Vietnam was given a birth and grow up and develop in Marine Hydrodynamics Research Centre, the Mechanic Institute, Vietnam. This include: Current data, water level, wave, hydrometeorology, tide and data of social economic information etc. These information were collected from many difference sources so they appear some difficulties in management and getting access. Under these characteristics, we decided to choose Mapinfo 4.0 software set and through Mapbasic language to write out private management programme set according to characteristics of Vietnamese Oceanographic Information to assist and serves to meet the needs of scientists and data managers in using and getting access marine data and information quickly, easily and effectively.

The structure of data was outlined base on primary map (Vietnamese Administration Map) and layers of data was brought in through Foxpro application with co-ordinates and summary information on study fields as follows:

- Current-vnam.tab (Current data)
- Wave-vnam.tab (Wave data)
- Hydromete-vnam.tab (hydrometeorology data)
- Waterlevel-vnam.tab (Water level data)
- Socialeconomic-vnam.tab (Social economic data)

Each above data layser has Map-link field which keeps data link code with maps and detail data.

As above mentioned, this programme was written base on Mapbasic language and work directly on Mapinfo environment, thus, this is very convenience to use, furthermore Mapinfo software is very popular in Vietnam in generally and for database in Mechanic Institute in particular at that moment.

# SESSION 3

## Living Marine Resources

*- Data Requirements, Needs & Products*

Keynote

## Utilization of Biological Data for IODE system in the WESTPAC area

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There are many on-going international projects related Living Marine Resources such as NEAR-GOOS, HAB, GLOBEC, Global Coral Reef Monitoring Network, Biodiversity and Large Marine Ecosystems in the WESTPAC area.

Utilization of IODE system is necessary in order to advance efficiency these projects. But there are many difficulties to promote of marine biological data. Accuracy of marine biological data is affected from complexly factors (many technical skill of data sampling and analyzing; classify enormous kind of species; variability of marine biological data on account of environmental change; shortage of specialist and knowledge on digital management of data).

Development and application of new technologies such as acoustical and optical instruments, is important to clear some factors in future.

**LMR01**

## Distribution of Intertidal Meiobenthos in Langkawi Island Malaysia

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A study on the density distribution of intertidal meiobenthos and its micro-scale vertical zonation into the sediments was carried out in Langkawi Island. Samples of meiobenthos were taken using a hand-corer with the inner diameter of 2.65 cm during low tide. A total of ten meiobenthos taxa were identified and quantified. They are Nematoda, Harpacticoida, Turbellaria, Foraminifera, Ostracoda, Polychaeta, Rotifera, Ciliophora, Cumacea and Tardigrada. Nematoda was the most dominant taxon in most of the stations except for stations at Tanjung Rhu and Pulau Kentut Besar, which were dominated by Harpacticoida. The highest number of taxa (7) was found at stations with medium sand and the lowest (3) was found at stations with coarse sand. Nematoda, Harpacticoida and Foraminifera were found in all stations whereas Tardigrada, Ciliophora, Cumacea and Rotifera were occurred at certain station. Mean density of the meiobenthos ranged from 40.50 ± 0.90 to 976.25 ± 341.01 ind. 10 $cm^{-2}$. The highest mean density was found at station with medium sand and the lowest was found at station with fine sand. In coarse sand, most of the meiobenthos occupied the uppermost 0 - 2 cm layer whereas in fine and medium sands, the meiobenthos concentrated between 0 - 4 cm layer of the sediments. In all type of sands the highest density was found at the uppermost 0 - 2 cm. Nematoda, Turbellaria, Ostracoda and Foraminifera were distributed down to 6 cm of the sediment. On the other hand, the distribution of Harpacticoida, Cliliophora, Rotifera and Polychaeta were restricted to 4- cm depth of the sediment. Spatially, the density distribution of meiobenthos showed positive correlation with median of sediment grain size, percentage of silt and clay and content of total organic matter. The result of the present study was discussed in comparison with other tropical meiobenthos studies elsewhere.

LMR02

## Seagrass Ecosystem in Indonesia: A Case Study in Lombok Island

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Indonesian is one of the world's largest archipelagos, containing more than 17,000 islands with 80,791 km coastline length. Although Indonesia can be considered as having the largest seagrass beds amongs the tropical countries, seagrass has long been neglected in Indonesia. Unlike coral reef and mangrove, little was known on the biology and ecology of Indonesian seagrasses.

Furthermore, there is no national seagrass research program in Indonesia, and no special management measure to conserve the seagrass ecosystem including its biota like turtle and dugong. In recent years studies on structure and dynamic of seagrasses were done in Lombok Island, Indonesia.

**LMR03**

# Leaf Growth, Production and Ecosystem Dynamics of Toothed Seagrass *Cymodocea serrulata* (R. Br.) Aschers. et Magnus in Port Dickson, Malaysia

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The leaf growth, production and ecological study of toothed seagrass *Cymodocea serrulata* were made in a sparse and mixed stand form ofseagrass bed in Batu Tujuh at Port Dickson coastal area. The mean shoot density was found 950 shoots $m^{-2}$ in this study area. The maximum leaf growth and production were observed 11.4 mm $shoot^{-1}day^{-1}$ and 1.84 g DW (Dry Weight) $m^{-2}day^{-1}$, with the mean of 7.66 mm $shoot^{-1}day^{-1}$ and 1.52 g DW $m^{-2}day^{-1}$, respectively. Mean Above Ground Biomass (AG) and Below Ground Biomass (BG) were recorded 25.37 and 37.93 g DW $m^{-2}$, respectively. The range of turnover rate was found 1.90 - 5.23 percent $day^{-1}$, whereas, the mean value was 3.54 percent $day^{-1}$ during the study period from this seagrass bed. Leaves and rhizomes of *Cymodocea serrulata* beneath the shading of macroalgae community were found comparatively longer than those are existing without shading condition. Among the dissolved inorganic nutrients concentrations phosphate and nitrate were low (< 0.1 ppm) and ammonium was moderately higher (< 0.6 ppm) in the overlying water of seagrass bed. The hydrological factors like water temperature, dissolved oxygen, salinity, pH and light intensity were suitable forseagrass growth in compare to other completed scientific study on seagrass beds in tropical and temperate regions. Despite having limited data on seagrass in this region, it is hoped that the data obtained from this study would be able to used researcher to better understand the ecology, dynamics of the biological community and as well as contribution of this important marine living resource in shallow marine ecosystem.

LMR04

## Some Observations on the Impacts of the Indo-Pacific Region 1998 SST Anomalies on Local Coral Communities

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A major coral bleaching phenomena were observed to occur among the reefs in many islands in the South China Sea, Java Sea, Celebes Sea and Sulu Sea in the Southeast Asian Region in early 1998. This paper demonstrates some observations made on the coral communities in Malaysia during the time when a higher than normal sea surface temperature occurred. Some record of observations made in the neighbouring countries were also noted.

# Ecological Aspects of Oceanic Squid, *Stenoteuthis oualaniensis* (Lesson) in the South China Sea, West Coast of Philippines

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In anattempt to come up with initial jigging fishery on oceanic squid in the Southeast Asian Region SEAFDEC conducted a comparative study on the squid in the Philippines Exclusive Economic Zone off the coast of Western Philippines from 17 April to 9 May 1998. The survey objectives are to determine the distribution and abundance of the ocean squid in relation to oceanographic conditions and to examine the feasibility of harvesting squid with jig gear.

Results from 11 sampling stations show that only one species of the purpleback flying squid, *Sthenoteuthis oualaniensis* (Lesson, 1930) were caught by automatic squid jigging gear. The distribution and abundance of the purpleback flying squid in term of the catch-per-unit-effort (CPUE, number of squid per line hour) are presented. Over theentire survey area, the CPUE of the squid averaged 5.7 squids/line hour. Drop-off rates for jigs fished on the jigging machines ranged from 0 to 0.33 squid/line hour. Angling depth where the squid were abundant ranged from 50 m to 100 m.

The squid had a mean overall mantle length of 147mm and an averaged weight of 0.17 kg. A total of 2,592 squid were measured and mantle length ranged from 90 to 250 mm. Female dominated the catch, according for 1,380 squid or 81 % of the 1,701 squid sexed. Males were generally smaller than females. The mantle length composition for males was single peak mode at between 120 and 130 mm. Females also had one peak between 140 and 150 mm mantle length. A similar length-weight relationship coefficients between male and female was found.

The squid were found in a warm water mass where the sea temperature range from 14°C to 31°C at the depth from 150 m up to sea surface at night. Good fishing grounds of the squid were at 18°N latitude (18.5 squids/line hour) and at 19°N latitude (11.6 squids/line hour) off the San Fernando and Currimao coasts, respectively where the upwelling occurred. Dissolved oxygen where squid abundant was ranged from 3.27 to 4.4 ml/l. Downwelling was found at 16°N along the 118°E where less potential of the squid, the water transparency depth in this area was deep of about 44 m. A period of 6 days before and after full moon day was good fishing day, while the percent illumination of the moon was less than 30%.

Keyword: purpleback flying squid, *Sthenoteuthis oualaniensi, fishing ground, south china sea*

LMR06

## Coccolithophorids (Nanoplankton) of the South China Sea - its Mass Water Transport

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The coccolithophorid flora of the South China Sea was examined by scanning electron microscopy. Thirty five taxa were identified and these are observed by scanning electron micrographs of complete coccospheres and single separate coccoliths. The most abundant species were *Emiliania huxleyi, Oolithotus fagilis* and *Gephyrocapsa oceanica* (collectively up to $10^3$ cells $L^{-1}$) which occurred in the maximum chlorophyll layer down to 40 m depth. Other species which were ubiquitous but never abundant (collectively up to $10^2$ cells $L^{-1}$) included Coccolithoceae (*Coccolithus pelagicus, Oolithotus fragidis*); Geophyrocapsaceae (*Gephyrocapsa oceanica*); Rhabdophaeraceae (*Discophaera tuhifera*); Helicosphaeraceae (*Helisosphaera carteri, H. pavimentum*), Rhabdosphaeraceae (*Acanthoica quattrospina, Discosphaera tuvifera, Rhabdoshaera claviger*); Syracosphaeraceae (*Coneosphaera molischii, Syrocosphaera pulichra, Umbellosphaera irregularis, U. tenuis*) and Halopappaceae (*Florisphaera profunda, Haloppapus* sp.).

The coccolithophorids of the South China Sea show a dominance change from *Emiliania huxleyi* (North East Philippine waters) to *Gehyrocapsa oceanica* (Sabah waters of South China Sea) and a southward transport of many tropical species (*Scyhosphaera apsteinii* and *S. pulichra*).

Keyword: coccolithophorid, nanoplankton, South China Sea transport

# Bio-prospecting, Research and Conservation of Deep-sea Resources within and beyond National Jurisdiction

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Technologies are emerging rapidly where submersibles andremotely-operated vehicles (AUVs, ROVs, etc) with high tech equipment on board are utilized for deep-sea bio-prospecting, and relatively recently for deep-sea scientific research and perhaps in the future for deep-sea conservation and management. With this rapid advancement of technology, discoveries of the marine realm previously unknown or beyond reach are being made e.g. the hydrothermal and cold vents and their associated marine resources. These deep-sea resources including the microbial genetic diversity, are of great interests to scientists as well as to commercial biotechnological, pharmaceutical and other industries. More work should be done within the Western Pacific region. However, there is great disparity between the developed and developing countries in their capability (scientific, technological experts, and finances) to discover these new natural resources located in the deeper sea areas including area of "common heritage of mankind". Equitable co-operation in the development and utilization of new marine technologies are needed. Additionally, these new natural resources are previously unknown and unclaimed, especially if they are in 'international waters' or in areas beyond national jurisdiction. Thus, a distributive (rather than re-distributive) issue arises, requiring perhaps unique allocation, management, and dispute settlement mechanisms in accordance with the 1982 United Nations Convention on the Law of the Sea (UNCLOS).

The UNCLOS entered into force in November 1994. In its preamble, recognition is made of the desirability of establishing a legal order which, *inter alia*, will *"promote the equitable and efficient utilisation of their resources, the conservation of their living resources, and the study, protection and preservation of the marine environment*', taking into account the interests of mankind as a whole, especially the special needs of developing countries, with the view of realizing a just and equitable international economic order.

This paper attempts to analyze the framework of activities and some of the concerns over these newly found deep-sea resources e.g. from the hydrothermal vents and cold seeps vis-à-vis research, bio-prospecting and conservation at these vents in the different maritime zones.

# SESSION 4

## Global Climate Change and Regional Oceanography

***- Requirements, Needs & Products***

Keynote

## Global and Regional Ocean Climate Change on Interannual to Interdecadal Timescales: Outstanding Problems, Global Networks, and Products

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A survey is given of basin- and global-scale climatevariability in the upper ocean on interannual, decadal, and interdecadal timescales over the past century, each producing significant peaks in SST spectra above the red noise background. On interannual timescales we discuss El Niño, the Southern Oscillation, the Pacific North American pattern, the Antarctic Circumpolar Wave, and the global ENSO wave within their global contexts. We examine the problems in understanding how atomospheric and oceanic teleconnections transmit interannual signals between ocean basins and between the tropics, and how ocean and atmosphere are coupled to one another. On decadal and interdecadal timescales, global spatial symmetries are described together with those in the evolution from warm phase to cool phase. Then we examine interdecadal modulation in the intensity and evolution of ElNiño and the Southern Oscillation. We show how network design theory can be used to establish optimal data networks required to observe global and regional climate variability in the upper ocean. We give examples of how these ocean data networks can be used to forecast climate change over adjacent continents on interannual timescales.

GCC01

# Long-term Variations of Surface and Intermediate Water Masses in the North Pacific and their Implications to Climate Change

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Distribution and properties of water in the ocean are the consequences of various processes including heat and fresh water exchange between atmosphere and ocean at the sea surface, oceanic flow fields and mixing. Any changes in water properties and/or its spatial distribution thus reflect changes in those processes. This is the ultimate reason why monitoring of water masses is useful for documenting and understanding changes in the climate system. Here are two examples which highlight particular aspects of significance of water masses in the context of climate research: a long-term memory integrating changes in surface fluxes and an active agent working in a mechanism of a coupled ocean-atmosphere decadal variation.

North Pacific Intermediate Water (NPIW) is characterized as intermediate salinity minimum over the subtropical North Pacific and believed to originate in the subpolar North Pacific. Recently, basin-wide freshening of NPIW over the past decades was reported based on comparison between historical hydrographic data and recent trans-oceanic hydrographic section (Wong et al., 1999). It was then related to a freshening of surface water in the NPIW source region and further to an intensification of the global hydrological cycle, which is hardly detected by direct measurements of surface fluxes. This example indicates that water mass analysis can be a powerful tool to document climate change if the hydrographic data has a required coverage of space and time.

Decadal changes of the atmosphere and ocean system in the North Pacific have been one of main issues in climate research. One of possible mechanisms to explain these changes is so-called "subduction oscillation" (e.g. Gu and Philander. 1996; Hanawa, 1996) in which water plays an essential role as follows. The water subducted from the sea surface at the midlatitudes carries a signal to the tropical thermocline, which eventually alters tropical sea-surface temperature (SST). The change in the tropical SST could rapidly send the signal back to the midlatitudes through atmospheric teleconnections and establish a decadal variation. Unfortunately, the whole story cannot be verified because we don't have enough data at the moment.

Even a couple of examples above illustrate importance of efforts to acquire and archive oceanographic data in each part of the world ocean. Progress in climate research highly depends on accumulation of such steady efforts.

GCC02

## Global Warming and Inter-Annual Variability

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In this study the time series (as well as the regression lines of their respective secular trends) of the mean annual: (a) temperature, (b) evaporation, (c) sea level pressure and (d) isolation to evaluate their behaviour due to global warming is addressed. To filter the ENSO events from the global warming effect, the deviations of the regression lines of the above mention meteorological parameters is considered. Correlation between ENSO years and non-ENSO years between temperature, evaporation, insolation and sea level pressure is also evaluated.

# Low Frequency and Quasi-Biennial Oscillations in the Regional Precipitation Anomaly in Malaysia and their Relations to the Winds, SLP and SST in the Tropical Pacific and Indian Oceans

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The present work investigates the spatial and temporal variability of the regional precipitation anomaly in Malaysia and the influences exerted by the Pacific and Indian Ocean. In particular, this paper examines the following issues: 1) The dominant modes of variability in the precipitation anomaly. As it will be shown that the most dominant modes of variability correspond to the oscillations in the low frequency (LF) and quasi-biennial (QB) frequency bands. 2) The temporal and spatial variations of the perturbations in these two bands. 3) The relations of the perturbations to the LF and QB signals in the wind, SLP and SST fields in the tropical Pacific and Indian Oceans. This study employs the empirical orthogonal function (EOF) technique to highlight dominant mode of variability in the data. To restrict the analysis on the LF and QB frequency bands, the original data is filtered by retaining only the Fourier components correspond to the LF and QB bands. The extended EOF(EEOF) technique is also applied to highlight the progressive nature of the QB signal. The precipitation data covered the period of 1951 - 1993 and was obtained from the Global Historical Climatology Network (GHCN) and the Malaysian Meteorological Services (MMS). A total of 12 stations were considered.

The EOF analysis on the unfiltered data showed that dominant modes of variability were modulated by oscillations in the LF (3 - 7 years) and QB (1.5 - 2.5 years) frequency bands. The first mode explained 27% of the total variance with periodicity of between 2.5 - 5 years. The temporal amplitude was well correlated with the Southern Oscillation Index (SOI) and the Nino3 SST. Hence the largest variability in the precipitation anomaly appeared to be associated with ENSO events. Spatially, the impacts appeared to be dominant in Sabah, Sarawak and the East Coast of Malaysian peninsula. Hence these area faced drought during an El Niño event and flood during La Niña. The second mode explained 17% of the total variance and appeared to be modulated by the mixture of the LF and the QB frequency with a periodicity of between 1.5 - 1.8 years. The EOF analysis on the LF filtered data confirmed that the most dominant mode of variability in the precipitation anomaly was due to ENSO. There was no evidence of propagation as revealed by the EEOF analysis. However, the signal appeared to be well correlated and preceded by the changes (in SST, zonal wind and SLP) in the Pacific Ocean. This consistent with the idea that the LF signals are characterized by standing waves large dipoles between the Indo-Pacific-Australia region and the eastern Pacific. The signals in the QB bands appeared to be preceded by the changes in the Indian Ocean and ahead of the changes in the Pacific Ocean. The EEOF analysis on the QB components showed evidence of eastward propagation. This is consistent of the notion that the QB signals propagate eastward from the Indian Ocean to the Pacific Ocean passing through the Southeast Asia region.

GCC04

## Physical Characteristics of Watermass in the South China Sea

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Our study provides new information on the physical characteristics of watermasses in the South China Sea. We analyzed the temperature, salinity and density profiles to determine the effect of the NE monsoon on the variability of the physical properties of watermasses, in the Gulf of Thailand and theeast coast of Peninsular Malaysia. CTD data were obtained from both the MV SEAFDEC cruises conducted before (September 1995) and after (April 1996) the northeast (NE) monsoon season.

We concluded that the NE monsoon season slightly caused the variability of the physical properties of watermasses, in the study area. We observed the movement of the thermocline, halocline and pycnocline layers from deeper depth to shallower depth, before and after the NE monsoon season, respectively. This movement could be linked todownwelling and upwelling processes in the region.

Keyword : thermocline, halocline, pycnocline, downwelling and upwelling processes

GCC05

## Properties of the water near the Strait of Malacca using the World Ocean Database 1998 from NOAA

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Using the bottle data, from World Ocean Database 1998 compiled by the National Oceanographic Data Center (NODC) the presentations of data (salinity, temperature, oxygen, phosphate etc ) are investigated in the area, 90-110ºE,0-10°N covering the Strait of Malacca including the western part of the South China Sea and the western part ofth Andaman Sea to clarify the properties of the water. The number of temperature and salinity profiles available are more than 5000. Besides the temperature and salinity, there are more than 2000 ofoxgin, 700 of Nitrate, 700 of phosphate and 400 of Chlorophyll profiles, which are available.

Around the strait, the results show that the temperature and salinity distributions at the surface do not only show the typical high temperature and low salinity but also some seasonal change. The waters near the strait seem to be homogeneous. This is because of the fact that the southern part of the straits is narrow, which is only30 m depth and 35 km width, and there are many small islands at Singapore. Distrributions of phosphate, nitrate etc as well as salinity suggest there are a certain amount of water flow from land into the strait.

GCC06

# The Regional Oceanographic Data Analysis and Simulation Modelling System for the South China Sea

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In order to simulate the hydrological and ecological climatology of the South China Sea, we was applied and developed the oceanographic data analysis and modelling system. Many international global oceanographic data sets as NODC, JODC, GODAR, … was used together with Vietnamese national and local university data sets.

Data used here have been analyzed by variational inverse method (VIM) on a 15 minutes latitude-longitude grid at standard oceanographic levels between the surface and sea bottom. The analyzed fields of temperature and salinity have been used as boundary and initial conditions in the 3D Eco-Hydrodynamic coastal model for the South China Sea.

The results of the thermohydrodynamic and ecological regime of the South China Sea are more detail, especially in the Vietnamese coastal regions, where more oceanographic data sources was used.

The coupled data analysis and simulation modelling system will be used to complete national oceanographic archives and to develop the regional marine environmental predictive model for the coastal region.

GCC07

## Long term Metocean Measurements in the South China Sea

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Petronas Carigali Sdn Bhd is now continuing the metocean data collection in the South China Sea, after taking over from the metocean service provided by Sarawak Shell Berhad. The data collection is to meet the operational and engineering requirement in the oil and gas industry. A brief history of the relevant measurement details is presented. This is followed by an assessment of the variability of metocean conditions observed over the last three years. The focus is on wave data, but wind data are also presented for comparison.

Platform metocean data collection has to meet the different requirements of offshore and onshore users. Offshore staff require metocean data in 'real-time' primarily to ensure safe, day-to-day operation. Engineers need continuous, high quality records of long duration for use in structural design/re-certification, and for long-term planning and logistic purposes. The latter requires a robust, reliable metocean data set that is representative of expected conditions.

GCC08

## Data Processing and Subsurface Thermal Structure in the South China Sea

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More than 50,000 temperature-depth profiles in the South China Sea (SCS) for the period 1959-1988 are collected and analyzed on a 2 (longitude) by 2 (latitude) grid in space and bimonthly in time using the optimal interpolation technique. Objective and scientific quality control on the data is made, and the procedure includes the collection of subsurface thermal data, check for the bad data, check for the duplicate observation, the development of the long-term bimonthly mean temperatures at standard depths as a reference for SCS, the computation of temperature residuals at standard depths using the bimonthly mean climatology for the sea, optimum interpolation of temperature residuals onto a regular grid, mapping horizontal temperatures and vertical sections in order to discover potential errors. It is successful in the quality control on the data set by comparison this processing result with the routine one, and numerical result.

The horizontal maps on 0, 100, 200, 300, and 400 m in SCS and vertical sections along 6, 12, 18°N are produced after data processing. There are pronounced seasonal and interannual changes in the thermal structure. Thethermocline is deeper in winter and summer than in spring and autumn. The cold and warm centers in SCS are not permanent except the cold one in the northern SCS, and very sensitive to the monsoon.

## SEAWATCH program in Indonesia

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Considering the National Guidelines (GBHN) 1993 which has put marine sector on development activity in economy field, Indonesian human resources and technology development on marine field have to be prepared. BPPT as an agency for the assessment and application of Technology has started to prepare the development by doing some projects in marine sector such as Baruna Jaya Vessel Project and SEAWATCH Indonesia Project. SEAWATCH Indonesia Project is a national project of government of Republic of Indonesia in co-operation with the government of Norway on science and technology. The first phase of this project has been done for 3 years from March 1996 until March 1999. Theobjectives of this project is to develop a real time and continuously database of marine environmental to serve fisheries, sea transportation, hydro-oceanographic, meteorology services and others.

The possibilities for SEAWATCH Indonesia Project was first introduced to the Minister of Research and Technology of Republic of Indonesia in Jakarta on November 1991 by the Minister of Oil and Gas of Norway. This project largely financed by Norwegian public funds. The background of this project is based on the big resources and potencies of Indonesia as a maritime continent with more than 17,000 islands with a total area estimated at 7.8 million $km^2$ consisting mostly of marine (74.3 %). Being the maritime continent it would be important to Indonesia to develop its own technology platform to form a part of the ocean observing system to be installed throughout the world, in the future. Areas of special Indonesian concern could be the development of advanced sensors to be integrated in the buoy systems and also development of applications, such as how to utilize the data flow for the various purposes in a most efficient way.

The SEAWATCH system consists of (a) sensors carrying buoys with real time data transmission system, (b) data analysis, data presentation and forecasting system,(c) data distribution system. The first part is mainly based on the oceanographic data collection buoy, equipped to collect the following parameters: air pressure, air temperature, wind speed and direction, waves, sea current, vertical sea temperature and salinity profile, oxygen saturation, particle or algae concentration and radioactivity. The collected data are internally processed

and checked and hence transmitted to shore by use of satellite communication, enabling near real time data evaluation. The second part is the data quality control, analysis, storage and forecasting parts. The large amounts of data to be collected need very careful data checking and storage systems. Operational model for forecasting of marine environmental parameters are also parts of this include hydrodynamics model, pollution transport model etc. The third part is the computer based information system for distribution of relevant information/data to interested parties. By using an ordinary PC equipped with the necessary software, various users can achieve the required data or relevant information in very easy and user friendly way.

The project for the first phase only covering the area around the Malaka Straits and Java Sea. It is planned to extend the location to the eastern part of Indonesia (Makassar Straits, Lombok Straits, etc.) in the next phase of the project.

## Marine Research Activities and Oceanographic Data Management in Vietnam

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Marine research activities in Vietnam already began in the '20s of this century, with the establishment of the Institute of Oceanography (I.O.) in Nha Trang in 1923. The marine investigation activities carried out by the I.O. at that time before 1945 - was considered as the first period of the marine research history in Vietnam. Since 1946 until 1975 even at the wartime, marine investigation continued, but conforming to the political context at that time, it was conducted separately in North Vietnam and South Vietnam.

The present period of marine research activities in Vietnam began from 1975, after the finish of the long wartime and beginning of the reunification of the country. The most remarkable features in this period is the National Marine Research Programme, organized during every State Quinquennial Plan of Socio - Economic Development, with the participation of different marine scientific institutions of the country.

Beside the expedition works, in the 1st three decades of this century, 17 coastal and island meteo - hydrological stations were established to collect regularly data on meteorological and hydrological characteristics of the Vietnam sea area, the most ancient were Hon Dau (Hai Phong) Vung Tau (Ba Ria - Vung Tau).

As results of a long period of marine investigation on the Vietnam sea and adjacent areas, a multidisciplinary oceanographic data stock has been collected from different sources, including data on physical, chemicalgeolo-geophysical, biological oceanography, on living and non-living resources and environment conditions. However, the oceanographic data management in Vietnam up to now remained many inadequate unsettled problems, as following: disperse status of the data collection, every institution kept their own data holdings, lacking workmanship and necessary technological capability, data exchange relations with international collective still notdeveloped …

In order to promote the oceanographic data management, from 1996 to 2000, a National Project on the establishment of a National oceanographic data base is implemented in the framework of the National Marine Research Programme, to establish a solid economico - technological basis, to propose an appropriate organisation system for data management at national level, and to give a preliminary capacity building for a National oceanographic data base.

For this purpose it needs an effort from marine research scientific collective and institutions, an attention from the government and an assistance of international organisations, particularly the IODE/IOC system and the cooperation with regional countries.

GCC11

# Oceanographic Observations and Coastal Environment Monitoring Programmes of Korea

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The National Fisheries Research and Development Institute (NFRDI) is responsible for the time series oceanographic observations and coastal environment monitoring in Korea. These programmes of observation and monitoring have been verified to predict the oceanographic conditions and fisheries ground environments in the sea around Korea.

The serial oceanographic observations are carried out bimonthly on 175 stations from 22 lines around Korea. The monitoring variables are water temperature, salinity, dissolved oxygen, nutrients and meteorological factors. The data are recorded in the Korea Oceanographic Data Center (KODC) file operated by NFRDI, and easily accessible to the end users. The vertical water temperature profiles from ship observation are provided within 2 days of observation time.

The upwelling cold water, low-saline water mass and harmful algal bloom have frequently occurred in the coastal areas of Korea in the summer. They resulted in an economic loss in the cultural production of fish and shellfish. NFRDI conducts the comprehensive coastal environment monitoring including pollutant content and ecosystem-related variable.

The real time sea surface temperature (SST) data is obtained directly from the advanced very high resolution radiometer (AVHRR) on the U. S. National Oceanic and Atmospheric Administration (NOAA) polar orbiting satellites. The SST data which are from the satellite and daily observations of 40 coastal stations are analyzed for providing the marine information, and used in the prediction and warning of near shore cold water. In the summer, monitoring for the low-saline water and harmful algal bloom is extensively implemented in the coastal area through the ship and buoy observations.

GCC12

## Oceanographic Data Management - Malaysian Experience

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The paper presents the on-going effort by the Royal Malaysian Navy Hydrographic Department (RMNHD) in managing the oceanographic data and research activities within the Malaysian environment. It focuses on various aspects of data management, training of personnel and capacity building in the field of physical oceanography.

The establishment of the Royal Malaysian Navy Oceanographic Data Centre (RMNODC) is considered a major initiative towards a more systematic oceanographic data gathering for the whole country. Subsequently, the Intergovernmental Oceanographic Commission (IOC) via its Circular Letter No. 1414 dated 25 May 1994, appointed the RMNODC as the Designated National Agency (DNA) for the International Oceanographic Data and Information Exchange (IODE) program in Malaysia. By 1997, the RMNHD was appointed by the Ministry of Science, Technology and Environment (MOSTE) to be the *focal point* for all IOC activities in Malaysia.

The success of RMNODC will depend on the support and co-operation from various agencies both in government and the private sectors includinginstitutions of higher learning involved in oceanography and marine science activities. A National Oceanographic Research Co-ordination Committee has been established to facilitate this co-operation for mutual benefit.

# SESSION 5

## Marine Pollution

***- Data Requirements, Needs & Products***

Keynote

## Exchanging Data and Information on Marine Pollution - Challenges and Issues

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The development of a data and information exchange mechanism for marine pollution is needed. However, unlike physical oceanographic data for which methods and instruments of data acquisition are fairly well standardized and the mechanisms for data exchange and validation have been around for a long time, data on contaminants are not as easily obtained and shared.

There are several challenges and issues that need to be considered. For example, agencies that have traditionally been able to provide physical oceanographic data (e.g., hydrographic departments) are not necessarily able or equipped to acquire marine pollution data. Parameters measured to assess marine pollution vary considerably. Also, data on contaminant levels generated by various laboratories, within a country and among countries in the region, may not be comparable. Problems remain in generating accurate data even for parameters that are relatively easy to measure (e.g., nutrients). Standard reference materials are expensive and, for some parameters and matrices, difficult to acquire. Monitoring of contaminants is often limited to nearshore areas because these tend to be more accessible to laboratories, thereby limiting the spatial perspective of contaminant levels. Because analysis costs are high and laboratory analysis sometimes time-consuming, the number of samples acquired and data generated are also limited. If contaminant levels are obtained by academic groups, they may be unwilling to share the data until after these are published in scientific journals. The disclosure of some environmental data to the public may also be seen to compromise economic activities of countries (e.g., coliform counts or red tide episodes in mariculture areas or tourist destinations); thus, there might be reluctance to provide such data especially on a real-time basis.

Some of these issues are not too difficult to address. Others will require new approaches to involve participants, acquire data, and share information. This will need time, resources, new technologies, commitment, and a shared vision among the countries of a better future made possible by sharing marine pollution data and information.

**MP01**

# Coastal Resource Sensitivity of Oil Spill Pollution using Remote Sensing and Geographic Information System

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The Straits of Malacca, regarding as one of the busiest shipping route in the world, is facing increasing threat oil pollution due to accident spills. This can cause serious pollution of the coastal ecosystems, which subsequently will affect the economic well-being of the fishermen in both Malaysia and Indonesia. MACRES has embarked on a project to look into the potential or remote sensing data to detect oil spills near real-time for prompt remedial action. The overall objective of the project is to zone the sensitivity of the ecosystem, both onshore and offshore, against oil spill pollution, using the integration of remote sensing and geographic information system. This paper highlights the methodology adopted and presents some results. The output of the project was coastal resources sensitivity map against oil spill pollution based on geomorphology, socio-economic and habitat ecosystem. Such map is an important input the early warning system against oil spill pollution being developed by the Department of Environment, Malaysia.

MP02

## The Straits of Malacca Environmental Information System (SMEIS)

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The Malacca Straits Demonstration Project (MSDP) has been commissioned as part of the GEF/UNDP/IMO Regional Programme for the Prevention and Management of Marine Pollution in the East Asian Sea. The specific objective of the MSDP is to develop a sub-regional environmental information system for the management of marine and coastal pollution of the Straits of Malacca. The tasks undertaken by researchers from the 3 littoral states includes the mapping and valuation of the coastal resources of the Straits, mapping of the sources of pollution and assessment of various pollution control technology options as well as the development of simulation models for assessing the impacts of oil spills and the discharge of pollutants by rivers into the Straits.

These maps, databases and simulation models are then integrated into a software package known as the "Straits of Malacca Environmental Information System" or SMEIS. The software package has been developed in the structure of a Geographical Information System (GIS) enabling the overlaying of maps, zooming and panning functions, querying of database and map attributes. The sub-regional information system has enabled for the first time the quantitative valuation of the coastal resources of the Straits as well as the assessment of the likely scale of impacts or damages of these resources due to both land-based and sea-based sources of pollution.

Based on the computed oil slick trajectory and landing densities, the likely damages of the coastal resources due to accidental oil spills in the Straits ofMalacca can be assessed. Based on the computation of river discharged pollutant dispersion in the Straits, the economic values of the coastal resources exposed to high pollutant concentrations can also be quantified. These quantitative impact assessments of marine environmental pollution will lead to the formulation of pollution control and management measures vital for the protection of the vast coastal resources of the Straits of Malacca.

**MP03**

## Marine Toxicology - its nature and significance in Malaysia

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Marine toxicology is a very neglected field of study in Malaysia due to its insignificant effect to the economy and to the population. The main group of people that are of concerned with marine toxicology are those that have encountered it either directly or indirectly and this include various medical practitioners, divers, toxicologists, beach goers and victims of various envenomation. The number of cases that have been referred to University Hospital are mainly from the US and Australia concerning with marine envenomation from marine organisms including jellyfish, sea anemones and various types of fish poisoning. However, database available on Malaysian marine toxicology is very inadequate and insufficient to answer even some of the basic questions regarding the source and nature of the toxic effect.

Circumstances such as the one described above has presented us with an opportunity to look into the study of marine toxicology in greater detail especially on natural toxins from marine organisms. Amongst the many marine organisms that are of medical importance are jellyfish and pufferfish as their toxins could affect human health. There have been several deaths caused by toxins from these organisms. Our studies have shown that these toxins are varied, not only in their nature but also their mode of actions ranging from severe pain and skin necrosis to respiratory paralysis and eventual death. Jellyfish toxins are proteineceous in nature and are very labie. The Toxins, stored in a capsule called nematocyst, are very potent in causing the formation of ionophore in cardiac muscles leading to a massive influx of the divalent, $Ca^{2+}$. These sudden increased of $Ca^{2+}$ causes cell death and eventual death to victims. Ultrastuctural studies using scanning electron and transmission electron microscopy have showed that the toxins are stored in various types of capsules called nematocysts that are activated via a trigger called cnidocil. The structure of the tubules these nematocysts can be ejected at a very high velocity to ensure penetration into the skin epidermis reaching the capillaries of the muscle. As the effect is mainly carditoxic coupled with some degree of neurotoxicity, the manifestation of the symptoms are almost immediate with death occurring within 3 minutes. The lethality of some Malaysian species of jellyfish, such as *Chiropsalmus quadrigatus*, *Chiropsalmus buitendjiki* and *Carybdea alata* are of significance since as they posed possible threat to all beach goers especially in popular area such as Batu Feringghi, Panang and Port Dickson, Negri Semibilan.

While the nature of the protein from jellyfish isproteineceous, studies on Malaysia pufferfish have showed that it contained terodotoxin which is very stable organic molecule even at high temperature such as 100°C. All Malaysian species of pufferfish studied, includied *Chelonodon fluviatilis*, *Gastrophysus lunaris* and *Torquigener oblongus*, are toxic and inedible. Pure tetrodotoxin and its derivatives can be isolated using various chromatographic techniques including column chromatography and HPLC. These toxins are useful for various scientific probes in the study of$Na^+$ - channels in neurones.

**MP04**

# Bioconcentration and Availability of Organo-Chlorine Pesticides (OCP) in Different Compartments of the Food-chain in the West Coast of Peninsular Malaysia

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There is an increasing global concern on the fate of persistent agrochemicals, particularly pesticides, that are introduced into the marine environment as a result of drainage, surface run-off and precipitation. In Malaysia, organochlorine pesticides (OCP) such as DDT, aldrin, dieldrin and heptachlor are widely used but very little information on their level in the environment is available. For 1990, the estimated cost of pesticide use in this country was around RM315 million, with an 8% increase annually. Neither the Department of Agriculture (responsible for pesticides under the Pesticide Act, 1974) nor the Department of Environment (responsible for the state of the environment under the Environmental Quality Act 1974/1988) is doing any routine monitoring of these group of contaminants. Early studies have shown that OCP can be magnified up to 100 or even 1000 times in animal tissues, especially due to their lipophilic nature. Various toxic effects due to exposure to these chemicals have been shown, the most famous being the thinning of egg shells in birds. As early as the 1970's it became widely known that some insecticides cause cancer, mutations and birth defects.

The aim of the present study is to investigate the extent of bioaccumulation and distribution of OCP in different compartments within the marine food-chain at three locations on the west coast of peninsular Malaysia, namely in the vicinity of the mouth of Sungai Kerian and Sungai Muda, as well as Teluk Aling in Penang.

In addition to surface sediment samples, six species of marine organisms, representing different trophic levels, were collected. These include 2 species of molluscs (*Anadara granosa* and *Perna viridis*), 1 species of crustacean (*Metapeneaus* sp.), 2 demersal species (*Arius* sp. and *Pennahia* sp.), a herbivorous pelagic species (*Valamugil* sp.) and a carnivorous pelagic species (*Lates calcarifer*).

The samples were analysed for 18 OCP compounds following the US-EPA method (with modifications). Emphasis was given to total-DDT, Dieldrin, Aldrin, Linden ($\gamma$-BHC), Endrin, Heptochlor, Endosulfan and Methoxychlor.

The results show that in all the samples several OCPs were detedted. Higher concentrations were found in the bivalves (*Anadara granosa* and *Perna veridis*), and in the fish species (*Valamugil* sp., and *Lates calcarifer*). These results suggest that several OCPs are bioconcentrated along the food-chain.

MP05

## Polycyclic Aromatic Hydrocarbons in Mussels from Malaysian Coastal Waters

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More than 2.3 thousand kiloton of Polycyclic Aromatic Hydrocarbons (PAHs) reach the marine environment every year and are ubiquitously distributed world-wide. The investigation of these compounds is of great scientific interest, since several of them show high carcinogenic and mutagenic activities. Amongst these PAHs, the compounds with 4-7 rings exhibit the greatest carcinogenic andmutagenic effects.

Mussels prove to be useful in biological monitoring programs designed to detect organic micro-pollutants contamination of the marine environment. As filter-feeding organisms, mussels are capable of accumulating a wide range of compounds includingPAHs and the concentration of contaminants in mussel tissue generally reflects that in the water column.

At present, scanty data is available on the contamination of Malaysian coastal water swith PAHs. In this study, green mussels (*Perna viridls*) were utilized for monitoring of the level of PAHs in coastal waters of Peninsular Malaysia.

Mussels of 7 - 9 cm in length were sampled from jetties, navigational buoys andaqua-culture cages from 11 stations along the West coast of peninsular Malaysia fromLangkawi to Johor. At least 25 individual mussels from each station were immediately shucked and soft tissues homogenized and kept at -18°C until analysis. Aliquots of 20 g of homogenized soft tissues were extracted in dichloromethane using polytron homogenizer. The extracts were cleaned up by 5 % deactivated silica gel column chromatography and then fractionated by second step column chromatography using 100 % activated silica gel. Fractionated compounds were analyzed by GC-MS after addition of dueterated internal standards. Spiked blank samples were used to check the recovery of the analytical procedure. The recovery percentage was generally between 80 to 95 %.

Concentrations of 17 individual PAHs including dibenzothiophene, phenanthrene, anthracene, 2-methyl anthracene, 2-methyl phenanthrene, fluoranthene, pyrene, retene, 1-methyl pyrene, benz(a)anthracene, chrysene, benz(k)fluoranthene, benzo(a)pyrene,

benzo(e)pyrene, acephenanthrylene, dibenz(a,h) anthracene and coronene were detemined in all mussels samples.

The concentaration of PAHs were both calculated based on wet and lipid weights. The highest level of PAHs was observed in Pasir Puteh in Johor and the lowest concentration was found in Pasir Panjang, Port Dikson with total PAHs concentration of 37.87 μg/g lipid wt. and 3.58 μg/g lipid wt., respectively. Among the individual PAHs, the highest level was dibenzothiophene while the lowest level was benz(a)anthracene with an average concentration of 2.62 μg/g lipid wt. (0.66 to 6.87 μg/g lipid wt.) and 0.007 μg/g lipid wt. (0.0 to 0.032 μg/g lipid wt.), respectively.

This study has shown that Pasir Puteh has the highest level of total PAHs while Pasir Panjang had the lowest level of total PAHs. Conclusively, Pasir Puteh could be one of the most polluted sites and Pasir Panjang could be one of the cleanest sites. These results are consistent with the highly urbanized and industrialized hinterland of Pasir Puteh and conspicuously absence of any industries around Pasir Panjang coupled with the remote nature of the site.

MP06

## Distribution of Polynuclear Aromatic Hydrocarbons (PAH)s and Total Aliphatic Hydrocarbons (TAHs) in the bottom sediments of the Gulf of Thailand and the South China Sea

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Surface sediments (0 - 2 cm) from 23 stations in the Gulf of Thailand and the South China Sea were analyzed for Polynuclear Aromatic Hydrocarbons (PAHs) and Total Aliphatic Hydrocarbons (TACs). Aromatic hydrocarbon was found to be in range between 0.7047 ug/g dry wt. to 26.6066 ug/g dry wt., while aliphatic hydrocarbon was in the range between 2.1819 ug/g dry wt to 25.5314 ug/g dry wt. Long chain aliphatic hydrocarbons (n > 20) were found to be the dominant species in most of the stations. High concentrations of both aromatic and aliphatic hydrocarbons were found in samples from the Gulf of Thailand.

**MP07**

# Trend in Environmental Water Quality of Inner Jakarta Bay, Indonesia

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Jakarta Bay is a semi enclosed coastal bay located north of Jakarta City near the Java Sea. Beside its importance of being the site of the international port of Indonesia, Jakarta Bay is also important for fisheries and recreation.

However, the bay and its rivers are being subject to various types of pollution arising from human activities, such as domestic and industrial effluent. Though the country is marching towards prosperity, the problem pollution is steadily increasing and has become a matter of public concern. The pollution, if left unchecked, would result in the degradation of water quality and environmental alteration, ultimately limit the beneficial uses of the coastal waters.

Annual water quality monitoring of Jakarta Bay have been conducted by the Research Institute for Urban Development and Environmental (KPPL) DKI Jakarta since 1982 and additional investigations have been conducted by several researchers.

In general, the environmental water quality in Jakarta Bay has showed a gradual decrease. However, the continuing presence of pollution in Jakarta Bay waters suggest recent input these matters, which is probably due toanthropogenic source.

This paper presents an assessment of water quality status of Jakarta Bay waters and analysis the trend over the past ten years.

MP08

## Dissolved Fraction of Metals in Malaysian Waters, Using an In-site Sampling and Extraction Techniques

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Determination of trace metals in water requires preconcentration of the contaminant from large volumes of water and this incurs contamination problems during sampling transportation and extraction. This study investigated the use of an INFILTREX (IN-situ FILTRation and EXtraction) sampler in determination of dissolved fraction of trace metal concentrations in coastal waters of the west coast of Peninsula Malaysia and open ocean waters along the continental shelf off East Malaysa. Dissolved fractions for copper, cadmium, zinc, chromium, lead and iron were determined in 22 sampling stations along Miri, Brunei, and Labuan. The results showed trace quantities (< 0.02 ppm Cu; < 0.086 ppb Cd; < 1.52 ppb Cr; < 2.30 ppb Fe, < 5.4 ppb) for all the stations with the exception of copper showing elevated values (0.22 ppm) in the vicinity of Labuan Island. Zinc values were all below the detection limit of the instrument.

# Concentration of Heavy Metal Contamination in Marine Sediments off East Coast Peninsular Malaysia

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A marine survey was conducted in 1993 along 2,475 kilometres of tract in the South China Sea offshore East Peninsular Malaysia to evaluate the presence of placer gold, tin and heavy minerals, as well as sand resources. Geophysical methods were employed, consisting of high resolution seismic profiling side scan sonar and magnetics. These data were supported by analyses from 232 cores and 241 grab samples obtained in the 25,000 square kilometre survey area. The presence of heavy metals in the seafloor sediments was also examined in order to address environmental concerns that might arise if mining were to ensue.

The heavy metals were predominant in the silt fraction as compared to the sand fractions. The most significant area is off the Pahang coast, between Nenasi and Tanjung Gelang, where the selected eight metals (As,Cr, Cu, Hg, Ni, Pb, V and Zn) investigated were present in significant amounts. The other anomalous areas were ih the south around the islands of Sibu, Tinggi, Babi Besar, Pemanggil and Aur.

The high metal values in the silt fraction, however, showed less correlation with the QME results. The absence of equivalent minerals (likechalcopyrite, galena and sphalerite) related to the metals investigated (like copper, lead and zinc, respectively), indicated that these metals were predominantly present in elemental forms in the sediments. The concentration of these metals appeared to be further enhanced by the organic matter in the sediments.

As the anomalous values of these metals are caused by accumulation due to either adsorption in the clay minerals or formation of complexes with the organic carbons or both, it is recommended that a separate assessment study be undertaken to ascertain the source(s) for these contaminants, of which those at the top one meter of the sediment depth are highly suspected to be from industrial point sources along rivers or industrial wastes that are being discharged directly to the marine environment.

MP10

## Organic Contaminants in Sediments of Melaka Strait

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Anthropogenic organic chemicals such as petroleum hydrocarbons and Persistent Organic Pollutants (POP) are contaminants of concern due to their persistency in marine ecosystem that can cause long term adverse effect to marine life. A coastal water area of major concern is the Strait of Melaka which is relatively shallow and narrow but one of the busiest water way in the world. The biggest seafood productions of Malaysia is also come from this area.

In view of the situation, a study was carried out to evaluate distribution and speciation of the contaminants in sediment of Melaka Straits coastal water area. The organic contaminants in sediment at 21 sampling points along the strait were determined. The sediments samples were collected using box coring device having 20 x 30 cm cross-sectional area.

The petroleum hydrocarbon and POPs were determined by GC-FID and GF-ECD respectively. Proper quality control and quality assurance (QC/QA) were established to ensure the precision and accuracy of the analytical technique employed. For example the applicability of the technique were ensured by analyzing the Standard Reference Materials (SRM). Participation in the Interlaboratory Comparison Studies organized by IAEA's Marine Environmental Laboratory in Monaco (under UNEP/IAEA/IOC programme) is another example of activity to ensure the applicability of our analytical system.

There were 16 petroleum hydrocarbon species, 18 organochlorine pesticide species and 16 PCBs (polychlorinated biphenyls) species were identified in the study. The total hydrocarbon petroleum concentration was in the range of 0.2 µg/g to 46.6 µg/g. Whilst the total organochlorine pesticide was in the range of 1.90 ng/g - 21.65 ng/g. The total PCBs was found existed in marine sediment at the range of < 0.02 ng/g to 6.69 ng/g.

## Monitoring Programme on Marine Pollution from a Coastal Power Plant into the Sea

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An open-cycle, once-through cooling and coal-fire electric generating station is situated at Map Ta Phut, Rayong Province on the Eastern coast of the Gulf of Thailand. It requires substantial quantities of condenser cooling water. This power plant discharges heat water to the sea during operation since April 1999. The thermal effluent has some impacts on atmospheric, biological, chemical and physical environments in the sea. The sources of potential ecological changes are investigated. Aside from the thermalloading of coastal waters, other impacts of power plants result from chemical releases, as well as impingement of organisms on intake screens and entrainment of organisms through plant condensers. The most notable chemical impacts are associated with biocides, particularly chlorine used to prevent and remove buildup of bacterial slime and other fouling organisms in condenser tubes. The effluent may contain some heavy metals from the containers. In order to predict the seawater velocity and temperature fields of the thermal discharge which will meet the standard of Environmental Protection Agency, a mathematical model was constructed. The satellite data are being analyzed to map the pattern of the thermal distribution in different season. The field surveys programmes have been conducted to monitor the biological, chemical and physical environments at the intake and discharge sea area before, during and after operations.

# POSTER SESSION

P01

## Oceanographic Chemical Dataset in the Northwestern Pacific

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Japan Oceanographic Data Center (JODC) has been playing the role of national oceanographic data bank for the purpose of preventing valuable oceanographic data from being scattered and lost and supporting user's activities in the sea by facilitating the exchange of oceanographic data and information.

In recent years, various oceanographic observations and studies have being carried out in view of global warming and global environmental issues. It is expected that joint research and reciprocal use of the oceanographic data and information among research community would be promoted in order to improve the quality of study result and the cost performance.

NOPACCS (Northwest Pacific Carbon Cycle Study) is the project aiming at investigating and studying the mechanism of the absorption of carbondioxide (CO2) to the ocean and subsequent behavior and cycle of the carbon in the ocean. The data on physical circulation, biogeochemical processes and accumulation on the seafloor have been obtained from the repeated field surveys in the middle of the North Pacific Ocean, and a quantitative numerical model to clarify the mechanism of carbon circulation in theocean has been developed by using of the data.

JODC prepared the dataset compiled the data obtained by the project in cooperation with NOPACCS interests, in view of insufficiency of thosedata in the middle of the North Pacific Ocean.

**P02**

## Distribution of *Ceratium* Species in Quarter Bay, Iran

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Studies on the identification and distribution of*Ceratium* species were carried out in 10 different stations in Quarter Bay. Phytoplankton samples were collected vertically with a nylon plankton net having a mesh size of 55 micron.

In this investigation 9 *Ceratium* species were observed in which the dominant species was *Ceratium fusus* and the most abundance of *Ceratium* species was found in station 4, 7 and 10. The least abundance was observed in stations 1 and 2.

P03

## Monitoring of Trace Metals in Sediments and Flat Tree-Oysters from Sepang Rivers, Malaysia

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Studies on trace metals concentrations (Zn, Cu, Pb and Cd) in sediments and flat tree-oyster *Isognomon alatus* were conducted in Sepang Besar River and Sepang Kecil River in west coast of Peninsular Malaysia. Metals concentrations were analysed by acid digestion and determined by atomic absorption spectrophotometry model 4100 Perkin Elmer.

Results indicated that patterns of metals occurrence, in order of decreasing concentrations for oysters and sediments were Zn > Cu > Pb > Cd. A positive correlation ( $r$ = 0.71; 0.73; 0.78, $p < 0.05$) between trace metals in oysters and sediments was obtained for Zn, Cu and Cd, respectively. Trace metals concentrations in the oysters and sediments from Sepang Besar River, which receive effluent discharged from pig farm, were found to be significantly ($p < 0.05$) higher than those collected from Sepang Kecil River.

These results can be a useful information for future studies and management of trace metals pollution inthese coastal environment.

Keyword: Trace metals, Oyster, Sediments, Malaysia

**P04**

## Identification of Fishing Areas in the Southeastern part of Samar Sea, Philippines

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The study aimed to identify the different fishing areas inSamar Sea and gather information on fishing gear and method used, fishing season,characteristics of fishing sites and species caught in the area. There were 12 fishing areas identified by the study. The northern division includes potential groundsfor pelagic and demersal fisheries. Fishing areas comprising the southern portion has a fishing depth range of 4 to 84 m with mostly muddy-sandy bottom. The northern portion has a fishing depth range of 3 to 100 m with muddy and sandy shell bottom.

Most of the bottom fishes were caught by trawling, seining and longlining at various period of the year. Trash fish such as gobies and young bottom fishes were mostly caught by trawl. Both day and night operation were observed in the 12 fishing areas inSamar Sea.

P05

## Bio-Physical Characteristics of Maqueda Bay, Samar, Philippines

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The area which is collectively known as Maqueda Bay comprises Maqueda Bay and its adjacent waters. It covers an area of 650 $km^2$ and is located on the central part of Samar Island Philippines. Maqueda Bay is a semi-enclosed estuary with no significant spatial variability of the mean annual water temperature that is 27.74°C to 29.69°C while the salinity ranges from 31.49 ppt to 34.17 ppt. Transparency reading recorded from 5 to 11 m. Dissolved oxygen at the water surface ranges from 3.19 ml/l to 5.40 ml/l while at the bottom ranges from 0.45 ml/l to 3.86 ml/l. The current patterns and water circulation of Maqueda Bay is generally influenced by the prevailing wind direction in the area (i.e., southwesterly from April to August and northeasterly from October to March). The variable wind speeds ranging from 3.5 - 33.5 km/hr could prevail in a given day. The climate is classified as Type IV with more or less evenly distributed rainfall throughout the year and the monthly average mean of 335 mm. Wind borne water masses coming from Carigara Bay and Samar Sea determine the general water circulation. The bay is shallow estuary with the average depth of 14m with around 33% of the total area while deeper portion (i.e. 21 - 28 meters) are 18 % of the bay area. Soft-bottom substrates comprise 80 - 95 % of the Maqueda Bay's total bottom area. The soft-bottom nature and the shallow depth of the bay make it the preferred habitat of highly diverse groups of demersal fishes and shrimps. Rock and patchy reef formation line the islands in Maqueda Bay that constitute only about 5 % of the bay of total area. The coral cover of all site surveyed was only 37.24% which is fair category. Five species of seagrasses in the area while the mangrove has a total of 12 species with an estimated area 8,476.6 ha. Three major river systems (Calbiga, Motiong and Villareal Rivers) with an estimated total catchment area of 814 $km^2$ and a total runoff of 1,494$m^3$ drain to the bay. Maqueda bay was the site of the first widespread episode of red tide in the Philippines caused by the dinoflagellate *Pyrodinium bahamense* var. *compressum*. From 1983 to 1996 there are about 1067 paralytic shellfish poisoning (PSP) and death.

**P07**

# The First Step for an Oceanographic Database of the Vietnam Sea Region in the Gulf of Thailand

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An oceanographic database of the Vietnam sea region (lat. 8°20' - 10°20'; long. 103°28' - 105°10') in the Gulf of Thailand was built to serve various needs of research.

The contents of the database include:

- Data of 3 oceanographic surveys in 1994 - 1998
- Data of 4 many-years hydrometeorological stations
- Some statistical data, metadata and summaries
- 10 reports of researches on natural conditions, currents, tides, circulation, environment, biology and fisheries of the sea region and the Gulf of Thailand (in Vietnamese)

The data is in the format of Microsoft Excel and VODC software (the software also included); the reports - Microsoft Word and the pictures - Windows bitmaps.

The database is stored in a CD-ROM disk.

P08

## State of Vietnam Coastal Erosion and Accretion and Environment Concerns

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Vietnam, a marine nation in South-East Asia with over 3,200 km coastline is facing with some coastal environment problems caused by erosion and accretion increasing.

During the last some decades, the coastal erosion has occurred in many coastal places of Vietnam with the rate of 2 - 10 m/yr, sometime 15 - 25 m/yr and even 30 - 50 m/yr. It has threatened directly settlements, destroyed buildings and dikes, narrowed down mangrove forests and coastal land. The coastal accretion has occurred mainly in the deltaic coastal areas. The large deltas such as Red River Delta in the North and Mekong River Delta in the South have expanded seaward by hundreds of hectare every year and created the precious land resources for the development of agriculture, aquaculture, mangroves, new settlements and economic areas. However, the coastal sedimentation in estuary area has impacted negatively on the shipping channels and port, that has made difficulty for the development of ports and waterway.

Moving of the sand dunes and barriers landward, moving and closing the lagoonal inlets and small river mouths have occurred in the central Vietnam. The dunes and barriers have moved landward by the rate ranging from 2 to 15m/yr, filling the ricefields, houses, roads. The migration and closure of the lagoonal inlets and small river mouths have caused floods, inundations and traffic snarls.

P09

## Cooperative Projects in the Sea of Japan and the Sea of Okhotsk: New Oceanographic Data for International Community

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During the last decades, FERHRI specialists implemented investigations on oceanography and chemistry of the North Pacific, Chukchi and Bering Seas, the Sea of Okhotsk and the Sea of Japan. Within the INPOC (International North Pacific Ocean Climate) program, a few joint expeditions with scientists from Canada and the United States were carried in the North Pacific from 1991 to 1993. Joint investigations with US scientists in the Chukchi and the Bering Seas were implemented within the BERPAC program from 1977 to 1993.

From 1993, joint investigations with specialists from Japan and Republic of Korea were fulfilled in the Japan Sea. These studies were implemented within the CREAMS (Circulation Research of the East Asian Marginal Seas) project. Since 1998, joint investigations of the Okhotsk Sea and the Japan Sea began with specialists from Japan and the USA.

The goals of investigations of the Japan Sea are (among others): to improve the hydrographic and chemical database; to examine the relationship between cold air outbreaks in winter along the Russian coast and the circulation of the Japan Sea. The subsurface current vectors and temperature/salinity profiles generated by PALACE floats should help to greatly improve our understanding of the space- and time-dependent circulation in the Japan Sea, especially in the winter, and the data can also be used in conjunction with numerical ocean models. A few large-scale cruises will obtain nearly synoptic pictures of the major components of the Japan Sea.

The specific goal of the Okhotsk Sea investigations is to study the role of the Okhotsk Sea and its ice cover in the process of ocean-atmosphere interaction. The objectives of multidisciplinary collaborative studies are as follows: to improve understanding of water circulation and ventilation in the Sea ofOkhotsk; to reveal water mass origin in the Sea of Okhotsk (especially source waters of the North Pacific Intermediate Water) and water mass transformation; to estimate quantitatively water exchange between the Sea ofOkhotsk and the North Pacific through Bussol Strait; to study mechanisms of ice cover formation and its annual and interannual variations. Joint expeditions in the Sea of Japan and theOkhotsk Sea will be continued in 2000-2001.

P10

## Measurement of Wave Height in the Gulf of Thailand

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Waves can cause serious damage to shore structures and effect to fisheries industry and any activities in the sea. Therefore wave data is very important to study waveclimatology in any area, which many sources capability to measure wave height simultaneously and scientists can improve their wave prediction models. Wave data are often required by meteorologists for real-time operational use and also for climatological purposes. Types of wave data which are available, namely, observed, measured andhindcast. The remotely-sensed data which are becoming of increasing importance in real-time applications. These new data sources have mode possible the assimilation of real data into wavemodeling procedures.

**P11**

## Development of Molecular Markers for Sea Cucumber (Holothuroidea)

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Malaysia is the country that is rich of its sea cucumber, but unfortunately very little genetic information about this organism is currently available. Detail molecular level study is urgently needed to obtain more knowledge about this organism system and so that various genetic manipulation for crop improvement can be made possible. Therefore this study was carried to overcome some of the problems associated with molecular studies and genetic analysis of sea cucumber. Genetic markers such as RAPD were used to generate informative fingerprint pattern between the populations and species. Fourteen species from four populations; Kedah, Perak, Terengganu and Sabah were used in this study. Genetic polymorphisms and species relationships were detected based on 98 RAPD markers generated by seven primers (Gibco BRL). The optimum polymerase chain reaction (PCR) temperature, condition and adequate sample size was used to amplify the fragments of DNA. 12 % nondenaturing polyacrylamide gel was used to resolve RAPD markers with a silver staining method. The number of amplified bands for each primer varied from 1 to 9 with an average of 4 band per primer. The amplified bands ranged in size from 80 to 1500bp. Reproducible major bands of amplified DNA was scored and analysed using the RAPDistance Package. The result showed the pairwise distance index ranged between 0.51 and 0.97 with the percent of similarly between 7 % and 80 %, suggesting presence of some genetic variability in the populations. Cluster analysis revealed 2 major groups with 4 cluster groupings. Species from Terengganu population are found to be genetically more close to Sabah population that those of Perak and Sabah.

P12

## The National Environment and Resource information Centre (NERIC) and Coastal Zone Management in Vietnam

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The National Environmental and Resource Information Centre (NERIC) was established as a part of Vietnam National Oceanographic Data Centre (VODC) for implementing the Coastal Zone Environmental and Resource Management Project (CZERMP) in Vietnam. One of the NERIC functions is to collect and identify all available data and sources on natural conditions, resources and environmental status of various areas along the coastline of Vietnam. NERIC encapsulates advanced computing facilities, image analysis capacity and GIS processing capability, which allow to conduct standardization for building the GIS databases, Metadata directories on Marine and Coastal Environment and resources. At. present NERIC is operated on the basis of a computer network connecting the VODC with collaborating research institutions and managing agencies within CZERMP.

The most important task of NERIC is data analysis and GIS processing with purpose to evaluate the status and to assess the environment impacts of economic development and human activities in coastal zones of Vietnam. During 1997-1999, aMetadata directory and GIS databases have been established for Van Phong Bay and Red River mouth area in Vietnam. The final results of study in these areas includeGIS products on Environmental Impact Assessment caused by tourism development, sea port construction, aquaculture development in Van Phong Bay area, as well as agriculture development and aquaculture exploitation in the Red river mouth area. GIS products have been transferred to managing agencies and decision makers for use in coastal environment and resource protection and sustainable development planning.

**P13**

# International Cooperative Effort on Oceanography and Sustainable Development of the Gulf of Thailand

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The International Cooperative Study on the Gulf of Thailand (GoT) was initiated as an cooperative effort among 3 regional bodies, the Intergovernmental Oceanographic Commission-Subcommission for Western Pacific (IOC-WESTPAC), the Southeast Asia Program on Ocean Law, Policy and Management (SEAPOL), and the Southeast Asia Global Change System for Analysis, Research and Training RegionalCenter (SEA START RC). By combining the expertise and strengths of these regional networks, the GoT program can achieve its important functions;

a) coordinating and facilitate for regional oceanographic data collection,
b) promote the exchange of data,
c) regional synthesis and review of the oceanographic processes and status of the Gulf of Thailand,
d) promote the use of oceanographic data and marine information technology in policy making and decision making at all levels.

Geographically, the Gulf of Thailand defined in this program represents the "Greater Gulf of Thailand" where a significant portion of the adjacent South China Sea is covered by the program. Local and rivers and the Mekong which play critical roles in the Gulf oceanographic processes are also included, and thus the landward boundary of the Gulf extend to cover drainage basins in South China, part ofMyanmar, Laos, Thailand, Cambodia, Vietnam and Malaysia.

The activities of the program since its establishment in 1996 include

a) Organized training courses on oceanographic data and information system (Bangkok 1996 and 1999), and training course on numerical modelling (Rayong 1998).
b) Organized advanced workshop on numerical modelling (Okinawa 1998)
c) Organized international oceanographic cruise (1999)

d) Special lectures by international experts (more than 10)
e) Operate the project data center and service for data such as oceanographic station, high resolution CTD, ADCP, meteorological, rivers, topography, and remote sensing.
f) Maintain the Internet Discussion Groups
g) Maintain the regional drainage modelling
h) Written contributions in books and projected organized by other programs
i) Provide the on the job training for international fellows and students of up to 3 months each

In addition to activities conducted directly by the program and its personnel, national contributions have also been important part. Some of such outstanding contributions were at least 5 cruises conducted by Malaysia (Hydrographic Department), Thailand (Pollution Control Department, National Research Council of Thailand/Southeast Asian Fisheries Development Center) and Vietnam (Hydrometeorological Services).

**P14**

## JICA/UPM Malacca Straits Expedition No2, Nitrogen and Phosphorous Distribution

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The secoond cruise of JICA/UPM Malacca Staits Expedition was conducted between 20th March - 4th April 1999 using the Fisheries Research Vessel K.KJenahak. Water sample were taken from the 24 sampling stations established previously; fromLangkawi to Johor. During the cruise, there was a heavy rainfall on land due to theSouth-east Monsoon season. The sea was rough during sampling. High ammonium and organic phosphorous levels were found in the study area especiallynear to the shore. Most probably it was due to the run-off from land because of the heavy rain. The overall mean values of ammonium at 0.5, 5, 10, 15, 20, 25, 30, 35, 40 and 50 meter depth were 2.248, 1.731, 2.392, 1.666, 1.348, 1.867, 2.766, 1.296, 2.083 and 1.136 μM respectively. For the organic phosphorus, the values were 4.849, 5.719, 5.541, 4.878, 6.997, 5.628, 5.755, 4.145, 3.395 and 4.930 μM respectively. These values are 5-10 times higher than that detected at the same sampling stations during the first cruise (between 23rd November - 2nd December 1998). These values were also much higher than the levels reported for other Malaysian sea. Low levels of nitrate, nitrite andortho-phosphate were detected in this study. Detail data of the nutrient distribution will be discussed and the area of contamination will be identified by using Surfer plot.

Keyword: Malaccan Straits, nitrogen and phosphorous

P15

## Quantitation of Polycyclic Aromatic Hydrocarbons (PAHs) in Marine Environmental Samples by Silica Gel Column Chromatography and GC-MS

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PAHs are widely distributed in the environment and they are environmentally significant compounds, including carcinogenic and mutagenic species. Analysis of these compounds is one of greatest interests in environmental pollution studies. In the past decade, quantitation of trace level PAHs has been made possible with the advent of high resolution GC-MS. In the case of marine environmental samples, it is generally difficult to separate PAHs from other micro-organic compounds such as, linear alkyl benzenes (LABs), alkanes, alkylphenols, polychiorinated biphenyls, etc. In this study, we used 2-steps silica gel column chromatography to separate and fractionate PAHs from other non-target organic compounds. The mesh size of the silica gel was 60 - 200 mesh. PAHs (containing 19 compounds including 2 deuterated internal standards), n-alkanes (containing C16 to C36) and LABs (1-$C_n$) standard mixtures was mixed together and introduced to the top of the 1st step silica gel column. The first step silica gel column uses 5 % water deactivated silica gel with 3:1 hexane/dichloromethane (Hex/DCM) as eluant. Prior to this step, exact volume of the solvent mixture was determined in the elution volume experiment. In the experiment, different volume of the solvent mixture was used to determine the exact volume in which the target compounds are eluted. The purpose of 1st step silica gel column chromatography was to purify the extracted samples. All other polar compounds are trapped in the column leaving behind hydrocarbons as the eluted compounds. The elution volume for all the target compounds was found to be 14.5 ml 3:1 hex/DCM. Fractionation of hydrocarbon compounds (aliphatic and aromatics), PCBs, LABs, were achieved by 2nd step silica gel column chromatography using fully activated silica gel. In this step, different groups of compounds are separated and collected. Different volume of solvent mixtures was used to determine the elution volume to separate each group of the compounds. It was found that exactly 5.5 ml and 4.5 ml hexane is needed to separate n-alkanes and alkylbenzenes, respectively while 7.5 ml 25 % DCM in hexane was needed to separate PAHs. The volume of PAHs fraction was reduced to near dryness and dissolved in iso-octane and injected into GC-MS. Based on the elution volume experiment, we applied to real environmental samples to quantify PAHs. The method proved to be successful since PAH were qualified and quantified. The recovery for the analytical procedure was found to be generally 85 - 95 %.

**P16**

## Distribution of Ortho-phospate in the Straits of Malacca

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The oceanographic surveys were conducted in the Straits of Malacca from 24 to 30 March 1998 (first cruise) and from 8 to 25 November 1998 (second cruise). A total number of twenty stations were established during both cruises. Water samples fororthо-phosphate analysis were collected at surface and bottom water. Ortho-phosphate concentration in the surface water for the first and second cruises range 0.01 - 0.20 μM and 0.04 - 0.27 μM respectively. While for bottom water, ortho-phosphate concentration in the first and second cruises ranged from 0.04 - 1.32 μM and 0.08 - 0.55 μM, respectively. Average concentrations of ortho-phosphate in the surface and bottom water for the first cruise were 0.06 and 0.72 μM, respectively. The average concentrations of ortho-phosphate in the surface and bottom water for second cruise were 0.11 and 0.26 μM, respectively. Generally, ortho-phosphate concentrations in the bottom water of the northern part of this study area were higher than the southern part.

P17

# Development of SINE-SLAB® for Coastal Erosion Control

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The Sine-Slab® is a patented concrete product developed by the Coastal and Offshore Engineering Institute, Universiti Teknologi Malaysia. The research group which started since 1993 has invented and developed the awards winning product to be used as an alternative solution for erosion control at the coastal and riverside areas. Coastal erosion however, is a localized problem and methods to combat vary from one location to another. Rubblemound or rock revetment has been a traditionally accepted method of coastal defense but at certain areas, the supply of rocks is limited, and the method is less environmental friendly. Among the objectives of the invention include to provide a method that is effectively stable and durable against hydraulic loading at the same time being environment-friendly. A major advantage of the articulated blocks designed and prefabricated as pre-cast concrete blocks is that they provide a high stability coefficient value ($K_D$). This allows for a lighter weight of the blocks plus additional design features which can provide the strength against the impacts of the waves, current and periodic tidal changes. Hydraulic model tests were conducted in the laboratory and more data is being gathered from the Pilot Project in Melaka. In order to provide comprehensive design chart, stability tests need to be further simulated for wave heights greater than 2 m. Applications of Sine-Slab® include for shore protection, land reclamation projects, flood control, ship berths and docks in harbours, beaches and marinas. Sine-Slab® patent is licensed to Zen Concrete Industries (M) Sdn Bhd for Commercialisation in Malaysia.

Keywords: Coastal, erosion, protection, hydraulic, design, patent, stability, pre-cast concrete

**P18**

# Screening for the Presence of Endoparasites in the Gastrointestinal Tract of Sea Cucumbers From Trengganu

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This paper describes the preliminary findingson the study of endoparasites in the gastrointestinal tract of sea cucumbers observed under the light microscope. Samples were obtained from Pulau Kapas, Terengganu. A few copepods are identified from the intestines of *Holothuria atra* Jaeger. Identification is based on its morphology. Marine nematodes observed in abundance in various stages of its life cycle in from the intestines of *Holothuria atra, Stichopus Chloronotus* Brandt and Stichopus Badionotus are identified and described. The worm has elongated body outline and may be in a curled up position. It is rounded at the anterior portion and pointed at the posterior end.

Both copepods and marine nematodes are zoobentos components of the seabed. Therefore, their presence in the gastrointestinal tracts could be as a source of food since these animals are filter feeders. Their abundance in the gastrointestinal tracts of these animals could be also be as indicators of pollution (Moller, 1987; Khan 1991; MacKenzie, 1995)

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*Sponsored by*

**The Nippon Foundation**
**Science & Technology Agency, Japan**
**Japan International Cooperation Agency**