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22292

**EMERGING
TECHNOLOGY
SERIES**

1 and 2/1998

***Marine Industrial
Technology***



**UNITED NATIONS
INDUSTRIAL DEVELOPMENT
ORGANIZATION**

Vienna, 1999

MARINE INDUSTRIAL TECHNOLOGY

Nos. 1 & 2/1998

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technology and spatial analysis in
coastal zone management
Kurt Fedra and Enrico Feoli

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Compiling and editing: D. Rhind

Published in 1999 by the United Nations Industrial
Development Organization (UNIDO)
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A. SPECIAL ARTICLE

Geographic information systems technology and spatial analysis in coastal zone management

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Abstract

This paper reviews methods and tools of spatial analysis, their integration and application to coastal zone management. Following a definition of the coastal zone and a short description of its peculiarities and unique management problems, the paper first describes the major tools for spatial analysis and, in particular, geographic information systems (GIS) and remote sensing, spatially distributed simulation modelling and optimization, and expert systems, as well as their integration in information and decision support systems.

This is followed by a short review of the main paradigms of spatial analysis, such as environmental impact analysis, risk assessment and policy analysis, and specific problems such as zoning and site selection. Special emphasis is given to the issues of industrial development in coastal zone management. Examples from the literature are used to illustrate concepts and trends, and the discussion addresses the role of information technology in spatial analysis and its application to coastal zone management in particular.

Key words: GIS, Remote sensing, Coastal management, Modelling

Introduction

Coastal zone, for the purpose of this paper, shall mean the area, on both sides of the actual land-water interface, where the influences of land and water on each other are still a determining factor—climatically, physiographically, ecologically or economically. Within a European perspective, this means a coastline of (fractal theory notwithstanding) at least 148,000 km, with an estimated 200 million people living within 50 km of it. And while overexploitation with its subsequent pollution and degradation can be found everywhere, no comprehensive coastal zone management scheme yet exists for Europe (Stanners and Bourdeaux, 1994).

The coastal zones around the world's oceans and inland seas, including the numerous small islands, share a number of characteristics that define both their value and their vulnerability:

- The coastal zone shows a high population density with a large number of urban conglomerations and, in consequence, in most countries, a fast population growth;
- Again as a consequence, they are characterized by a high concentration of economic and, in particular, industrial activities with all the resulting problems of resource consumption, waste management and technological risk.

High levels of population and industrial activities cause high resource requirements, water and energy being the most obvious ones.

Population and industry also induce passenger and freight traffic which, for the coastal zone, includes both shipping as well as land-based forms of transportation and, of course, air traffic.

On the coastal water side, we have fisheries and aquaculture, exploiting a generally highly productive ecosystem that is not only productive in its own right but plays an extremely important role in the aquatic ecology as a breeding and nursing ground for many commercially important fish species. Very specific and valuable, as well as vulnerable, a typical coastal ecosystem includes estuaries, salt marshes, mangroves, sea grass meadows and coral reefs (e.g., Lean and Hinrichsen, 1992).

Offshore activities, such as oil and gas, as well as mining, are additional forms of exploitation of the coastal zone.

A most important form of land-use is recreation, which is often the dominant economic activity in many parts of the area.

While these activities, and in particular fisheries and recreation, would benefit most from a pristine environment, they, like all the other forms of land-use and resource exploitation, in fact often seriously degrade the coastal environment.

In addition, the coastal zone is also the recipient of all water-borne waste streams, including non-point sources primarily attributable to agriculture, its fertilizers and agrochemicals, and all the treated and untreated waste water the hinterland produces in the respective catchments. They all drain into the coastal waters.

A systematic classification of coastal zone uses can be found in Vallega (1993). It includes seaports, shipping (carriers, routes, navigational aids), sea pipelines, cables, air transportation, biological resources, hydrocarbons, metaliferous resources, renewable energy, defence, recreation, waste disposal, research, archaeology, environmental preservation and protection. These are further subdivided into a total of 250 kinds of uses, all focusing more or less on the aquatic part of the coastal zone. All of these activities compete for space, for resources and for the waste absorption capacity of the coastal zone. The intensity of activities that characterize the coastal zone implies competition for the use of the available land, in particular, since many activities such as industrial and recreational use are mutually exclusive.

Other specific problems include, on the one hand, the exposure of the terrestrial zone to marine impacts and, on the other, terrestrial impacts on the coastal waters.

The first group includes such phenomena as storms, tides and surges, the occasional tsunami, and the prospect of sea level rise, coastal erosion, salt water intrusion in rivers and aquifers caused by (often man-made) low-flow and excessive withdrawal.

The second group includes problems such as coastal pollution from a variety of sources, including polluted rivers, more local waste water outflows, unsustainable coastal fisheries, and more exotic problems such as genetic pollution from aquaculture.

Somewhere in between are problems related to shipping accidents such as oil spills and not so accidental spills, and losses from offshore activities or, on the terrestrial side, classical pollution problems from urban and industrial development, or the socio-economic problems of rapid urban development.

All these problems have an obvious and often dominating spatial aspect, which makes coastal zone management a spatial problem.

An illustrative and most recent example of coastal zone problems is given by Ajour and Drabih (1997) for Gaza, Palestine: while covering only 44 km in length and about 74 km², by the author's definition, the list of problems includes: destruction of beach landscape, destruction of natural coastal habitat, waste water discharges, dumping of solid waste and construction waste directly on the beach, beach erosion, unplanned (random and scattered) development, conflicting land uses, lack of awareness by the public and government. As economy on coastal zones increases there are increased pressures on natural resources which render it very difficult to foresee the environmental dynamics without proper scientific and high-level technological tools.

To solve conflicts and/or find optimal solutions, the integration of recent tools, such as GIS, image-processing systems (IPS), remote sensing (RS), with data management, data analysis and modelling, looks to be a promising exercise. As a matter of fact, in the general information and guidance on developing and implementing an integrated coastal management (ICM) programme, UNEP (1995) includes special tools and techniques of GIS and data

management to face problems of protected areas, ecosystem management, impact assessment, economic evaluation and risk assessment, and searching the Internet with ICM and GIS as keywords, yields a surprising number of returns. In this paper we try to present state-of-the-art GIS technology and its applications in coastal zone management.

GIS technology and coastal management

Coastal zone management, by definition, is spatial management. Spatial management means the distribution and allocation of space, ultimately of parcels of land (with or without water covering it), to alternative uses or activities, or the control of processes that in turn may affect space, such as emissions. Many of the underlying processes within the domain of environmental (both physical and ecological) modelling can be represented by spatially distributed models that describe environmental phenomena in one (for example, in river models), two (land, atmospheric and water quality models, models of population dynamics), or three dimensions (again air and water models). The increasing development and use of spatially distributed models replacing simple spatially aggregated or lumped parameter models is, at least in part, driven by the availability of more and more powerful and affordable computers (Loucks and Fedra, 1987; Fedra and Loucks, 1985).

The term "geographic information systems" (GIS) means a set of computer tools to capture, manipulate, process and display spatial or geo-referenced data. By GIS technology we mean the integration of all the methods and tools that can be useful to establish a decision support system (DSS) for spatially related problems. Notwithstanding the fact that in the specialized literature (e.g. Holsapple and Winston, 1991) DSS is mainly viewed as a mathematical technique or set of techniques for optimizing something under some constraints, we consider DSS in its broad meaning as an information system that can be used to support decisions.

The system needs the following components: GIS, data analysis and image processing, modelling and expert systems, simulation and optimization, and a suitable user interface. These components are discussed as follows.

Geographic Information Systems

A Geographic Information System (GIS) is a set of computer tools designed to efficiently capture, store, update, manipulate, analyse and display all forms of geographically referenced information (e.g. ESRI, 1992). A GIS typically links data from different sets, using geo-referencing, i.e., spatial coordinates, as a common key between different databases. The power of a GIS stems from its ability to combine many data sets and display them in a common framework as thematic maps. To obtain thematic maps the GIS may have internal software tools for database and data analysis and image processing, or may be easily interfaced with external software. There are many GIS on the market, commercial and public domain GIS, and they are all different from each other. They may answer more or less easily and completely the following typical questions depending on how they have been designed:

- *Spatial identification*: find locations where certain conditions are satisfied, including the logical (Boolean) or arithmetic combination of multiple layers (overlay analysis);
- *Trends*: find the differences within an area over time or along spatial dimensions;
- *Patterns*: find correspondences between distribution of different attributes; calculate similarity between patches, fractality, indices of fragmentation, and so on;

- **Modelling:** answer "what if" questions.

However, to answer more complex questions one needs to combine (static) geographic data layers with dynamic and spatially distributed models.

Data analysis and image processing

Many GIS have internal data analysis and image-processing functions that can calculate different pattern indices such as fragmentation, fractality, entropy, etc. (Turner, 1989). Some GIS, such as IDRISI, ILWIS, GRASS, have the possibility to treat remote sensing data coming from LANDSAT, SPOT, NOAA, etc. by using the maximum likelihood algorithm and fuzzy set theory (IDRISI). GRASS also allows the use of sophisticated neural network algorithms (Openshaw, 1993; Fisher, 1993, 1994). However, these GIS do not offer the possibility to treat ancillary data of specific operational geographic units (OGU). These may be pixels, polygons, sets of pixels and sets of polygons, for hierarchical classifications and ordinations by methods such as cluster analysis and factor analysis (Arentze, Borgers and Timmerman, 1996) or fuzzy set theory (Fabbri and Chung, 1996). These methods are still available only on external packages. However, all modern GIS support convenient data import and export functions. Many packages are available for data analysis. However, except for the method of maximum likelihood, they rarely include methods of classification and ordination based on probability (Feoli and Zuccarello, 1996). The advantages of using such functions derive from the fact that similarity between OGU's may be tested in a probabilistic way within the data sets representing the system under study. With probabilistic similarity functions the similarity may be tested within and between time intervals. These functions, based on Goodall's probabilistic index (Goodall, 1964), have been included in the information system developed by ICS/UNIDO (Feoli, 1995) especially for applications in coastal zone management and for treating remote sensing data (Altobelli et al., 1995).

Modelling and expert systems

In GIS, the basic concept is one of location, of spatial distribution and relationship; basic elements are spatial objects. In environmental modelling, by contrast, the basic concept is one of state, expressed in terms of numbers, mass, or energy, of interaction and dynamics; the basic elements are "species", which may be biological, chemical, and environmental media such as air, water or sediment.

The overlap and relationship is apparent, and thus the integration of these two fields of research, technologies, or sets of methods, that is, their paradigms, is an obvious and promising idea (Fedra, 1994, 1995).

Simulation and optimization modelling is a powerful tool of analysis and forecasting. Another example of possible integration is provided by quantitative numerical models and rule-based, qualitative expert systems. Expert systems can be used just as any other model to assign a value to an output variable given a set of input variables; they do this, however, by using rules and logical inference rather than numerical algorithms.

In the context of models, expert systems are often used to help configure models (implementing an experienced modeller's know-how to support the less experienced user) and estimate parameters. A number of these "intelligent front end systems" or model advisers have been developed in the environmental domain (Fedra, 1992).

A rule-based approach can also be a substitute for a numerical model, in particular, if the processes described are not only in the physical and chemical, but in the biological and socio-economic domain. An example could be

environmental impact assessment based on a checklist of problems, which can be understood as a diagnostic or classification task. A qualitative label is assigned to potential problems, based on the available data on environment and planned action, and a set of generic rules assessing and grading the likely consequences. An example of such a rule-based system for impact assessment is described in Fedra et al. (1991).

And finally, a model can be integrated into the inference chain of an expert system. Recent examples of environmental expert systems are given in Hushon (1990), Fedra (1992) and Wright et al. (1993).

The possibility to integrate models in place of rules in an expert system and at the same time use embedded rule-based components in models provides a very rich repertoire of building blocks for interactive software systems that link policy level information with the underlying data and methods through hierarchies of methods and intermediate data. The flexibility to use, alternatively or conjunctively, both symbolic and numerical methods in one and the same application allows the system to be responsive to the information at hand and the user's requirements and constraints. This combination and possible substitution of methods of analysis, and the integration of databases, geographical information systems, and hypertext allows the user to efficiently exploit whatever information, data and expertise is available in a given problem situation. The approach is based on a model of human problem-solving that recursively refines and redefines a problem as more information becomes available or certain alternatives are excluded at a screening level. Learning, i.e., adaptive response to the problem situation and the information available, and the ability to modify function and behaviour as more information becomes available, is a characteristic of intelligent systems.

In this context the application of cellular automata modelling, coupling cellular automata and differential equations, may offer new tools for modelling by GIS. The cellular automata concept is based on a set of contiguous cells with rule-based interactions, e.g., fluxes between cells. These rules may come from numerical models or from logical models. Cellular automata modelling could help to simulate many alternative scenarios in coastal areas both concerning pollution of water and/or urban and industrial development (Camara, Ferreira and Castro, 1996; Roy and Snickars, 1996; Sanders, 1996).

Simulation and optimization

Another example of the integration of different methods is the coupling of simulation and optimization: optimization usually requires an (often-gross) simplification of the problem representation to become tractable. Simulation models, on the other hand, while capable of representing almost arbitrary levels of detail and complexity, are rarely capable of solving inverse problems, i.e. determining the necessary set of inputs or controls to reach a desired outcome.

One can, however, combine the approaches in that a simplified model (e.g. steady state and spatially aggregated) is used as the basis for optimization; the result of the optimization is then used as the basis for a more detailed, e.g. dynamic and spatially distributed simulation model, that also keeps track of the criteria, objectives and constraints used for the optimization, but with a higher degree of spatial and temporal resolution and possibly a more refined process description. If, in the simulation run, constraints are violated or objectives not met, the corresponding values can be tightened or relaxed in the optimization to obtain a new solution, which again is subjected to more detailed examination with the simulation model.

Modelling of marine systems has a considerable tradition in both physical and biological oceanography. For summary treatments, more recent model comparisons, and some classics in the field, see, for example, Riley et al. (1949); Nihoul (1975); Goldberg et al. (1977); Kremer and Nixon (1978); Falconer et al. (1989); Fransz et al. (1991).

However, most of these approaches are designed to improve scientific understanding of physical and biological processes, with the notable exception of some of the fisheries models that have obvious management implications (e.g., Andersen and Ursin, 1977). Other management-oriented and model-based studies of marine systems include the RAND Corporation classic on the Oosterschelde (Bigelow et al., 1977) or the recent study of MANS (Management Analysis North Sea) (Rijkswaterstaat, 1988; Klomp, 1990). Here, as well as in a number of similar projects including models, the emphasis is on environmental and resource management issues, and decision support, rather than primarily scientific progress.

The user interface

Analysis in GIS is based on the map paradigm, maps in inherently static objects, and the basic level of analysis is (Boolean) map overlays. Complex relationships and dynamic processes may require another layer of tools, namely simulation models, to be integrated with a GIS.

The integration of GIS and environmental models can come in many forms. In the simplest case, two separate systems, the GIS and the model, just exchange files: the model obtains some of its input data from the GIS, and produces some of its output in a format that allows import and further processing and display with the GIS. This seems to be a rather common approach, since it requires little if any software modifications. Only the file formats and the corresponding input and output routines, usually of the model, have to be adapted. Depending on the implementation, however, a solution based on files shared between two separate applications, usually with a different user interface, is cumbersome and possibly error prone if it involves a significant amount of manual tasks. Deeper integration provides a common interface and transparent file or information sharing and transfer between the respective components. Possible ways are the use of higher-level application language or application generators, increasingly common as built-in features of commercial GIS packages as the basis of numerous integrated applications. Application generators and modelling capabilities with commercial GIS also offer the possibility of tight integration within the limits of the respective package options.

An alternative is to use an open GIS tool kit that uses a standardized interface, such as GRASS (Gardels, 1988; Fedra and Kubat, 1993). Modules of the overall GIS system (which really is a set of tools with a standardized pipeline-type flexible coupling) can be included in modelling applications. The X-Windows system and a number of interface-building tool kits make this a rather efficient integration strategy. Any integration at this level, however, requires a sufficiently open GIS architecture that provides the interface and linkages necessary for tight coupling.

Using such predefined tools and components, while efficient for fast prototyping, can also be restrictive:

investments in tool kits always carry the temptation to reformulate problems in terms of the available tools rather than the other way round.

Another alternative is the use of do-it-yourself tool kits that provide both customized GIS functionality as well as interface components for simulation models. A recent example of integration that draws together GIS, models, spreadsheets and expert systems in a programmable system is RAISON (Lam and Swayne, 1991).

Integrated environmental management information and decision support systems, built around one or more coupled models, numerical simulation models or rule-driven inference models and integrated with GIS, feature:

- An interactive, menu-driven user interface, that guides the user with prompt and explain messages through the application. No command language or special format of interaction is necessary: the computer assists the user in its proper use; help and explain functions can be based on hypertext and possibly include multimedia methods to add video and audio technology to provide tutorial and background information; in other words, they must be easy to use even for the non-specialist;
- Dynamic colour graphics for the model output and a symbolic representation of major problem components that allows easy and immediate understanding of basic patterns and relationships. Rather than emphasizing the numerical results, symbolic representations and the visualization of complex patterns support an intuitive understanding of complex systems behaviour; the goal is to translate a model's state variables and outputs into the information requirements of the decision-making process; also, the coupling to one or several databases, including geographical information systems, and distributed or remote sources of information in local or wide area networks provide necessary input information to the models and the user. The user's choice or definition of a specific scenario can be expressed in an aggregated and symbolic, problem-oriented manner without concern for the technical details of the computer implementation; data on chemical properties of the substances of concern, used in pollution fate and transport models, are one obvious example;
- Embedded Artificial Intelligence (AI) components such as specific knowledge bases allow user specifications in allowable ranges to be checked and constrained, and ensure the consistency of an interactively defined scenario; as a special case this could also include QSAR methods that can be implemented in a combination of rule-based methods and algorithmic methods;
- And they are, wherever feasible, built in direct collaboration with the users who are, after all, experts in the problems areas these systems address.

The examples of integration discussed above mainly refer to internal integration, i.e., linking components of an information system. There are, however, two more important dimensions to integration that need to be considered: integration with the user and integration with the information sources of a system (compare figure 1). Important issues here are interaction and visualization, intelligence, and customization, that is the integration into the institutional framework of a system's intended use.

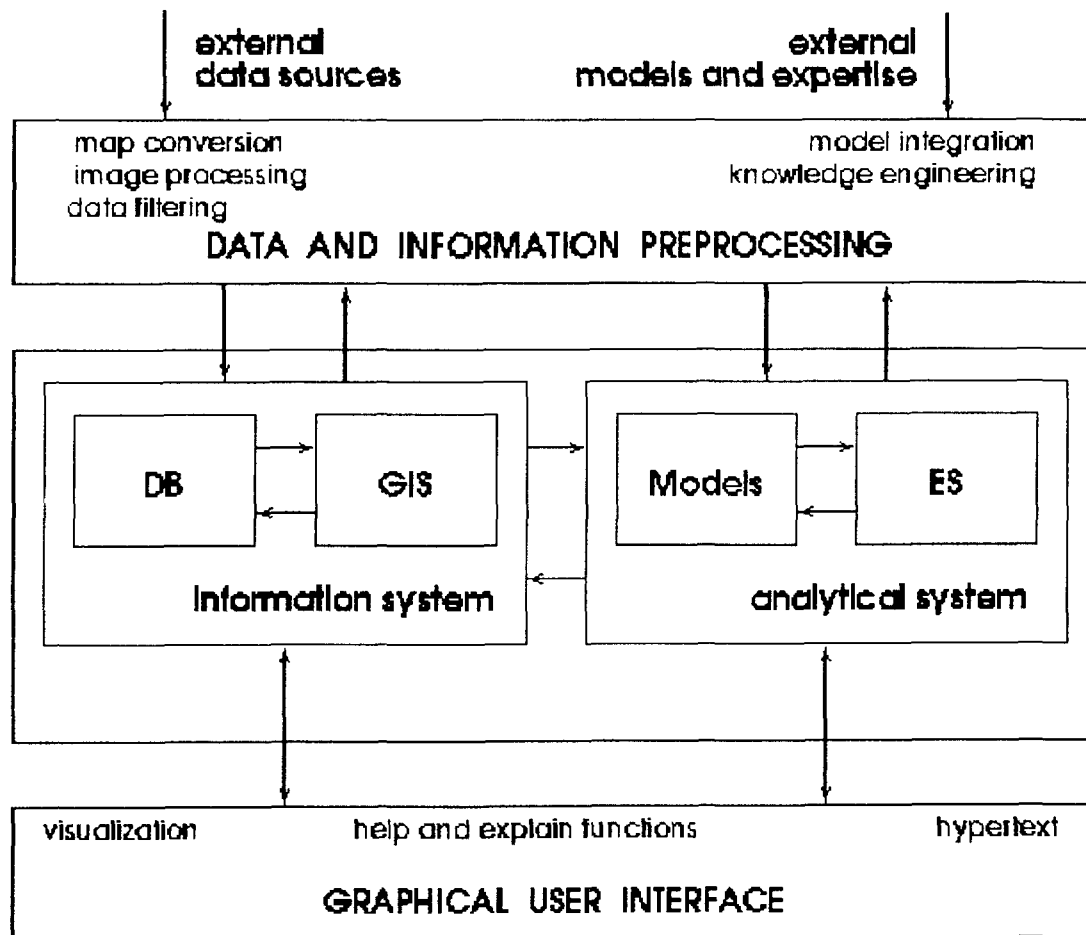


Figure 1: Linking spatial analysis with information resources and the user

Interaction is a central feature of any effective man-machine system: a real-time dialogue, including explanation, allows the user to define and explore a problem incrementally in response to immediate answers from the system. Fast and powerful systems with modern processor technology can offer the possibility to simulate dynamic processes with animated output, and they can provide a high degree of responsiveness that is essential to maintain a successful dialogue and direct control over the software.

Visualization provides the bandwidth necessary to communicate and understand large amounts of highly structured information, and permits the development of an intuitive understanding of processes and interdependencies, of spatial and temporal patterns, and complex systems in general. Also, many of the problem components in a real-world planning or management situation, such as risk or reliability, are rather abstract: a graphical representation of such concepts makes them tangible objects that can literally be manipulated and understood intuitively.

Intelligence requires software to be knowledgeable not only about its own possibilities and constraints, but also about the application domain and about the user, i.e., the context of its use. Defaults and predefined options in a menu system, sensitivity to context and history of use, built-in estimation methods, learning, or alternative ways of problem specification depending on the user can all be achieved by the integration of expert systems technology in the user interface and in the system itself.

Customization is based on the direct involvement of the end-user, and the consideration of institutional context and the specifics of the problem, domain in systems design and development. It is the users view of the problem and their

experience in many aspects of the management and decision-making process that the system is designed to support. This then must be central to a system's implementation to provide the basis for user acceptance and efficient use.

Decision support systems and their interfaces are representations of the problems they address as much as of the planning and decision-making processes they are designed to support. In the latter field, if not also in the former, their users are the real experts. Thus, their expertise and experience needs to be included in the systems. As a consequence, users must be involved in the design and development, so that they can accept responsibility and ownership for the software system.

Institutional integration also must look at aspects such as user training, data entry, maintenance issues of keeping systems current and operational, providing adaptations and updates, etc. Any complex information system has more than one user at more than one level of technical competence and with different roles within an institution. Different users have different requirements that need to be supported: flexibility and adaptability are therefore important features. Systems must be able to grow with their users. Therefore, the institutional commitment and technical infrastructure to keep a system alive and evolving are as important as the scientific and technical quality of the original software system.

Decision support systems

The management of natural resources requires the integration of often very large volumes of disparate information from numerous sources; the coupling of this information with efficient tools for assessment and evaluation that allow broad, interactive participation in the planning,

assessment, and decision-making process; and effective methods of communicating results and findings to a broad audience.

Information technology, and in particular the integration of database management systems, GIS, remote sensing and image processing, simulation and multi-criteria optimization models, expert systems, and computer graphics provide some of the tools for effective decision support in natural resources management.

The ultimate objective of a computer-based decision support system for natural resources management is, or should be, to improve planning and decision-making processes by providing useful and scientifically sound information to the actors involved in these processes, including public officials, planners and scientists, and the general public.

This decision-relevant information must be:

- Timely in relation to the dynamics of the decision problem; depending on the nature of the problem (planning, training, operational management), this may imply for operational forecasting considerably better-than-real-time performance;
- Accurate in relation to the information requirements; this requires the use of state-of-the-art tools, methods, and models, and the necessary input data;
- Directly understandable and useful; this implies that the output of any formal, numerical method can be presented in a format that is directly and reliably understandable, that is graphical and symbolical, in multi-media formats rather than purely textual and numerical;
- Easily obtainable, i.e., cheap in relation to the problem's implied cost which, however, in the case of coastal zone management, may be considerable.

Decision support is a very broad concept, and involves both rather descriptive information systems as well as more formal normative, prescriptive optimization approaches. Any decision problem can be understood as revolving around a choice between alternatives. These alternatives are analysed and ultimately ranked according to a number of criteria by which they can be compared; these criteria are checked against the objectives and constraints (our expectations), involving possible trade-offs between conflicting objectives. An alternative that meets the constraints and scores highest on the objectives is then chosen. If no such alternative exists in the choice set, the constraints have to be relaxed, criteria have to be deleted (or possibly added), and the trade-offs redefined.

However, the key to an optimal choice is in having a set of options from which to choose that which indeed contains an optimal solution. Thus, the generation or design of alternatives is a most important, if not the most important, step. In a modelling framework, this means that the generation of scenarios must be easy so that a sufficient repertoire of choices can be drawn upon.

The selection process is then based on a comparative analysis of the ranking and elimination of (infeasible) alternatives from this set. For spatially distributed and usually dynamic models—natural resource management and, as a member of this class, coastal zone management, problems most commonly fall into this category—this process is further complicated, since the number of dimensions (or criteria) that can be used to describe each alternative is potentially very large. Since only a relatively small number of criteria can usefully be compared at any one time (due to the limits of the human brain rather than computers), it seems important to be able to choose almost any subset of criteria out of this potentially very large set of

criteria for further analysis, and modify this selection if required.

Modelling for decision support, or model-based decision support systems for environmental and resource management problems have been discussed and advocated for a considerable time (de Wispelaere, Schiermeier and Gillani, 1986; Fedra and Reitsma, 1990; Fedra, 1991; Holcomb Research Institute, 1976; Labadie et al., 1989; Loucks, Kindler and Fedra, 1985). Success stories of actual use in the public debate and policy-making processes are somewhat more rare, in particular at the societal rather than commercial end of the spectrum of possible applications.

The specific role of integrated DSS, including models integrated with expert systems and GIS wrapped into interactive graphical user interfaces, is primarily in their heuristic and didactic value. Graphical displays such as topical maps are an easy to understand form of communicating complex information. They can generate a widely accepted and familiar format for a shared information basis supporting an open debate.

Because of the complexity and high dimensionality of alternatives that include spatially distributed variables—for example, the concentration of air pollution in a city or downwind of a major power plant (project) or soil erosion in a river basin affected by changing land-use—the effective display, e.g. as a topical map, is an important component of providing decision-relevant information, and understanding the physical aspects of the decision problem. Similarly, the ability of expert systems to describe their function in terms of near-natural language rules and explain, step by step, their reasoning, supports understanding, and thus acceptance.

Analysis paradigms

Paradigms of analysis and decision support range from simple descriptive information systems that present the status quo to still descriptive, but analytic, scenario analyses that answer “what if” questions, and ultimately to prescriptive or optimization approaches.

Resource management problems usually involve a mixture of natural science and engineering aspects, as well as socio-political and economic elements. While measurable phenomena and causal relationships characterize the former domain, the latter is better characterized by subjective or collective values and judgements, preferences, perceptions and expectations, and plural rationalities rather than a universal, agreed upon yardstick. And in the scientific and engineering domain, assessment also involves forecasting, designing and analysing “what if” scenarios, which is an inherently difficult problem in almost any domain (e.g., Biswas and Agarwala, 1992; Colombo, 1992) and fraught with usually large uncertainties.

Coastal zone environmental and resource management problems are complex and multidisciplinary in nature. They involve the need to forecast future states of complex systems often undergoing structural change, subject to sometimes erratic human intervention. This in turn requires the integration of quantitative science and engineering components with socio-political, regulatory, and economic considerations.

Finally, this information has to be directly useful for decision-making processes involving a broad range of actors. It seems obvious that no single method can address all these requirements credibly and satisfactorily.

Another way of organizing the various approaches to management information systems, spatial analysis decision support, is in terms of broad application areas and conceptual frameworks such as environmental impact assessment, risk assessment, or policy analysis.

Environmental impact assessment (EIA) is a well-known and widely applied assessment methodology. It is, by definition, project oriented and designed, in its various stages, to identify and compare likely environmental consequences of a major development project. While not in itself a spatial analysis method, EIA increasingly draws upon the application of GIS and spatially distributed models to estimate impacts.

Similarly, in the domain of risk assessment, spatially explicit tools are being used (Fedra, 1997). The European regulatory framework for technological risk is based on Directive EEC 82/501, its amendments (87/216 EEC, 88/610 EEC) and its latest version (96/82 EEC). The directives and their national implementations focus on information about risk, primarily substance oriented, as the central element of risk management. Within this framework, a number of specific classification criteria are defined for the reporting of accidents to the Commission; in addition to the substances involved, health and economic criteria, these include explicit spatial criteria such as:

- Permanent or long-term damage to terrestrial habitats:
 - 0.5 ha or more of a habitat of environmental or conservation importance protected by legislation;
 - 10 ha or more of more widespread habitat, including agricultural land.
- Significant or long-term damage to freshwater and marine habitats:
 - 10 km or more of river or canal;
 - 1 ha or more of a lake or pond;
 - 2 ha or more of delta;
 - 2 ha or more of a coastline or open sea.
- Significant damage to an aquifer or underground water:
 - 1 ha or more.

These classification criteria, however, are only used to classify accidents for reporting. Given the high concentration of industrial facilities in the coastal zone, risk assessment is of obvious relevance to integrated coastal zone management. An example of land-use planning around a coastal industrial site, using a multi-criteria approach, is presented by Papazoglou et al. (1997). In risk assessment, an important element is risk communication and perception, an obvious application domain for GIS and topical maps. Carvalho and Coelho (1997) discuss coastal risk perception in a case study of the Aveiro district in Portugal, with coastal erosion as the main area of concern.

Application examples

Applications of GIS and spatial models to coastal zone management problems span a wide range of issues. At the recent MEDCOAST 97 conference (11-14 September, Qawra, Malta) an entire section of the proceedings (Özhan, 1997) is specifically dedicated to GIS and remote sensing applications.

The section includes remote sensing applications, primarily based on CZCS (Coastal Zone Colour Scanner), primarily analysing surface water colours and temperature, in an attempt to locate and quantify historical trends (Barale and Zin, 1997) and terrestrial influences, respectively.

Mapping of biological marine resources using GIS technology is described by Gaofalo et al. (1997), who create, and overlay, a set of topical maps centred on 36 target species of fish, crustaceans and cephalopods. Meaden and Do Chi (1996) describe the general applicability of GIS to fisheries.

Also Abdel-Aal (1992) addresses the modelling of shoreline change phenomena. Other sources of remote

sensing data include airborne digital photographic systems (Curr et al., 1997) or side-scan sonar for benthic littoral surveys (Pasqualini et al., 1997).

A more methodology-oriented example is given in Romao et al. (1997). They discuss multidimensional visualization tools in coastal zone management, using an oil spill model as an example of a dynamic, process-oriented component integrated in a GIS environment.

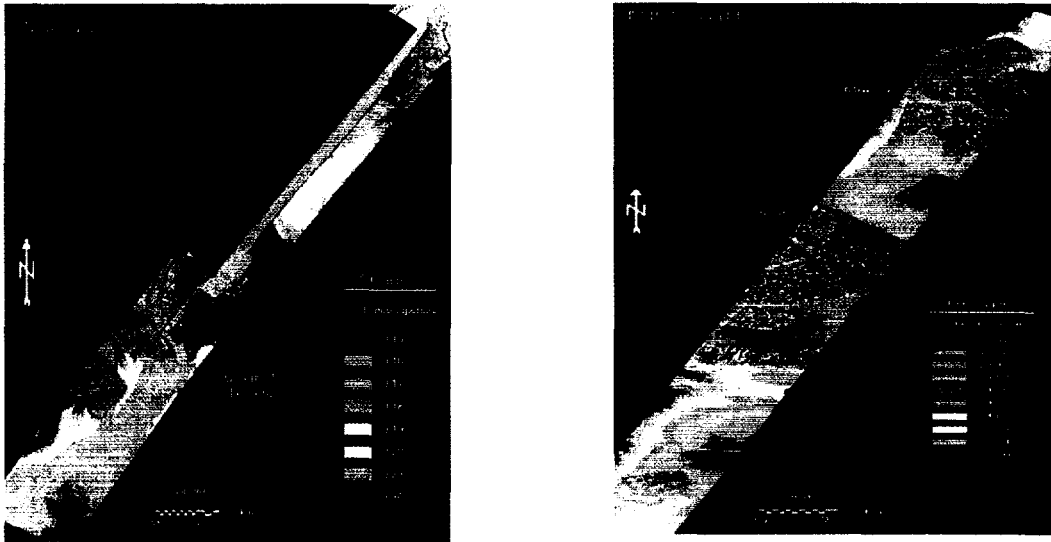
The above examples all refer to classical GIS applications with basically static data layers and overlay analysis as the major analytic method, mapping of resources being the main objective. More complex analyses require the integration of various models.

The integration of coastal water quality models dealing with the water quality consequences of the design and location of ocean (waste water) outfalls is described in Fedra (1994). The system was implemented for a number of locations in the Irish Sea, with a case study for Swansea Bay. The Swansea Bay area is heavily industrialized, leading to water quality problems not only from domestic waste water and sludge with organic material, BOD, and coliform bacteria, but also from several industrial sources containing heavy metals (Collins et al., 1980). An example of application of a GIS for analysing spatial pattern of industries in a coastal industrialized area of north-east Italy to assess surface water pollution is given by Altobelli et al. (1996). Another one with several remote sensing applications is given for the Venice Lagoon by Borfecchia et al. (1997) (figure 2 (a) and (b)).

Recent applications of simulation models in this field include, for example, Lewis and Riddle (1989) and Krohn et al. (1991). Mates and Scheinberg (1991) discuss a model with emphasis on recreational activities, and Barnes (1988) looks at non-point sources and a cartographic approach. A food chain model for PCB accumulation is presented by Connolly (1991), and Reed et al. (1989) discuss a complex model system, namely the Natural Resource Damage Assessment Model System for Coastal and Marine Environments that is primarily oriented towards accidental spills. Economic aspects in the case of effluent charges and chlorine residuals from the forest industry polluting the Baltic Sea are considered by Hultkrantz (1991).

The model system for Swansea Bay simulates the fate and distribution of various types of pollutants, such as conservative tracers, BOD, or coliform bacteria from one or several outfalls or offshore dumping locations. The system includes a structure as in figure 3: A database of these major sources of pollution, e.g., waste-water treatment plants and outfall pipelines are linked to:

- Geographical information system (GIS) components that can manage spatial data such as land-use information or bathymetry, as well as observational data, such as flows, tidal records, or water quality measurements;
- An interactive and graphical interface to both model scenario editors as well as for running the models visualizing the dynamic model output; coupled to
- The scenario editors, an embedded expert system for scenario editing and parameter estimation; and as a post-processor of model results;
- An expert system for impact assessment, coupled with both the expert system's rule base as well as the editor functions; and
- The overall help and explain functions, a hypertext system for additional textual information.



(a) Murano

(b) Airport

Figure 2. Examples of the distribution and concentration of dissolved organic matter (DOM) in two localities of the Venice lagoon

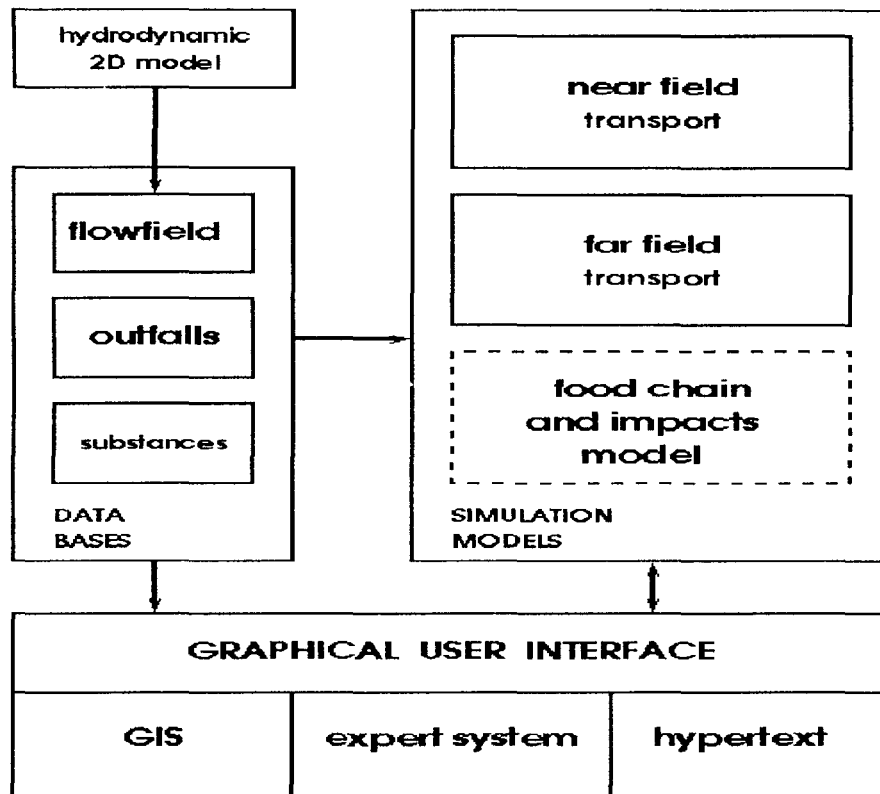


Figure 3. Integration example of simulation models with a GIS

A similar, more recent application involves POM, the Princeton Ocean Model for the Saronikos Gulf in Greece, as part of the ECOSIM Environmental Telematics project (<http://www.ess.co.at/ECOSIM>). The Saronikos Gulf is a semi-enclosed coastal sea lying to the south of Athens, a city of 3.5 million people. 720,000 m³ of domestic waste per day are released inside the Inner Gulf through the Central Metropolitan Outfall after undergoing secondary treatment. Further to that, industrial wastes are discharged in the Elefsis Bay in the northern part of the gulf.

The coastal water model is based on the well-known academic community model, the Princeton Ocean Model (POM). POM is a sigma-coordinate, 3-D thermodynamically active model that has been primarily designed for coastal water studies. A research group at the University of Athens has developed a new module of POM for the dispersion of passive tracers. The scheme can simulate several surface and subsurface sources with different pollutant load (figure 4). This module has been tested in several areas and has been proved to be an effective tool for monitoring the fate of tracers in the coastal environment. The sources can be either point sources (e.g. rivers, sewage, etc.) or linear-sources (landfills).

A similar approach of coupling a hydrodynamic and pollutant transport model with a GIS is described by Tsanis and Boyle (1997), while Durand et al. (1997) use SPOT satellite-derived maps of suspended matter to compare with their 3D numerical study of the Ebro delta zone hydrodynamics.

Direct applications to overall management issues are rare; Anderson and Skrizhevskaya (1997) describe an ambitious approach that is also supposed to include socio-economic aspects in an integrated coastal management

approach for the Ukrainian Black Sea region, where they associate with a list of ICM issues the corresponding GIS activities (figure 5).

Discussion

Integrated coastal zone management is an inherently and increasingly complex task. To provide formal yet practical decision support requires a new approach that supports a more open and participatory decision-making process. A new paradigm of man-machine systems is needed where the emphasis is no longer on finding an optimal solution to a well-defined problem, but rather to supporting the various phases of the problem definition and solving process.

Problem owners and various actors in the decision-making process have a central role; supporting their respective tasks requires man-machine interfaces that are easy to use and easy to understand: the paradigm of the thematic map offered by GIS is a powerful tool for this purpose. The map provides a familiar and visually attractive and easy to interpret framework that integrates other, often more abstract, information as well.

An effective decision support system must first of all provide a common, shared information basis, framework and language for dialogue and negotiation. The dialogue between the actors in the decision-making process is extended to a dialogue with the DSS, which plays the role of a technical expert and bookkeeper rather than an arbiter.

This requires that information provided is adequate for and acceptable to a broad range of users involved in the respective assessment and decision-making processes, including analysts, technical managers, regulators and policy makers, as well as the affected citizen, interest groups and the general public (Sundee Sahay and Walsham, 1997).

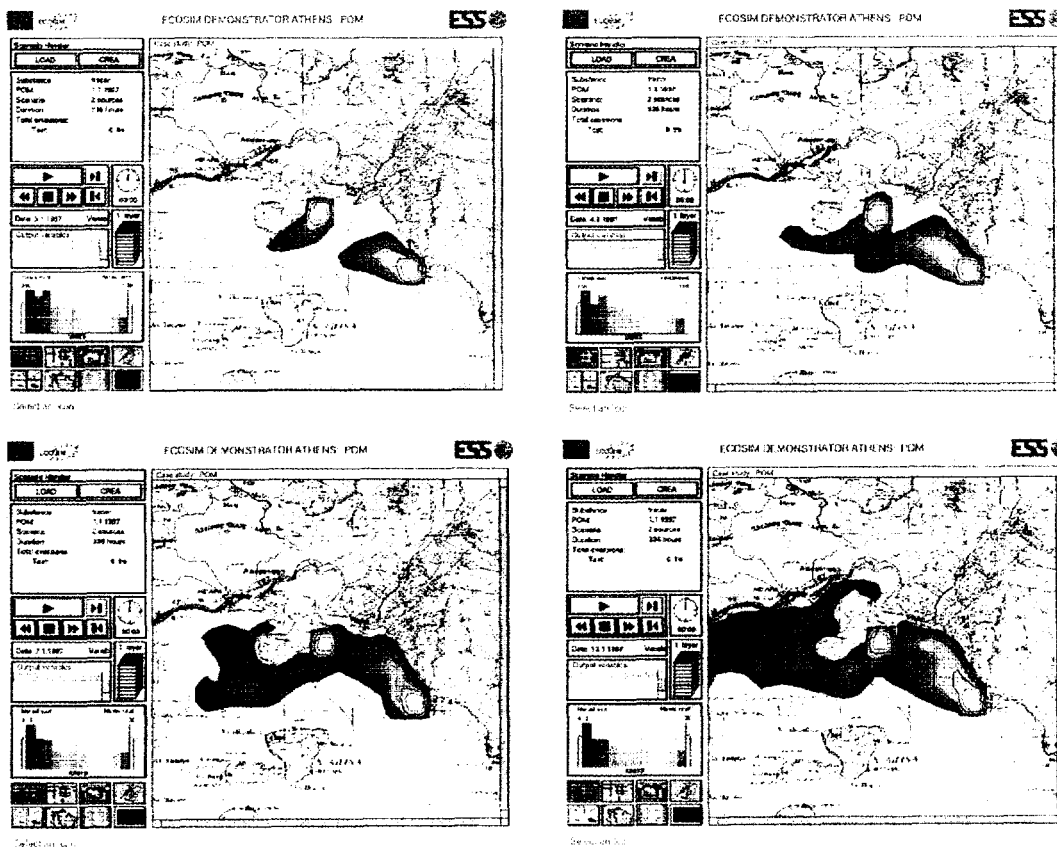


Figure 4. Animation of dynamic model results as map overlays

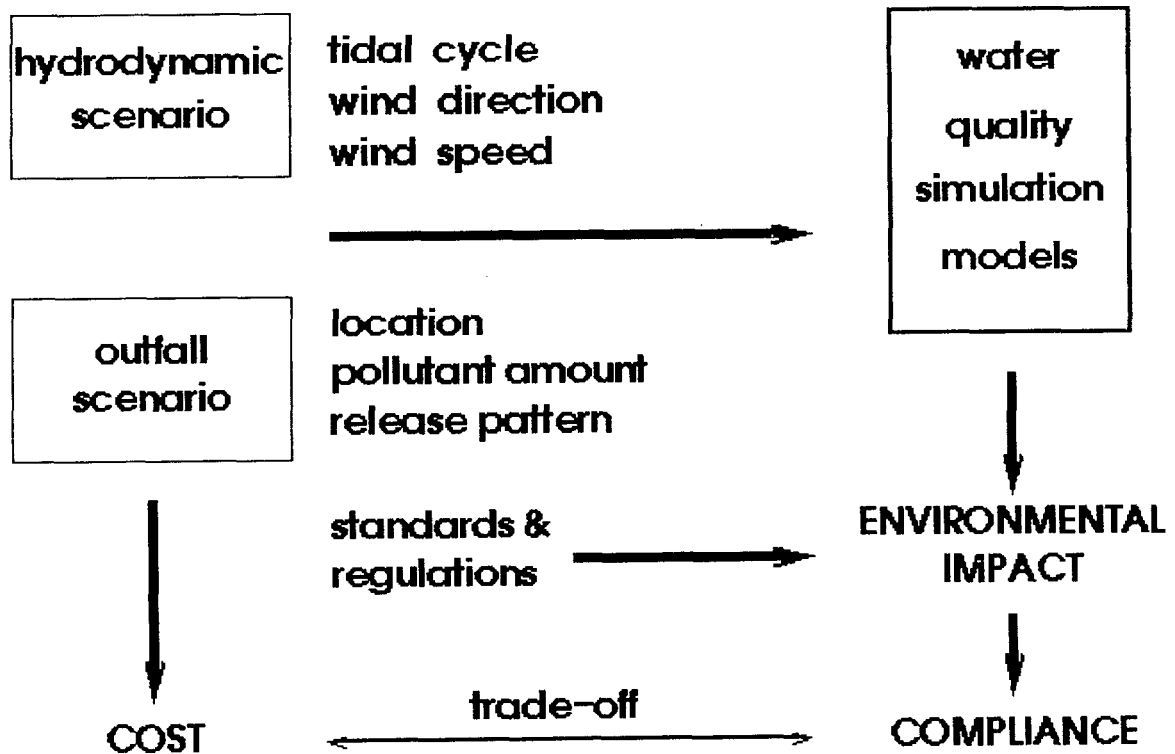


Figure 5. Integrating spatial analysis in a management framework

An information system that can cater to all these needs must be based on more than good science and solid engineering. It requires a number of special features as well as an approach that takes psychological and institutional aspects as well as scientific and technical ones into account.

From a technical point of view, many of the basic tools are available, the underlying concepts well developed. And new technologies such as wide area networks and in particular the Internet, globally distributed client-server applications, multimedia and virtual reality, and their promise of easy access to potentially large volumes of information are rapidly becoming available. Of course, many problems such as the availability and quality of data remain and will always remain, since new and emerging problems will always require new data. Uncertainty of data and models and the limits of predictability are inherent in the study of natural systems, and decision support systems must address and communicate this uncertainty to make it a useful component of decision-making strategy rather than a problem.

The need for better tools to handle ever more critical environmental and resource management problems is obvious, and the rapidly developing field of information technology can provide the necessary machinery. The integration of models and geographic information systems, expert systems, and interactive graphics, generating a virtual reality version of the decision problem, is a promising and challenging development in environmental systems analysis, strategic decision support, and applied informatics. Integrated coastal zone management is one obvious, and promising, application domain. The biggest challenge, however, seems to be the integration of new information technologies and more or less mature formal methods of analysis into institutional structures and societal processes, that is, putting these tools to work in practice.

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B. INDUSTRY NEWS

World's largest seismic vessel

In March 1999, Norwegian shipbuilder Mjelllem & Karlsen plans to deliver the world's largest seismic vessel to Geco-Prakla. The 10,600-ton vessel, code-named project SS2000, will have 40 per cent more equipment storage capacity than other vessels. This will enable it to hold the equipment necessary to offer a survey footprint of more than 11 sq. km.

The SS2000 will have a traditional double-skin hull design, but will have twice the pulling power and two-and-a-half times the storage capacity of conventional seismic vessels. The SS2000 will feature a 39-metre-wide back deck with 20 towing points, enabling the vessel to provide the "streamer carpet" necessary for high-resolution surveys. The vessel has also been designed to use less fuel per unit area during streamer deployment using low-drag monowing technology. This technology allows the company to offer cost-effective surveys with bigger spreads.

The vessel will be powered by decoupled diesel/electric propulsion units which will make it acoustically quieter than other boats. The hull will have a 700-mm impact zone to provide damage stability and better environmental protection in the event of a collision.

The company expects that the vessel will be used for large 3D exploration surveys of 5,000-10,000 sq. km in areas such as the Gulf of Mexico and Brazil. (Source: *Offshore*, March 1998)

Global subsea well production will double by year 2002

The number of subsea wells worldwide could double by the end of 2002 if all of the planned subsea development projects come to fruition. Demand for subsea trees is so high that some subsea tree manufacturers are concerned about having enough capacity to supply the industry with all its equipment needs. The normal lead-time for a subsea tree has increased in the last couple of years—from 8-10 months to 10-12 months today.

About 2 million bbl of oil and 1.3 tcf of gas are produced by subsea production methods each day, says Derrick Booth, owner of Austin, TX-based Subsea Data Services. He adds that forecasts suggest the market will continue to grow at some 10 per cent or more annually until 2020.

Since oil flowed from the first subsea completion installed by Shell in 1961 in the Gulf of Mexico, 1,117 subsea wells have been completed, according to Booth. The industry required 36 years to install the first 1,000 subsea

trees, mainly because skeptics believed that subsea wells could not be easily accessed in case of emergency or for remedial work.

The next 1,000 subsea completions will take only about five years, according to Offshore Data Services (ODS). And they are being installed in deeper and deeper waters. According to figures supplied by ODS, a total of 1,041 subsea trees are to be installed during the next five years, including those installed during 1997.

The number of subsea trees scheduled to be set during 1998 is nearly double from 1997. The number of subsea trees scheduled for 1999 drops significantly to 147. However, these figures could increase dramatically due to the present strong deepwater drilling activity in the US Gulf of Mexico and the fact that Brazilian state oil company Petrobras said it would require more than 200 subsea trees during the next five years.

The recent push towards deepwater exploration and utilizing subsea completions as a development tool is evident in the number of trees set in water depths of 1,300 ft., since the first subsea well was completed, according to Subsea Data Services' Subsea-Data-Base. Only 123 trees have been set in water depths of 1,300 ft. and greater.

During the next five years, these figures are expected to more than double. ODS' figures show that 582 subsea trees are planned in water depths of 651 ft. and greater. This includes 339 trees in water depths of between 651-1,500 ft. and 243 trees in water depths greater than 1,500 ft.

The subsea option is employed across the spectrum of operators, from small independents to the industry giants. And while subsea completions are efficient for deep and ultra-deep waters, it also is very useful for development of satellite wells tied back to an existing platform, early production, and fast-track development schemes.

North Sea

While water depth records are broken in the Gulf of Mexico and off Brazil, the most active area continues to be the North Sea. The North Sea boasts 40 per cent of the subsea trees installed worldwide, according to Subsea-Data-Base. Another 102 subsea development projects are under construction or in the planning stages, according to ODS. These projects will utilize about 600 subsea trees, if all are installed as planned.

Brazil

Brazilian state oil company Petrobras is perhaps the most active operator worldwide in terms of the sheer number

of subsea completions under construction and planned. The company said it would require more than 200 subsea trees during the next five years.

Petrobras' increased activity is due primarily to its need to commence production on the fields it wants to keep before the Government begins offering areas to foreign investment. It is not simply a matter of Petrobras making a discovery. The field must be producing for Petrobras to claim it. Consequently, many of the projects Petrobras is developing are on a fast track. (Source: *Offshore*, December 1997)

World's largest jackup

Rowan is building the world's largest mobile jackup drilling unit—the Super Gorilla V. According to Rowan Drilling, the Super Gorilla V is a Rowan/Le Tourneau enhanced Gorilla-class, slotlever, cantilever jackup, and also a mobile, self-elevating, offshore drilling and production platform. The unit is designed for harsh environment exploration and development drilling operations, production platform operations, and simultaneous drilling and production operations.

The Super Gorilla has a variable load of 12,500,000 lb independent of the combined hook, setback and conductor tensioning loads of 3,750,000 lb. The jackup is designed to operate year-round in 400 ft. of chart datum water depth satisfying the North Sea 50-year return storm environmental criteria south of the 61st parallel. The design incorporates a 170-ft. tall, 40 ft. by 40 ft. base derrick with a 2,500,000-lb static hook load. The new generation of Gorilla-class jackup also allows fore and aft. movement of the sub-base, independent of the cantilever beams, and an industry-first dual mud system with four 7,500 psi WP mud pumps.

Upon expected completion, the Gorilla V will begin a contract with Amoco in the UK North Sea. Rowan has also begun the initial stages of construction for a second Super Gorilla-class jackup, the Gorilla VI, which is scheduled for delivery in the third quarter of 1999. (Source: *Offshore*, December 1997)

Paradigm shift for team-oriented exploration

At one time, geologists, geophysicists and engineers seldom involved themselves in each other's business. Today, teams are the rule. Just as the world of paper maps gave way to computer screens using 3D visualization, that paradigm is shifting into the world of "Star Trek's holodeck". Initiating this shift, Texaco has built a 3D Visualization Center in Houston, patterned after the Silicon Graphics Reality Center visualization conference rooms. The new facility will allow geoscientists to interact with subsurface data in realistic 3D environments to analyse reservoir production simulations.

Seeing the "Earth model" in its full intricacy, "flying" into and out of the model will further blur the working scale differences that have traditionally separated the professions.

In the new facility multidisciplinary teams will work in collaboration to interpret complex problems, optimize business operations, and enhance decision making, thereby reducing time and cost on projects. Texaco expects to triple its 3D seismic analysis capability through the use of this facility, improve oil and gas extraction, and reduce the cost of oil production. The facility incorporates a hemispherical screen, 25 ft. wide by 9 ft. high, with a 160-degree field of view. Other elements include three projectors, a digital display interface for edge blending and colour balancing as well as a surround-sound system for audio data simulation. A "driver's seat" will be used to navigate participants through interactive environments.

Silicon Graphics pioneered the Reality Center in 1994 as a business and research tool. The Texaco facility is

powered by an Onyx2 Infinite Reality visualization supercomputer in conjunction with Texaco proprietary technology.

A form of "group mind" centred on 3D visualization is the developing paradigm. It will be fascinating to watch the different group personalities develop between competing companies and teams. Most companies preach that "people are our most important asset" but have not walked that path with the necessary faith. The soft skills of human relations and team dynamics will force an attitude change that can only better the performance of all. (Source: *Offshore*, December 1997)

Supercomputer power for eight

Silicon Graphics introduced the Onyx2 GroupStation bundle for oil and gas applications. The system provides supercomputer power for up to eight users, each operating a two-headed workstation. The system uses up to 64 processors with 64 gigabytes of memory and 100 gigabytes of disk storage available as shared resources. The system is scalable. A base configuration for two users includes: four R10000 processors, 512 megabytes of memory and 9 gigabytes of disk storage. Stephen L. Goldsberry, Director, Global Energy Industries, explained that two fundamental shifts in the geoscience market led to the development of the Onyx2 GroupStation:

- More software is designed to do 3D visualization.
- Growing data sets require more computer resources.

A drop in the price of hardware coupled with a rise in the value companies place on 3D interpretations now makes this level of power available to geoscience interpreters. (Source: *Offshore*, December 1997)

ProMAX upgrade

Landmark Graphics released the latest upgrade of ProMAX for 2D/3D seismic processing. ProMAX 7.0 now offers major enhancements for high-volume processing of large 3D seismic data sets. Improved velocity analysis tools are part of the new release. Marine seismic data can be processed either with or without a database, which can reduce processing cycle time. New visualization software, DBTools, provides faster 2D and 3D visualization of a larger number of seismic attributes. Dr. Jim Black, Vice-President of Geophysical Processing Products, said "DBTools allows rapid visual detection of problems with geometry, statics and many other database attributes. In addition, we have coupled DBTools with interactive data viewing and new, flexible data navigation capabilities." (Source: *Offshore*, December 1997)

Web accessible resources

The Earth Sciences and Resources Institute, University of South Carolina (ERSI-USC) is now offering a subscription-based database of Major Oil & Gas Fields of the World. The database contains over 2,100 oil and gas fields worldwide with over 60,000 items. All fields listed are over 100,000 BOE in size. Reference bibliographies for the fields are included. Also offered is the On Line Catalog of Geological Data. Well logs, maps, seismic sections, reports, theses and dissertations from over 25 years of international hydrocarbon research are available through this database. Contact ERSI-USC at <http://www.ersi.sc.edu>. (Source: *Offshore*, December 1997)

Deep Ocean Engineering builds pipeliner ROV for salt domes

Deep Ocean Engineering Inc. (San Leandro, CA) has introduced the Pipeliner ST, a modification of the Phantom Pipeliner remotely operated vehicle (ROV), for investigating

nine man-made underground salt caverns near New Orleans, according to DOE's Dr. Phil Ballou. Louisiana Offshore Oil Port (LOOP) LLC operates the 40-million-barrel-capacity caverns.

The vehicle has five thrusters, two colour video cameras (front and rear), two scanning sonars (675 kHz and 225 MHz), 1,000 watts of light, a manipulator, and a tactile sensor. A third sonar is suspended in the centre of the cavern from a depressor frame. Due to poor visibility in the saturated brine, essentially all navigation is acoustic, with close-up visual inspection being aided by a clear-water cone. A swinging keel allows the operator to change the gravity-stabilized axis of the vehicle from horizontal to vertical for access into the cavern through a 24-inch vertical pipe. The vehicle alternately carries a core drill for taking samples of the cavern's wall or other inspection and maintenance tools, Ballou said.

Although many solution-mined salt caverns exist around the world, until now no one has ever seen the inside of one of them, and very little is known about their physical or biological characteristics. Using the Pipeliner ST, a glimpse of this subterranean world is possible including taking samples of the cavern walls so preventative repairs can be made. (Source: *Sea Technology*, February 1998)

Development phase of CoSWaSS programme begins

A consortium of eight oil companies recently commenced Phase 2 of the configurable subsea water separation system (CoSWaSS) programme, according to a spokesperson. The programme aims to provide technology to enable subsea water separation, and reduce substantially the requirement for the transportation and topside processing of produced water.

High levels of water in the fluids produced from oil reservoirs, sometimes in excess of 80 per cent of total produced fluids, tie up capacity in transportation pipelines and process systems on offshore platforms. This restricts the production from additional satellite reservoirs or does not maximize the potential of existing ones. If this water can be removed from the wellfluids at the subsea wellhead and re-injected into the reservoir, the potential for profitable production from existing or additional reservoirs is considerably improved. A wide range of potential applications exists for CoSWaSS—particularly in the North Sea, Gulf of Mexico, offshore Brazil, and offshore West Africa.

The main objective of Phase 2 is to develop and test critical components, together with the preparation of functional specifications for those components not being considered as part of the current demonstration projects and other joint industry projects. Six components have already been prioritized and agreed upon by the steering group, including oil-in-water metering, vertical water separation, compact partial processing, level control, sand management, and subsea packaging.

The programme is being conducted in three phases under the direction of a steering group. Phase 1 comprised the conceptual design of a subsea water separation system, together with screening studies for different potential system configurations and analysis of technology shortfalls and their implications. Five generic subsea water separation and disposal case studies were analysed during Phase 1, and systems designs, weights, and costs proposed. These case studies were based on a range of water depths, throughputs, step-out distances, and fluid types likely to be encountered by consortium members.

The CoSWaSS consortium consists of Amerada Hess, Norsk Agip, BP Exploration, Elf Norge (Stavanger, Norway), Mobil Norway, Norsk Hydro (Stabekk, Norway), Statoil (Stavanger, Norway), and Texaco Britain. (Source: *Sea Technology*, February 1998)

GAA says shrimp aquaculture can be economic force

Shrimp aquaculture can be a significant contributor to the economic well-being of many developing nations and government policies should be encouraging its growth, the Global Aquaculture Alliance (GAA) told a United Nations Food and Agriculture Organization (FAO) technical conference in Bangkok, Thailand, in December 1997.

"Trade in seafood products now generates \$50 billion annually and will grow with steadily increasing demand for such high quality products as shrimp favoured by consumers throughout the world", said Lee J. Weddig, speaking for the GAA.

In the United States for example, shrimp accounts for 25 per cent of the fresh and frozen seafood consumed. It is extremely popular in Japan and Western Europe as well, he said. A growing middle class in many developing nations is also increasing consumption.

About 20 per cent of today's international seafood trade is in shrimp products, said the GAA. Pointing out that population growth alone will generate a two or three per cent increase in demand each year, the GAA spokesperson said responsible aquaculture will be the primary source for additional supplies since catches from the oceans' resources have generally plateaued in most areas of the world. (Source: *Sea Technology*, March 1998)

Hearings held on proposed sea turtle critical habitat

The National Marine Fisheries Service (NMFS) recently held public hearings in Puerto Rico to obtain public input on the proposed designation of critical habitat areas in the waters off Culebra, Mona, and Monito Islands to protect the threatened green sea turtle and the endangered hawksbill sea turtle, according to a spokesperson. The agency published a proposed rule under the Endangered Species Act (ESA) in the federal register on 9 December 1997 to announce its intent to designate the areas.

Critical habitat is defined under the ESA as the specific areas within the geographical area occupied by the species on which are found those physical or biological features essential to the conservation of the species and which may require special management considerations or protection; and the specific areas outside the geographical area occupied by the species essential for their conservation.

Critical habitat for the green turtle is proposed to include waters extending seaward to three nautical miles from the mean high water line of Culebra Island, Puerto Rico. Critical habitat for the hawksbill turtle is proposed to include waters extending seaward to 3 nautical miles from the mean high-water line of Mona and Monito Islands, Puerto Rico.

Extensive beds of sea grass in the Culebra archipelago support a large population of juvenile green turtles. This area was recognized by the US Fish and Wildlife Service in 1993 as a Category 1 Resource identifying it as unique and irreplaceable habitat. Additionally, a small population of adult green turtles have been documented in those waters.

The waters surrounding Mona and Monito Islands are one of the few known remaining locations where hawksbill turtles occur in considerable densities. The hawksbill turtles

in the area have been shown to be resident for at least several years. During the 1996-97 nesting season, 354 nests were recorded. Limited green turtle nesting is also known to occur on Mona Island. (Source: *Sea Technology*, March 1998)

In deep waters

A global boom in uncontrolled deep-water fishing is devastating stocks of several fish species and could alter entire oceanic ecosystems.

Members of the Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR) will put new limits on catches of the deep-water Patagonian toothfish, *Dissostichus eleginoides*, known in the US as the Chilean sea bass. The CCAMLR is responsible for an area of ocean round Antarctica that in places stretches halfway to the equator, but officials say the new limits will do little to protect the species, which has declined dramatically since it began to be heavily fished off southern Chile in 1989.

Commercial interest in deep-water fisheries has grown as traditional fisheries, which are nearly all in water of less than 200 metres, have become depleted. Deep-water fish are typically rich in oil, which helps them to stay buoyant at depth. The oil makes them attractive to fishing companies because it helps to maintain the fish's flavour and texture after freezing.

But these species are also slow-growing and late-maturing. Fleets take more fish in a short time than a species can replace, says Malcolm Clark of the New Zealand Ministry of Fisheries. After a few years of big catches, numbers decline rapidly.

The vessels that fish for Patagonian toothfish in southern waters are mostly Norwegian-owned but registered in countries such as Panama that are not governed by national or CCAMLR quotas. Since stocks off Chile crashed in 1992, the boats moved to Argentinian waters. By 1995 these stocks had also crashed, and the fleet moved to South African waters. Now catches there have fallen, and the fleet is again moving east.

Australia, South Africa and New Zealand want the CCAMLR to increase limits on the toothfish, to extend the fishing season, or allow catches over a greater area. They say this would help to protect the fish, claiming that more legal boats on the fishing grounds would make it harder for illegal boats to work. They point out that most of the damage is done by illegal boats and that a larger legal quota will hardly affect toothfish stocks. Only 32,991 tons were caught legally in 1996, yet 130,000 tons of the fish were sold on the world market, most of it from the Antarctic.

Other deep-water fish are also suffering. Stocks of New Zealand's orange roughy, one of the first deep-water fish to be exploited, fell by some 90 per cent in the decade to 1982. There is still no sign of recovery. Nor is the problem confined to the far south. A new fishery for giant redfish opened by Norway on the Mid-Atlantic Ridge last year yielded 1,000 tonnes in its first season, but "only a few hundred tonnes" in 1997, says Nils Hareide of the Møre and Romsdal Research Foundation in Ålesund, Norway.

Hareide thinks the fisheries will permanently alter deep-water ecosystems in favour of faster-reproducing fish. This has already happened in shallow waters with the Atlantic halibut, a slow-growing species that has disappeared from all fisheries in which it was initially abundant. (Source: *New Scientist*, 8 November 1997)

Fibre-reinforced polymer composites upgrade navy pier

The Naval Facilities Engineering Service Center (NFESC), Port Hueneme, CA is using fibre-reinforced polymer (FRP) composites to increase the strength of

existing navy piers. By using FRP reinforcement, many piers will not have to be rebuilt or replaced, and can often remain in service as upgrades are applied. Shore facility managers had to develop another way to extend the useful life of existing pier assets. Pier 11 at Naval Station Norfolk, VA, demonstrated feasibility. The 14-year-old, reinforced concrete structure, which berths nuclear-powered aircraft carriers, is heavily trafficked by large trucks and other vehicles.

When built, the pier was rated for 70-ton truck-mounted cranes. However, operators discovered that five longer deck spans of the pier had design shortfalls that limited 70-ton crane service to less than optimal capacity—thereby hobbling fleet operations. To address the shortfall, one of the five spans was chosen for the upgrade demonstration.

NFESC engineers designed a carbon-graphite, composite-laminate upgrade to increase the deck strength by 10 per cent—increases of more than 40 per cent have been demonstrated. The upgrade was designed to allow unlimited 70-ton and limited 90-ton service. Two upgrade areas of 19 feet, 2 inches by 15 feet, 11 inches were located adjacent to the curbs and outboard of the utility trenches. The upgrade consisted of adding external, biaxial reinforcing on the underside of the deck.

The form marks and surface discontinuities were knocked down by removing concrete with a small, compressed-air-driven hammer. The concrete surface was ground smooth and cleaned by sand blasting. Workers then applied an epoxy primer to the concrete and allowed it to cure. The composite consisted of uniaxial carbon graphite fibre sheets and epoxy resin matrix (saturant). The laminate was hand-laid and cured without the aid of external heating or vacuum bags. The pier remained in service during installation.

Post installation tests indicated that the composite laminate was acting integrally with the reinforced concrete. The measurements indicated that stresses in the laminate and steel reinforcing bars would be well within allowable limits.

The Center for Intelligent Materials Systems and Structures (CIMS) at Virginia Polytech Institute and State University developed piezoelectric patches to monitor the long-term performance of the upgrade.

Graphite composite laminating costs about \$150/pound or \$82/square yard. Installation time is fast—labour costs are estimated at less than \$55/square yard. (From *Navy Civil Engineer*, Winter 1997/1998). (Source: *Sea Technology*, May 1998)

Potential for seahorse culture

The Marlborough Sounds region of New Zealand looks set to become the first in the country to test-farm the seahorse, a tiny marine creature. Seahorses are in huge demand in Asia for treating a broad range of medical conditions in traditional medicine and for general health. The firm which is carrying out the research hopes, if it is successful, to tap this market and eventually export dried seahorses to Hong Kong.

The first stage of the study would involve the catching of wild seahorses to form an initial broodstock. The seahorse has an extraordinary reproductive behaviour. The young female lays eggs in a pouch in the male's abdomen, where they grow until the male spawns 150-600 tiny fully formed seahorses. If conditions are right, these will grow rapidly to maturity in three months. They are difficult to raise because they must have live food, mainly zooplankton. The other challenge would be to put structures in place with a small enough mesh to keep in the juveniles but allow a free flow of water. (Source: *INFOFISH International*, June 1997)

Intensive shrimp culture in raceways

The Brackishwater Aquaculture Centre (BAC) of the Department of Fisheries at Gelang Patah, Malaysia, is conducting a study on the feasibility of intensive shrimp culture in concrete raceways. Shrimp culture is commonly carried out in earthen ponds but there are several problems with this method of culture, including choice of a site with suitable soil and water quality. A major problem with many earthen ponds is the incidence of acid sulphate soils and the accumulation of sludge on pond bottoms which give rise to disease and retarded growth in cultured shrimp.

The BAC study uses four concrete raceways measuring 160 m². Each raceway is 40 m long. Water is pumped into the raceways using high-powered pumps. In addition to controlled water exchange, aeration is carried out by means of pumps. The high-water exchange and aeration enable a relatively high stocking density to be utilized. At present, shrimp are stocked at a density of 156 shrimps/m² compared to an average stocking density of 49/m² in earthen ponds. A good growth rate has so far been reported and, if the trial proves to be successful, the system will be introduced to farmers in the industry. (Source: *INFOFISH International*, January 1998)

Mussel pearls

Australian rural general practitioner Dr. Peter Barker has an innovative sideline—he grows pearls in native mussels. His farm is at Cohuna, northwest of Echuca in Victoria state, where he has 10,000 shells at various stages of cultivation in the Gunbower Creek. His idea for the farm began when he read about Western Australia's pearl industry eight years ago, and found that the local mussels produce a pearl in about one out of every 600 mussels. The pearls are pink, black or gold, and are worth between A\$ 40 and A\$ 300 each.

Peter has a success rate of about half, using a technique of anaesthetizing the harvested mussels and implanting an irritant inside the shell. The pearls produced are blister pearls, since the alternative technique for implanting the irritant deep inside the flesh to make spherical pearls carries a very high mortality rate. Four years later, Barker harvests the mussels. (Source: *INFOFISH International*, May 1998)

Jellied feed from fish waste

Waste fish and offal can be turned inexpensively into a new jellied feed using a method developed in Norway, reports *Fishing News International*. The feed—for farmed fish such as Atlantic salmon in Norway and yellowtail in Japan—is the work of Algea AS, part of the Norsk Hydro group, and Rubin, a Norwegian research foundation devoted to the utilization of organic by-products.

Norsk Hydro's Bjorn Olav Gabrielsen, who initiated the development, says that the production equipment needed is both unsophisticated and low cost, so it is possible to make the feed locally. It is most cost effective in places where the distance between offal generation and the fish farm is short. Already some salmon farms in Norway have started to produce jellied feed using raw materials such as undersized herring, and offal from saithe and cod. Bjorn Gabrielsen claims also that the addition of Algea's seaweed binder Algibind stimulates the immune system of salmon.

The production of jellied feed is made possible due to a principle with the polysaccharide alginate, a constituent of seaweed, explains Bjorn Gabrielsen. According to him, alginate can be converted from a water soluble state to a water insoluble state by a simple chemical reaction which takes place in a jellying bath. Since the jellied wet pellets are bound together with an alginate which does not dissolve in

water, pollution in the form of destroyed or dissolved pellets is minimal. Even though the jellied pellets are quite soft, they do not stick together and can be pumped in a water stream. (Source: *INFOFISH International*, March 1998)

Wrasse for lice control

Trials carried out in 1997/98 with the fish species ballan wrasse *Labrus bergylta* show that it can be used in cages with large salmon to keep the number of salmon lice down. A number of Norwegian farms are already using the smaller goldsinny (*Ctenolabrus rupestris*) to feed on lice.

According to senior consultant Per G. Kveinseth at the KPMG Centre for Aquaculture and Fisheries in Norway, it is possible to let juvenile ballan wrasse grow together with the salmon, but their number has to be managed carefully so that they do not attack the salmon. From an environmental perspective, the use of ballan wrasse is a superb alternative to killing lice with chemicals. (Source: *INFOFISH International*, March 1998)

Definitions of sustainability

Sustainability has become an important prerequisite for all major activities of man, not just aquaculture, and there are several definitions of sustainability.

The Den Bosch Conference of 1991 defined sustainable development as "the management and conservation of the natural resource base and the orientation of technological and institutional change in such a manner as to ensure the attainment and continued satisfaction of human needs for the present and future generations. Such development (in the agriculture, forestry and fisheries sectors) conserves land, water, plant and animal genetic resources; is environmentally non-degrading, technically appropriate, economically viable and socially acceptable".

The International Service for National Agriculture Research (ISNAR) describes sustainable development as "the capability to ensure adequate standards of living, an acceptable quality of life for the participants and reasonable returns to capital investment, always keeping pace with and able to adjust to changing circumstances and realistic production demands, without irreversible loss or serious reduction of the natural productive resources or their inherent or developed long-term productivity; and without serious damage to natural resources and environment and/or their agricultural produce or by-products".

The World Resources Institute defines sustainability as "a system that improves in a substantial and enduring way the underlying productivity of natural resources and cropping patterns so that farmers can meet increasing levels of demand in concert with population and economic growth, as well as environmental necessities". The International Federation of Agricultural Producers, in turn, defines sustainable agriculture (or, by extension, aquaculture) as "stable, regenerative, productive and profitable, resilient, appropriate, self-reliant and socio-culturally non-disruptive".

Stephen Clark of the Earth Centre based in Doncaster, UK, defines sustainable aquaculture as "a means to profitable production, efficiency of natural resources, best aquatic environmental practice and a way forward to keep pace with world aquaculture consumption without compromising the overall ecological integrity of our eco-systems". He continues that it is "a method for culturing aquatic plants and animals at reasonable stocking densities to allow efficient production without undue reliance on chemicals and artificial feeds and without negative impact on the environment". The Earth Centre is a project whose vision is to promote sustainable development via popular education.

While there are many definitions for sustainability, it is important to note that, by and large, they all focus on certain key elements, i.e. the project must (i) cater to the needs of not only the present generation but also future generations, (ii) conserve natural resources and genetic diversity, (iii) not endanger the environment but instead protect it, (iv) adopt appropriate technology for the culture system, and (v) be socially acceptable. Thus sustainability embraces the elements of long-term predictability, conservation, environmental protection, appropriate technology use and acceptance by society at large.

Holmenkollen guidelines

Concern over potential negative impacts of aquaculture development if it is not carried out in a responsible manner has prompted various concerned groups to come out with guidelines for sustainable aquaculture development. One of these sets of guidelines was developed at an international symposium on Sustainable Fish Farming held at Holmenkollen in Oslo, Norway, on 28-31 August 1994. The goal of the symposium was to discuss on a scientific level the prevailing practices and trends of development in the fish farming industry and search for sustainable directions for future development.

About 100 persons from 12 countries in America, Asia and Europe attended the symposium. They came from research institutions, national and international governmental organizations, as well as from the industry. Highly qualified lay people were also invited to provide the "public opinion" input. This gathering of people discussed the major issues facing world aquaculture and came out with an important document which has come to be called *The Holmenkollen Guidelines for Sustainable Industrial Fish Farming*. The document lists areas and issues which should be taken into account when undertaking an aquaculture project.

The *Holmenkollen Guidelines* stress the importance of developing aquaculture within the context of an integrated coastal zone management plan which takes into account other resource uses and various social, economic and environmental criteria. During farm operations, the *Guidelines* place importance on the adoption of the best available environment-friendly technology, good feeding practices and proactive veterinary methods. Emphasis is placed on the conservation of genetic diversity and improving research, education and training within the industry and on the industry being more customer-oriented.

FAO code of conduct

In 1995, the Food and Agriculture Organization (FAO) of the United Nations came out with the *Code of Conduct for Responsible Fisheries*. The Code, which is directed at nation states, sets out principles and international standards of behaviour for responsible practices with a view to ensuring the effective conservation, management and development of living aquatic resources with due respect for the ecosystem and biodiversity. Article 9 of the Code deals specifically with the subject of aquaculture development.

The Code emphasizes the need for states to develop an appropriate legal and administrative system for responsible aquaculture. It stresses the importance of advance evaluation of effects on genetic diversity, ecosystem integrity and livelihoods of local communities. It also highlights the need to protect transboundary aquatic ecosystems. The conservation of genetic diversity is emphasized, as is the need to minimize risk of disease transfer and other adverse effects through introduction and transfer of exotic species.

The Code also outlines responsible aquaculture practices which may be adopted at the production level.

These include selection of appropriate feeds, feed additives and fertilizers, the promotion of safe and effective farm and fish health management practices, the regulation of chemicals which are hazardous to human health and the environment, and the proper disposal of waste, effluent, diseased fish and excess drugs and chemicals. The food safety aspect of aquaculture products is also stressed by the Code and particular care before and during harvesting and during processing, storage and transport is advised.

Bangkok shrimp consultation

The latest initiative towards the promotion of sustainable aquaculture, this time specifically in shrimp farming, took place in December 1997. The FAO organized a Technical Consultation on Policies for Sustainable Shrimp Culture from 8-11 December in Bangkok, Thailand. Present were representatives and observers from FAO member countries, intergovernmental organizations, international financial institutions and non-governmental organizations.

After listening to various country reports and position papers on the industry, the participants of the consultation broke up into separate workshops to discuss in detail specific topics, viz. (a) legal, institutional and consultative frameworks for shrimp culture development and management; (b) planning and regulatory methods and tools and economic incentive schemes for shrimp culture development and management; and (c) the potential role and contents of a voluntary code of conduct for sustainable shrimp culture.

At the end of the deliberations, the Bangkok Technical Consultation came out with a draft report which includes recommendations on policies and guidelines for the conduct of shrimp culture in a sustainable manner. The recommendations are based largely on the FAO Code of Conduct for Responsible Fisheries (Article 9) as applicable to shrimp farming. The recommendations will be published by the FAO as a report of the Technical Consultation in due course. (Source: *INFOFISH International*, January 1998)

The use of mangroves for aquaculture—can it be sustainable?

By Choo Poh Sze*

If carefully conducted, aquaculture development can take place without compromising the sustainability and carrying capacity of the mangrove ecosystem, argues the author.

Intensive fishing activities over the last two decades have caused landings from world capture fisheries to peak at 89.7 million mt, which is believed to be the maximum sustainable yield from the world's coastal waters and oceans. In Malaysia, landings from coastal fisheries have plateaued at 900,000 mt and a further increase in fish production is expected to come from the offshore sector and from aquaculture. By the year 2010, apart from the 900,000 mt landed from the coastal waters, the Department of Fisheries of Malaysia has projected a production of 430,000 mt from the offshore sector and 600,000 mt from aquaculture. Any increase in fish production after the year 2010 is anticipated to come mainly from aquaculture as fisheries resources from the offshore waters would very likely be exploited at the maximum sustainable level.

Prior to the mid-1980s, not much emphasis was given by aquaculturists towards making the aquaculture industry sustainable. Hence, widespread crop failures due to disease outbreaks and problems associated with the degradation of

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the environment were reported in various parts of the world in the 1980s and 1990s, for example in Taiwan, China and Thailand. For aquaculture to survive, it is imperative that the industry should become more compatible with other users of common resources and with the environment.

A big concern in Malaysia in recent years has been over the development of mangrove areas for aquaculture. Production from aquaculture in 1995 totalled 132,742 mt of which 7,407 mt originated from 2,623 ha of brackishwater ponds. The brackishwater ponds were either developed from mangrove areas or from unproductive agricultural land; the exact heactarage from mangrove is not known although several estimates have been given. In mid-1996, the Malaysian Government, concerned over the loss of mangroves for agriculture, housing, industrial and aquacultural purposes, imposed a ban on the clearing of any new mangrove areas for development.

Status of brackishwater culture

The area under mangrove cover in Malaysia in 1993 totalled 641,172 ha, with Sabah having the largest area (365,460 ha), followed by Sarawak (167,992 ha) and Peninsular Malaysia (107,720 ha). The total area of brackishwater ponds in Malaysia amounted to 2,623 ha in 1995. Although some of these ponds are located on non-mangrove land, due to the lack of data, the mangrove area used for ponds is assumed to be the total area under brackishwater ponds. The area of brackishwater ponds comprises a mere 0.4 per cent of the total mangrove area in the country.

Examination of data on a statewide basis shows that brackishwater pond culture is relatively undeveloped in some states, especially Sarawak. Species cultured in brackishwater ponds include the penaeid shrimps (tiger and banana shrimp), sea bass, grouper and the mud crab. The predominant species cultured is the tiger shrimp (*Penaeus monodon*) which constitutes more than 80 per cent of the total brackishwater production.

After the initial phase of expansion in the late 1970s and early 1980s, which witnessed a lot of failures due mainly to unsustainable practices, recent penaeid shrimp culture practices are more sustainable as farmers and state governments have learned from the initial setbacks and mistakes. Adverse impacts of penaeid shrimp culture include the following:

- Acid sulphate condition created during pond excavation;
- Coastal erosion and flooding;
- Increased nutrients resulting in eutrophication;
- Antibiotic and other chemical contamination;
- Disease outbreaks;
- Declining coastal fisheries resources;
- Socio-economic problems.

Recent developments in penaeid shrimp culture have overcome most of these problems. It is now realized that the "hutan darat" or back swamps which contribute relatively little to the productivity of the mangrove ecosystem are more suitable for farming. New farms are now commonly sited 100 m or more behind the coastal mangrove belt. Coastal erosion, flooding and acid-sulphate problems are not encountered and drainage of ponds is better accomplished on higher grounds. However, siting of brackishwater ponds on higher grounds may lead to salination of the adjacent areas. This problem could be solved by the construction of peripheral canals and the allocation of buffer zones.

Effluent treatment facilities are also included in recently constructed farms. Seaweed, molluscs and some herbivorous/omnivorous fish are generally reared in the

effluent treatment ponds to reduce the nutrient and solid matter loadings before the effluents are discharged. To avoid problems such as disease and high waste loadings, the semi-intensive culture system is recommended. The Aquaculture Regulations which are being prepared by the Department of Fisheries will impose a code of practice on the aquaculture industry to ensure its sustainability.

Is brackishwater culture sustainable?

In recent years, opposition to brackishwater farming, particularly shrimp farming, has become rather intense in the country. Even though less than 1 per cent of the mangrove has been utilized for shrimp farming out of a total of 30 per cent developed for various purposes, this industry has borne the brunt of the criticism for mangrove destruction. The negative view of shrimp culture could be a result of the spectacular collapse of this industry in several countries in the mid-1980s and early 1990s, notably in Taiwan, Thailand, Philippines, Indonesia and, to some extent, Malaysia. The crashes have been linked to unsustainable production exceeding the carrying capacity of the area.

In efforts to stop widespread mangrove destruction, Ecuador formulated mangrove governance policies in the mid-1980s to focus on centralized enforcement of a virtual prohibition of mangrove use. However, none of the experts tasked with offering guidance to Ecuador to formulate a Coastal Resource Management Programme advocated pursuing the no-use policy even though all were greatly concerned about the rapid degradation of mangrove ecosystems. Instead, these experts offered a variety of recommendations for sustainable utilization to be incorporated into a special area management plan.

It has been well established that mangroves are important feeding and nursery grounds for many species of prawn and fish fry. They also offer protection against soil erosion and act as traps for nutrients and pollutants. Mangroves can be utilized up to a certain extent without affecting the carrying capacity of the adjacent coastal waters, although establishing the extent of the area that could be exploited would involve many scientific disciplines. For example, a 1994 study indicated that the loss of large tracts of mangrove in Klang and Port Klang did not appear to affect the adjacent fishery. It was also shown that shrimp landings on the west coast of Peninsular Malaysia over the years from 1984-1993 did not decline despite the fact that a greater area of mangroves was cleared in 1993 than in 1984.

It has been suggested that intensive one-species aquaculture, such as shrimp farming, could be made sustainable if the culture systems are integrated with the ecosystem processes and functions. The Department of Fisheries, Thailand, is also promoting shrimp farming as a sustainable industry and has laid down policies to ensure its sustainability. Among the regulations are:

- Shrimp farms in the country will not exceed 76,000 ha;
- Shrimp farms must be registered with the Department of Fisheries;
- Shrimp farms over 8 ha must be equipped with waste water treatment or sedimentation ponds covering not less than 10 per cent of pond area;
- Water released from the shrimp ponds must not contain BOD of more than 10 mg/l;
- Salt water must not be drained into public freshwater resources or agricultural areas;
- Sludge or bottom mud sediment should be kept in a suitable area and should not be pumped out to a public area or canal.

By the year 2010, the Department of Fisheries, Malaysia, has projected a production of 82,500 mt from

penaeid shrimp culture for the country. Basing on a production of 4 mt/ha/yr (the present average productivity), this would mean that a total of 20,625 ha of land would be needed. Future development of brackishwater ponds will not be sited on prime mangrove land and may only utilize a portion of the back swamps.

To ensure sustainable development of our coastal zones, a holistic and integrated approach which takes into account the interests of all users must be formulated. Perhaps what is important is to bear in mind that leaving the mangroves intact may not be the best option, but instead efforts to enhance the productivity of this ecosystem by using and managing it

wisely for various purposes without compromising on its carrying capacity and sustainability should be considered.

Conclusion

It is strongly believed that penaeid shrimp farming could be sustainable if strict guidelines for its development are followed. The utilization of back swamps for penaeid shrimp culture will not necessarily adversely affect the productivity of the mangrove if recommended guidelines and a strict code of practices are adhered to. A coastal zone management plan is necessary to ensure the sustainable development of our coastal areas.

Area under mangrove cover and brackishwater ponds in Malaysia

State	Mangrove cover (ha)	Brackishwater ponds (ha)	Percentage pond/mangrove
Johor	24 697	587.84	2.38
Kedah	8 134	389.30	4.79
Kelantan	20	67.85	?*
Melaka	314	20.24	6.45
Negeri Sembilan	1 061	30.50	2.87
Pahang	2 482	171.82	6.92
Penang	506	86.72	17.14
Perak	43 469	356.47	0.82
Perlis	100	7.75	7.75
Selangor	25 983	297.72	1.15
Trengganu	954	48.48	5.08
Sabah	365 460	544.59	0.15
Sarawak	167 992	14.16	-
Total	641 172	623.44	0.41

Sources: Mangrove cover—Forestry Department, Malaysia (1993 data); Brackishwater pond area—Annual Fisheries Statistics (1995).

*Note: In Kelantan, mangroves are still found in several areas, e.g. in Pantai Sri Tujuh. A major portion of the brackishwater ponds is very likely sited in areas of non-mangrove origin.

(Reprinted from *INFOFISH International*, June 1997)

C. TECHNOLOGY UPDATE

A breakthrough in maritime propulsion

To the delight of its developers in Finland, Azipod propulsion technology offers significant technical and economic advantages over its competitors. VTT Manufacturing Technology participated in the development of the new technology by carrying out tests with hydrodynamic scale models and computer simulations.

The results of tests show that Azipod propulsion is a safe and economically advantageous system. Compared to conventional solutions Azipod propulsion takes less space within the hull. Ship designers gain more room to utilize hull space according to the individual requirements of each ship. The new technology is more energy efficient than conventional diesel-electric power systems. In addition, Azipod propulsion significantly improves the manoeuvrability of ships.

Eight large 14-MW Azipod electric motor units are under construction which will power two 70,000 GT passenger cruise ships being built in Helsinki for Carnival Cruise Lines. In addition, Royal Caribbean Inc. has selected the technology for its giant 130,000 GT passenger cruisers that are due to be completed in Turku by 1999 and 2000 respectively. Each of these two enormous ships will have two 14-MW steerable units and one fixed unit of similar power.

The commercial opportunities offered by Azipod propulsion will be exploited by a company founded by the developers of the technology, Kvaerner Masa-Yards and ABB Industry, together with an Italian partner, Fincantieri.

The dominant paradigm of ship propulsion relies on a diesel engine running propellers with long shafts. In Azipod technology the shafts are replaced with an electrical motor in close proximity to the propeller. The electrical motor is housed outside the hull, within a pod installed at the end of a fin-like strut.

In conventional designs the propeller always pushes the ship. In Azipod propulsion the propeller can be fitted in either end of the pod. If the propeller is aft of the pod and strut, it will exert a pushing force. Conversely, a propeller in front will pull the strut and the ship.

Azipod technology eliminates the need for long propeller shafts and saves valuable space. Yet, in order to make this radical departure possible, the developers of the new technology had to solve several problems, one of which was to reduce the size of the electrical motor so that it would fit in a pod of reasonable size.

One of the strengths of the new technology is also the way in which it improves the ships' manoeuvrability. The

pod housing the electric motors can be turned a full 360 degrees. Even without a propeller, such a pod would act as a rudder. With the propeller, the strut-pod construction offers excellent manoeuvrability properties even at low speeds, particularly during berthing. The propellers can also move the ship sideways. Further details from Harri Soininen, VTT Manufacturing Technology, harri.soininen@vtt.fi. Tel.: +358 9 456 6223. (Source: *Industrial Horizons*, December 1997)

Indoor recirculating aquaculture system

A researcher at the College of Fisheries, University of Agricultural Sciences, Mangalore, India has designed and fabricated a model closed recirculating system with biofilter suitable for indoor aquaculture. The system, developed by Dr. H. Shivananda Murthy, consists of 24 circular fibreglass tanks each with a capacity of 120 litres. The tanks are arranged in two tiers of 12 tanks each. The biofilter consisted of three rectangular fibreglass tanks, each with a capacity of 1,000 litres, and one circular tank of 750 litres. The biofilter tanks were placed outside the laboratory and covered to avoid direct sunlight.

The tanks are connected to each other so that the waste water from the outlets of the 24 experimental culture tanks is led into the circular tank, the first biofilter tank in the series. A double layered sponge mat is placed in a perforated plastic tub just above the circular tank in order to trap coarse suspended particles. After passing through the sponge mats, the water passes through graded layers of sand and enters a partitioned-off section of the circular tank through a hole in the bottom of the partition.

The water enters the second (rectangular) biofilter tank which is filled with oyster shells for biological filtration. The third filter tank contains clam shells as substrate. The filtered water then enters the fourth tank which serves as a temporary storage tank. The water is pumped from this tank to an overhead 2,000 litre PVC tank. Flow rate in each culture tank is normally maintained at 1 litre/minute. An air blower is installed to supply continuous aeration to the culture and biofilter tanks.

The closed recirculating system gave good results with the Indian major carps rohu and catla, African catfish and tilapia. An average of 30 per cent faster growth was achieved compared to conventional systems. The enhanced growth rate is mainly attributed to the improved water quality, particularly in terms of total ammonia and nitrite levels, and increased dissolved oxygen concentration. In each cycle of

water flow, the ammonia and nitrite levels were reduced by more than five times in the biofilter. On average the water is recirculated eight times a day.

The system is considered ideal for use in areas where clean water is scarce, particularly in summer. It can be used for fish and prawns and, with minor modifications, can also be used for brackishwater and marine species. (Source: *INFOFISH International*, January 1998)

Extending the uses of a ship simulator with new technologies

The control system simulator (CSS) for ship manoeuvring enables simulations for research and training. The design and evaluation of the manoeuvrability of new ships are typical applications performed for shipyards and shipping companies. The structure of the simulation model is modular, making possible various combinations of modules representing different properties of the ship and its manoeuvring environment. The simulations can cover a wide speed range from Full Ahead to Full Astern and include harbour manoeuvres with large drift angles.

Simulating the ships' operational limits and safety factors helps fairway and port design. A large number of simulations are needed to find out wind restrictions for a particular ship and fairway. A series of simulations can be carried out by using automated, accelerated simulations, which run ten times faster than the simulations in real time.

The CSS navigation software presents shorelines, fairways, tracks and the ship symbol with a predictor. The predicted position after a selected time interval is calculated using the ship's present state of motion. The position is shown on the electronic chart display, which helps manoeuvring in narrow waterways and harbour areas.

The addition of the virtual reality technology has further extended the simulator's capabilities. The virtual environment as seen from the bridge of the ship is projected to the front. Besides normal visibility control, including different lighting and fog, the viewpoint can be moved and the situation observed from outside the ship. The free choice of the viewpoint makes it possible to observe views also from different positions on the bridge, which is useful in designing the bridge layout, as the expense of building mock-ups is eliminated.

The creation of the simulator imagery is started by converting digital maps and maritime charts to two-dimensional CAD drawings. The elevation data of the ground is acquired from databases for constructing the three-dimensional model. For far-away shorelines simple models are sufficient, but harbour areas and archipelago fairways require detailed shore models. Buildings and other structures are rendered by using photographs of real building façades.

The PC-based simulator system is upgrade-friendly and the program development is convenient. Customizing of the simulator for training with different ships and adding new equipment is easy. Simulations of land-vehicle and traffic are possible with customized modules. (Source: *Industrial Horizons*, December 1997)

Inspection tool devised for splash zone

An inspection tool that combines a frame and cameras has been devised by British Petroleum and Stolt Comex Seaway to eliminate divers and remotely operated vehicles (ROV) during riser inspections in the splash zone. The use of divers and ROV units depends on calm sea conditions, and the two companies sought another means of dealing with riser corrosion problems.

The tool frame is clamped around the riser at the surface. Rollers allow the frame to be lowered and raised.

Eight cameras provide a 360-degree visual inspection of the riser and protecting coating. (Source: *Offshore*, October 1997)

Coatings breakdown in double-hull tankers

In as little as three years, owners of double-hull tankers are reporting a breakdown in coatings on free edges, in high-stress areas, on stringers and internal fittings between the hulls. Double-hull tankers are a new or expected requirement for entry into most maritime countries, and little information has been available on double-hull longevity. Intertanko has issued a report asking for frequent inspection of coatings in the between-hull areas. The American Bureau of Shipping is compiling a database of double-hull experience to track performance.

Much of the trouble appears to rise in the design of ballast tankage in the double-hull areas, and access for inspection and maintenance. Ballast-tank corrosion in double-hull ships is 2.5 times greater than single-hull tankers with segregated ballast tanks. A third concern is in gas-freeing and ventilation of double-hull spaces. (Source: *Offshore*, October 1997)

Boron fibre epoxy patch developed

A boron fibre-reinforced epoxy patch has been developed by Sandia Laboratories to patch cracks on aluminium skins in aeroplanes and its use may be expanded to cover other products. The patch replaces complete change-out of aluminium plates. A thin layer of the polymer composite material is applied to the crack and cured with heat overnight. Sandia National Laboratories (United States) developed the product and is looking at uses outside the airline industry. (Source: *Offshore*, October 1997)

Gravity gradiometry

Bell Geospace, a new company, is now providing gravity gradiometry data on more than 800 blocks of the Gulf of Mexico's subsalt and deep-water areas for use by the offshore oil and gas industry. Utilizing Bell Aerospace technology, the data was acquired by the US Navy, but has remarkable value in imaging the subsurface. Not the same as the gravimeters presently used by the industry, which only provide a vertical vector, gravity gradiometric data represents directional gravity, something like 3D gravity, since it detects changes in mass densities. As a consequence, it provides a far better image of contrasts in impedance, and this allows pre-stack depth migration with greater resolution. Thus, by combining a gravity gradiometric density cube with a 3D seismic velocity cube, a better image of the true geology is produced. (Source: *Offshore*, October 1997)

Composite underwater repairs studied

The use of carbon fibre composites to repair and strengthen platform jacket members, pipelines, and deficient metal subsea structures, is being examined by a joint industry project (JIP), headed by Devonport Royal Dockyard and MSL Engineering in the UK. The project includes Amoco, BG, Elf Exploration, Enterprise, Mobil, and Rockwater.

Composite materials are flexible upon application, do not require heating, are durable and relatively lightweight. The fibre and resin components are easily handled and formed on site, conforming to the desired shape. In repairing an underwater structure, a carbon fibre preform is set around the repair point and surrounded with a watertight bag. The bag is de-watered and resins are forced through the preform. An adhesive bond forms between the composite and existing metal structure.

A full-scale underwater repair of a tubular joint with accompanying load testing is planned. (Source: *Offshore*, March 1998)

Transas Marine (UK) Ltd. reveals latest development

Transas Marine (UK) Ltd. (St. Petersburg, Russia) recently announced developments concerning several of the company's newest additions to the field of maritime navigation, according to a spokesperson.

As the company's Navi-Sailor increasingly penetrated the worldwide market, it became clear that the functional resources were not being utilized to their fullest advantage. The idea to improve the information available to the navigator involved designing a special device for the purpose of incorporating the information from the radar/ARPA receivers in real time and displaying it directly on the Navi-Sailor's electronic chart.

The radar integrator board (RIB) was officially launched to the market in June 1997. The RIB is an automated digital module, which may be installed into a Navi-Sailor system and provides direct input of the raw radar signal from sources of radar information to form a digitized radar overlay on the electronic chart display and information systems (ECDIS) chart. The RIB is additionally capable of automatically detecting and tracking targets and sending the relevant associated data to the Navi-Sailor system for analysis.

The main benefits of using the RIB with the Navi-Sailor include: the navigator receives radar/ARPA-generated information on all stationary objects in the area of navigation which is then directly transmitted to the electronic chart display; the navigator may receive automatically all information on targets moving on the sea surface directly on the chart display; all parameters of targets are traced by the system; the number of extracted targets has been extended to a maximum of 512; and all pre-set alarms are active, regardless of whether the targets are monitored on the screen or not. (Source: *Sea Technology*, March 1998)

Underwater light for cage culture

An underwater light designed to stop early maturation of cage culture fish and to give a better feeding response has been developed by SM Remote Systems AS, jointly with ROV Scan Services (UK), Scotland. Trials have shown that one underwater light can replace five or six surface lights in one cage. The higher efficiency of the former is apparently due to its ability to cut off the surface reflection normally encountered with lights used above water.

For example to get the 400-W effect of an underwater light you need above-water lights of total 3 kW. According to SM Remote Systems, in a fish maturation study conducted in a 24 m² cage, a single 250-W underwater light has been shown to be adequate. The light is normally placed in the centre of the cage at one or two metres under water. If deeper cage nets are used it may be necessary to use two lights, one at two to three metres and the other at five to six metres.

According to a report in *Fish Farming International*, the company also intends to develop the underwater camera system it markets by incorporating sensors for feeding and for recording by computer, information on water salinity, oxygen, temperature, currents etc. (Source: *INFOFISH International*, February 1998)

Cargo catamaran concepts

There is a growing belief in parts of the fast ferry industry that high speed cargo will be the next major development. Incat Tasmania is already building a 96-m

ro-pax wavepiercing catamaran that is expected to enter service during the final quarter of 1998.

One project that has reached an advanced stage involves Advanced Multihull Designs, Halter Marine and Caribbean Cargo, a United States company established to develop a fleet of high-speed cargo catamarans servicing the Western Caribbean market. Halter Marine has quoted for two vessels and reports that they could be operating in early 1999.

The design proposed is the AMD 1240. This is described by AMD as "a shallow draught, fast catamaran configured for high speeds whilst laden with cargo in unprotected waters. Loading of containers is accomplished via the use of terminal tractors which manoeuvre the cargo over shore-based ramps into position on the main deck. A system of guide rails is located on the deck to assist loading and securing of cargo.

"The vessel has the capacity to carry 20 48-ft. trailers in five lanes which, when coupled with a fuel capacity for an 800 nautical mile range, equates to 367 tonnes of dead weight. Accommodation is provided on a resiliently mounted wheelhouse deck."

Facilities here include a passenger lounge, communications centre, two staterooms for VIP passengers, shower/toilet and duty-free shopping.

Crew accommodation is also provided aft for the captain and chief engineer, in separate cabins with bathrooms; two deck officers, in individual cabins with shared toilet and shower facilities; and eight able seamen in four cabins with bathrooms. A crew lounge and mess for both crew and passenger meals will also be provided.

Austal Ships are promoting a range of mixed traffic and cargo vessels developed from their Auto Express passenger/vehicle ferries.

Four designs, having lengths overall of 95 m or 112 m, would be powered by either four Pielstick 20 PASC STC 8.1 MW diesels or a pair of ABB GT 10 21.5 MW gas turbines. A fifth would have a codag arrangement of two MTU 20 V 1163 TB73L 6.5 MW diesels and two Rolls-Royce Spey 14 MW gas turbines.

Potential markets for the designs, Austal feels, include feeder operations carrying 20-100 tonne payloads to air hubs, and overnight services for door-to-door customers carrying 600-1,500 tonne payloads up to 500 nautical miles.

The company has also detailed research that has been conducted into ride control systems for fast freighters. (Source: *Fast Ferry International*, March 1998)

NGA updates Pentamaran designs

Nigel Gee & Associates has released updated details of its fast car ferry and container ship designs based on the Pentamaran concept developed by the company with the sponsorship of the Swiss-based Norasia Services.

As NGA puts it, "The hull form might best be described as a slender monohull stabilized with small outboard sponsons. The company has also revealed "that a similar, smaller passenger vessel is due to begin operations in the United States in 1999".

Referring to the vehicle ferry design, now known as Project PECAN, NGA says the design lends itself to application as a fast car ferry because of its high efficiency and its natural rectangular planform for the stowage of vehicles.

The ferry is based on the Pentamaran hull form (International Patent Application PCT/GB96/02313) and designed to give the best possible combination of low resistance and good seakeeping capabilities.

In Project PECAN stability is enhanced by the use of two pairs of slender sponsons which give the vessel the required stability with very little effect on resistance and powering.

The result is a design that can be propelled at high speed using significantly less power than other forms of vessels. A PECAN vessel, built in aluminium and using high-speed diesels would require only 75 per cent of the installed power of existing designs of fast aluminium monohull and catamaran car ferries.

Alternatively, if built in steel and propelled by medium-speed diesel engines, vessel powering is roughly equivalent to the current generation of monohull and catamaran vessels.

The PECAN high-speed car ferry uses steel construction throughout the hulls and car decks with only a limited amount of aluminium in the passenger and control spaces. The vessel is propelled by a pair of Wärtsilä 20 V 380 medium-speed diesel engines.

The first PECAN ferry designed has an overall length of 133 metres and overall beam of 28 metres. The vessel can carry up to 1,000 passengers and 200 cars at speeds of 40 knots.

All vehicle loading is over the stern through six lanes, such that loading and unloading can take place simultaneously. Passenger loading is over the stern or via side access doors on the two upper decks.

The Pentamaran concept evolved from an approach to NGA in July 1995 from Norasia Services, a container ship operator, who were interested in the possibility of carrying 12,500 dead-weight tonnes at 30 knots but using an installed power of only 30 MW.

United Kingdom and world patents for the proposed hull form have been applied for and the PEBOS project is currently at the stage of detailed shipbuilding quotations. The present PEBOS design is for a ship having an overall length of 242 metres with a capacity for 1,571 teu. A service speed of 30 knots is achieved at a delivered power of just over 36 MW.

Total installed power is just over 46 MW from a pair of Wärtsilä 12 V 64 medium-speed diesel engines driving a single controllable pitch propeller through a combining gearbox.

The installed power allows the ship to achieve the 30 knots service speed with machinery running at 90 per cent mcr and with due allowance for sea margin and a 2.5-MW electrical generator driven from a gearbox power take off. Additional on-board power generation is from two 1,500 kVA diesel generators.

The design concept can be employed on faster and larger vessels. NGA is currently looking at ships with a capacity of 2,000-3,000 teu operating at speeds up to 35 knots. It is anticipated that future ships of this type would also have a high refrigerated container content. (Source: *Fast Ferry International*, April 1998)

Microbiological hazards and emerging food-safety issues associated with seafoods

The United States is entering into a new era in which dwindling natural fisheries resources are forcing regulatory agencies to develop a more holistic approach to seafood safety and natural marine resource issues. Public health issues associated with seafoods can be grouped as (i) environmentally induced (i.e., natural or anthropogenic), (ii) process-induced, (iii) distribution-induced, or (iv) consumer-induced hazards. Similarly, loss of habitat and ecosystem degradation threaten the future viability of fisheries and have important ramifications for seafood safety. In the United States, large-scale legislative efforts are under

way to re-examine regulatory food control systems. The driving forces behind these efforts are the discovery of new emerging pathogens for which little information is available and dramatic improvements in analytic technology that allow for detection of low levels of microbial and chemical contaminants in foods. The global nature of seafood trading issues and the worldwide implementation of new preventative food safety programmes such as hazard analysis for critical control points are driving some of the efforts to build new scientific bridges that will re-evaluate current risk analysis strategies. New scientific bridges are needed to close the gaps between the scientific community and society concerning the effects of anthropogenic impacts on seafood safety and the health of coastal habitats and associated fishery resources. The driving force behind this latter issue is the realization that the United States has lost over half of its original coastal wetlands areas. Protecting, conserving and restoring the health and safety of fisheries resources will require an integrated approach of food science and fishery science. (Source: *Journal of Food Protection*, 60(11): 1409-1415, November 1997)

Studies of the large-scale sea transportation of liquid hydrogen

Hydrogen is anticipated to be one of the promising energy carriers used in the 21st century. In Japan, research for establishing a hydrogen energy technology is being conducted in the WE-NET (World Energy Network) research programme of the New Sunshine Project, promoted by the Ministry of Trade and Industry since 1993 and aimed at completion in 2020.

During the first three years, studies of hydrogen tanker development, conceptual design of a 200,000 m³ hydrogen tanker based on the liquid natural gas ship technology, and some investigations on the insulation and support system for hydrogen tanks were carried out by the joint shipyard team of the WE-NET programme. An outline of our research and some considerations are reported. © 1997 International Association for Hydrogen Energy. (Source: *International Journal of Hydrogen Energy*, 23(2): 115-121, February 1998)

Efficient turbine for wave power conversion

Prof. T. Setoguchi and a research team at Saga University, Japan, have developed a new turbine for wave power conversion. The improved turbine has guide vanes with self-controlled pitch, and provides a link between the upstream and downstream vanes to increase conversion efficiency.

The turbine has a rotor with cup-shaped blades to ensure that it revolves in the same direction no matter which direction the driving flow has due to changes on the water surface. The linked guide vanes make certain that the rotor turns fast enough even with modest waves.

The research team estimates that the new turbine has a peak power that is one-and-a-half times more than the Wells turbine, the conventional wave power converter. Mean outputs for the whole range, including lesser waves as well, are calculated to achieve a higher ratio of 3.

India's National Institute of Ocean Technology will set up a 1-m diameter turbine of the new design in the Indian Ocean to produce electricity of 50 to 100 kilowatts per hour with the actual value depending on various factors including the magnitude of waves. In China, Guangzhou Institute of Energy Conversion is building a 30-cm diameter turbine.

Further details from Saga University, Department of Mechanical Engineering, 1, Honjyomachi, Saga City, Saga

Pref. 840, Japan. Tel.: +81-952-28-8605; Fax: +81-952-28-8587 (Source: *JETRO*, October 1997)

Saltwater and freshwater purification system

Ishikawajima-Shibaura Machinery Co., Ltd. has started taking orders for a newly developed saltwater and freshwater purification system that can filter and sterilize natural saltwater for complete sterile saltwater. This is the first case of mass production of a system capable of treating both seawater and freshwater in Japan.

The system uses an ultrafine hollow filtration membrane (made of polyethylene) and features a fractionation capacity of 0.1 μm , by which *E. coli*, such as the pathological bacterium 0157, as well as protozoans such as cryptosporidium, which cannot be eliminated by chlorine, are completely removed.

A myriad of ultrafine holes are formed on the surfaces of a tubular hollow film assembly. The liquid penetrates from the outer surface and must pass through the ultrafine pores to reach the inner surface. The ultrafine pores are linked together in the filter wall and act as a sieve to obstruct the passage of foreign substances such as large floating particles. In the process of filtration, the foreign substances in the water and accumulations on the hollow film assembly are temporarily removed by counterflow of the treated water. At the same time, air bubbling is carried out with a blower on the underside: the film oscillated by the bubbles rises in the water, and the foreign substances are exfoliated and removed. Therefore, the volume of water required to clean the film is minimized.

The system is lightweight and compact, the filtration pressure is low due to filtration with the hollow film assembly and, since the system is designed to be simple, it is operated with minimal power. In addition, it is automatically operable with just a push-button action and is therefore a labour-saving system. The film assembly is made of polyethylene with rugged durability, and withstands long use for about five years.

The system is compatible with the Hazard Analysis Concentrated Control Policy (HACCP) and the FY 1998 Version Food Sanitation Act (regarding the handling of fisheries products exported to EU countries) about which the food processing industry is much concerned. The new system, by removing floating substances and bacteria in seawater and enabling purified water to be used in all processes of defreezing and washing, contributes immensely to improving quality standards and to retaining the freshness of fishery products. Also, by using bacteria-free water for fish culturing, the hatching ratio and survival rate of fry are improved considerably, while the water used for defreezing, washing, cooling and processing by food processing plants can be recycled. Further details from Ishikawajima-Shibaura Machinery Co., Ltd., Research Development Division, 5-32-7, Sendagaya, Shibuya-ku, Tokyo 151-0051, Japan. Tel.: +81-3-3358-4211; Fax: +81-3-3358-4233. (Source: *JETRO*, February 1998)

System utilizing waves to automatically remove shells adhering to marine structures

Kuribayashi Kiko Co., Ltd. has developed a system that utilizes wave action to automatically remove shells and other marine organisms adhering to marine structures. Compared with conventional manual work, the system is a safe, floating type system permitting removal at low cost by utilizing the vertical motions of waves and tides.

The newly developed system, called Clean Float, consists of a linkage of pieces of polypropylene resin 12 cm long, 3.5 cm wide circled around girders. The motion of tides

moves the ring up and down and removes shells and other marine organisms adhering to the pillars. The removed organisms are collected in a net attached to the system. Clean Float enables marine organisms to be removed safely without being influenced by the weather and without requiring any direct labour for removal.

The adhesion of shells and other marine organisms to bridge girders and pier pillars accelerate corrosion, fatigue and concrete deterioration to shorten their service lives. The part of the sea from the surface to a depth of about 10 m is influenced largely by waves and currents, and this is also the part where marine organisms proliferate the most. In addition, the adhesion of marine organisms enlarges the diameters of the pillars and increases the influences of waves, leading to increased vibrations that accelerate pillar deterioration. Further details from Kuribayashi Kiko Co., Ltd., Public Relations Dept., 4-3-14, Shinkai-cho, Tomakomai City, Hokkaido 053, Japan. Tel.: +81-144-55-8727; Fax: +81-144-55-8729 (Source: *JETRO*, January 1998)

Race to develop 10,000-ft. water depth equipment continues

More and more tools are emerging from the design boards and machining halls to deal with the seafloor forces in ultra-deepwater drilling. The latest is Cameron, which has developed a drilling and completion collet connector to attach the blowout preventer stack to the well-head, especially for dynamically positioned vessels.

The connector is designed for 10,000 ft depths and for a combined loading of 5.5 million ft/lb bending, 3 million lb external tension, 300,000 ft-lb torque, and 15,000 psi internal pressures. Cameron says it will add a dual-hub well-head profile, which will allow connection of a standard Cameron HC connector in lower range loading situations. (Source: *Offshore*, December 1997)

Deep-water exploration drives demand for advanced thrusters

As the number of deep-water exploration projects continues to increase, there is a growing demand for vessels that rely solely on dynamic positioning. The offshore industry is therefore making substantial investments in new generation deep-water rigs and support vessels. The Kamewa Group has been working closely with vessel owners and designers in order to carry out feasibility studies for this type of application.

Since reliability is a critical factor in deep-water projects, the owners themselves usually make the decisions regarding selection and configuration of propulsion equipment.

Kamewa's offshore team has secured an impressive number of high-profile orders to supply both new-build and conversion projects with advanced dynamic positioning.

As part of a joint venture, Transocean Offshore is building the Discoverer Enterprise which, when completed, will be the world's largest mobile offshore drilling rig operating in water depths up to 3,000 metres. The exploration and development of the vessel's propulsion and thrust for dynamic positioning will be supplied by six Aquamaster UUS 7001 thrusters with a total output of 30,000 kW.

Kamewa is also supplying dynamic positioning systems for two new-build drill ships being built for the Conoco/Reading & Bates joint venture in the Republic of Korea. Each vessel will be fitted with six demountable Aquamaster UUS 6001 azimuthing thrusters providing a total

power of 24,000 kW and fitted with Kamewa's patented tilted nozzles enabling them to drill at water depths of up to 3,000 metres.

Kamewa is also closely involved in a number of conversion projects such as the Ocean Clipper, a drill ship owned by Diamond Offshore. The vessel is being refitted with an upgraded positioning system consisting solely of Kamewa products. The order includes a single top-side demountable Aquamaster USL 3001 azimuth thruster and five Kamewa TT 2,400 fixed-pitch tunnel thrusters. A unique locking device means that thrusters are easily installed or removed at sea.

Although orders for deep-water drilling and supply vessels will probably slow down within the next couple of years, DP systems will continue to be in demand.

One such project has already involved Kamewa which is supplying six Aquamaster 3001 azimuth thrusters for a derrick barge that is being converted into a DP pipe-laying vessel by Global Industries. For more information contact Anders Pettersson, Kamewa Group. Tel.: +46 550 84480; Fax: +46 550 84049. (Source: *Offshore*, October 1997)

Easy to manoeuvre CAP combines steering, propulsion, thrust bearing

Motala Verkstad has developed an innovative method of vectoring propeller thrust. The CAP propulsion system is intended to replace thrusters and the principle of operation is relatively simple yet ingenious.

The CAP hub assembly unit comprises a fixed mounting and two hubs, both of which rotate at an angle relative to each other and relative to the vessel. This rotation cancels out the vertical plane so the shaftline remains horizontal but, seen from above the aft hub, which carries the propeller shaft, can move to an angle of 30 degrees each side of the amidship's position. The propeller thrust is directed accordingly and, if required, a nozzle can be mounted on this aft hub moving with the hub and therefore giving a steerable nozzle propeller effect.

The CAP propulsion unit combines propulsion, steering, steering gear and thrust bearing into one common unit. A fixed-pitch propeller is supplied with varying combinations of the number of blades and blade area ratios to suit different applications.

The unit is lubricated by oil under pressure from a header tank located above the waterline. Currently, the unit covers the power range of 200-5,000 kW corresponding to hub sizes from 33 to 125 cm.

Motala claims that the CAP propulsion system makes manoeuvring and steering much more efficient and faster than a normal rudder arrangement. The absence of a rudder and steering gear results in lower ship resistance, lower installation costs, and better fuel economy. Vibration and noise levels are also reduced since the propeller thrust is transmitted through the hubs to the vessel structure rather than through the shaft.

The CAP propulsion system comes with an electronic remote control system supplied in two different versions. The basic system controls the steering angle on the CAP unit while the CAPMATIC version combines control of the steering angle, the main engine RPM and the rotation of the propeller. The basic version consists of a control console located on the bridge with a control lever for follow-up steering and push-buttons for back-up steering. The console also houses the CAP position indicator, indication lamps for oil pumps and push-buttons to operate the hydraulic pumps. Additional control consoles for indoor or outdoor placement are also available. (Source: *Offshore*, October 1997)

Optical laser sensor improves weld control and data feedback

ESAB has upgraded its successful adaptive butt welding (ABW) system for submerged arc welding with an optical laser sensor for contact-free joint measurement. The smart sensor continuously scans the weld joint geometry to calculate parameters and bead positioning to give a totally automatic and adaptive controlled joint filling.

Based on smart optical sensor technology and laser light sources, the new sensor will, for most applications, replace the previous mechanical measuring sensor due to its high speed data processing capabilities. According to ESAB, this ability has considerable advantages when assessing feedback associated with the image analysis of the acquired configuration of previously deposited welds.

For a welding system to be fully automatic it must be able to adapt the bead size and shape continuously and automatically when the joint volume varies along the joint line. Without an intelligent adaptive joint fill control, the operator cannot leave the weld area since any deviations in the joint geometry need to be adjusted manually.

The majority of all butt joint preparations are made prior to fit-up and will always result in some degree of gap variation or mismatch, regardless of the welding method used. This will in turn lead to volume deviations along the joint line and, with a fixed weld parameter setting, will affect how flush the joint can be filled. A fully automatic system, therefore, has to be able to control both the run placement and bead size continuously and adapt the joint fill accordingly.

The ESAB ABW system, incorporating the new optical sensing technology, is able to solve this problem by compensating for irregular joints using its perfect joint fill adaptation programme. This program controls three different fill parameters, independently securing the joint to be filled flush with the upper edges prior to capping.

Based on taking continuous measurement points delivered by the optical sensor, cross-sections of the joint, principally related to the residual area to be filled layer after layer, are calculated by the system's PC controller. These calculations and measurement values control the adaptive programs relating to weld speed, current and bead placement.

For weld speed, the system compensates for changes in the volume of the joint along its length and adjusts the amount of weld metal required for each section. The current adaptation program controls the current level transversally and for each polygon section along the weld. Where one side of the joint has a larger section than the other, the program determines the required current level for beads to be deposited either side of the joint's centre line with this line always maintaining the nominal current level.

The bead placement program controls the positioning of intermediate beads in relation to each other and in relation to the outer beads. In the case of a high-low edge situation, the program displaces the position of the intermediate beads towards the high edge.

Based on its experience using single wire ABW applications, ESAB has also introduced a system to handle tandem applications. The two-wire system improves productivity while maintaining an extremely constant and repeatable welding quality.

The head for the second wire is also provided with an independent servo-motor which places the electrode at an angular setting. The outer beads are always positioned at an incline in order to optimize penetration at the side walls as well as delivering a smooth concave transition to the side of the joint.

The two servo-controlled contact jaws for DC and AC wire can be programmed with different angles allowing independent wire tips at the offset side wall—for example 4 mm for the DC-wire and 6 mm for the AC-wire. In a typical application, the DC current is 500-550 A and the AC current 650-650 A. The DC voltage range is 26-30 V, while the AC voltage range is 30-32 V.

Flux-cored wire has already been successfully used with the ABW system for high tensile steel, and the first commercial tandem system was commissioned in Germany in 1997.

For more information contact Margareta Swenson, ESAB Welding Equipment. Tel.: +46.584 81496; Fax: +46 584 12308. (Source: *Offshore*, October 1997)

D. OCEAN RESEARCH

In-situ pH sensor accurately measures sea water hydrogen ion concentration

The Central Research Institute of Electric Power Industry and the Japan Marine Science and Technology Center, by using an ion-sensitive field effect transistor (ISFET) as the pH electrode, have developed an *in-situ*-type pH sensor that can measure sea water hydrogen ion concentration (pH with accuracy, 5-100 times that of conventional type sensors. Measurements are possible from the sea surface to more than 4,000 m deep. These measurements will clarify how much carbon dioxide the sea is up taking from the atmosphere.

The electrode incorporates a thermistor that enables temperature compensation of the pH value *in situ*. The reference electrode is a pressure compensation electrode that is employed in the field of nuclear power technology. A porous ceramic material is used in the liquid junction unit.

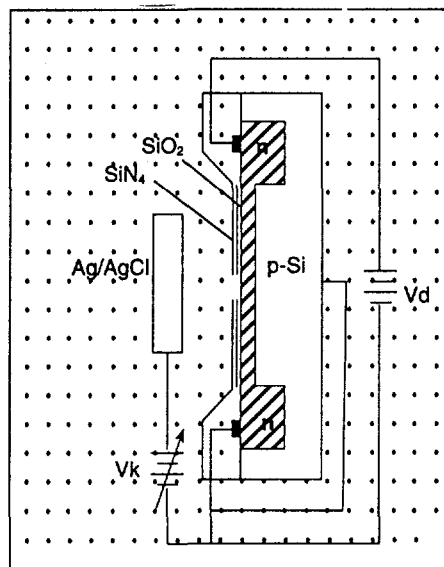
Today, the final uptake of about one half of the CO₂ generated by fossil fuels throughout the world is unknown, and there is a difference of about 1 billion tons (carbon equivalent) between the estimated amount deriving from sea measurements and the amount of CO₂ actually generated. There is therefore an urgent need to accurately measure the oceanic CO₂ uptake and elucidate the mechanism of the oceanic CO₂ system.

This new pH sensor uses the ISFET as its pH electrode that was developed for use in the medical treatment sector. This transistor consists of p-type silicon and its surface is coated with thin films of silicon oxide and silicon nitride. A gate voltage is impressed against the reference electrode. Changing the gate voltage changes the carrier density inside the channels of the semiconductor layers (in the domain where carriers are induced in the semiconductor layers in the proximity of the insulator and the semiconductor boundary surface).

A voltage is impressed between the source and drain, and the current flow will be larger with a higher carrier density (figure). Therefore, if the thin insulating film on the ISFET gate is in an aqueous medium, a boundary surface potential will be generated in conformance with the ion activity in the solution, by which the current value between the source and drain will be determined. In this case, silicon nitride is used as the ion-sensing film, so hydrogen ions will be sensed to permit pH measurements.

The pH sensor accuracy is as high as 0.01-0.005 pH with a very fast response. Since it is a solid sensor, it is highly resistant to pressure and impact. Measurements are possible at great oceanic depths, and it is also usable as a

long-term monitor for accurately measuring pH in the deep sea.



Basic principle of IFSET

Further details from The Central Research Institute of Electric Power Industry, Public Communications Div., 1-6-1, Ohtemachi, Chiyoda-ku, Tokyo 100, Japan. Tel.: +81-3-3201-6601; Fax: +81-3-3287-2863. (Source: *JETRO*, December 1997)

Magnetotellurics

BG plc, the gas development company previously known as British Gas, is currently involved in a fascinating research project in its research and technology division, to develop a marine magnetotelluric system for taking measurements at sea to map salt domes and structures beneath volcanics. The prototype is now being tested in the USA.

Magnetotellurics is a technique that draws upon energy from the sun and thunderstorms to map resistivity changes in the Earth from depths of a few metres to several kilometres. These energy sources create eddy currents in the strata that can be detected at the surface. The amplitude and direction of the currents depend on the resistivity and depth of the geological formations so, by recording electric and magnetic fields at the surface, the subsurface structures can be delineated. Once processed, a simple model of the resistivity

structure can be produced to determine 2D and sometimes 3D subsurface structures that could contain hydrocarbons. In the marine magnetotelluric system, the instrumentation is placed on the ocean floor. (Source: *Offshore*, October 1997)

CRADA signing could lead to new deep ocean technologies

Meridian Sciences Inc. (Hanover, MD) recently teamed with the Naval Meteorology and Oceanography Command (Stennis Space Center, MS), University of Southern Mississippi (Hattiesburg), and COTS Technology (New Orleans) in a cooperative research and development agreement (CRADA) to develop new technologies for deep ocean exploration.

Meridian spokesman Jeff Burns said potential commercial applications include ocean bottom exploration for such projects as mineral and oil prospecting, pipeline and cable repair, salvage operations and archaeological expeditions.

Specific objectives of this agreement include: (1) cooperation in the development of mission planning software, simulation software, vehicle control software, operational procedures and technical documentation for ROVs and unmanned underwater vehicles (UUVs), (2) development and integration of new hardware and software for deep ocean navigation and location of objects with multibeam sonar mapping sensors, and (3) creation and upgrading of software to simulate underwater navigation and the actual location of objects in the deep ocean by UUVs.

CRADAs are made possible under the Federal Technology Transfer Act of 1986, which authorized US government agencies to enter into CRADA with non-government organizations, Burns added. (Source: *Sea Technology*, April 1998)

Radiometric measurement comparison using the Ocean Colour Temperature Scanner (OCTS) visible and near infrared integrating sphere

As part of the pre-flight calibration and validation activities for the Ocean Colour and Temperature Scanner (OCTS) and the Sea-viewing Wide Field-of-view Sensor (SeaWiFS) ocean colour satellite instruments, a radiometric measurement comparison was held in February 1995 at the NEC Corporation in Yokohama, Japan. Researchers from the National Institute of Standards and Technology (NIST), the National Aeronautics and Space Administration/Goddard Space Flight Center (NASA/GSFC), the University of Arizona Optical Sciences Center (UA), and the National Research Laboratory of Metrology (NRLM) in Tsukuba, Japan, used their portable radiometers to measure the spectral radiance of the OCTS visible and near-infrared integrating sphere at four radiance levels. These four levels corresponded to the configuration of the OCTS integrating sphere when the calibration coefficients for five of the eight spectral channels, or bands, of the OCTS instrument were determined. The measurements of the four radiometers differed by -2.7 to 3.9 per cent when compared to the NEC calibration of the sphere and the overall agreement was within the combined measurement uncertainties. A comparison of the measurements from the participating radiometers also resulted in agreement within the combined measurement uncertainties. These results are encouraging and demonstrate the utility of comparisons using laboratory calibration integrating sphere sources. Other comparisons will focus on instruments that are scheduled for spacecraft in the NASA study of climate change, the Earth Observing System. (Source: *Journal of Research of the National Institute of Standards and Technology* 102(6): 627-646, November-December 1997)

An overview of platform types, supporting technologies and selection techniques to meet present and future mission requirements

The information presented is intended to provide a first-cut basis for platform selection for the non-naval architect by providing: an overview of platform types and their relative attributes and (Johnston, 1985) outlining a methodology of matching mission needs and design constraints with the most suitable platform.

This paper presents a general methodology for matching envisioned near-shore and offshore missions with the required platform. The platform types currently available are discussed indicating their attributes and limits, as well as the identification of the mission categories which would benefit from their application. The advantages and issues associated with monohulls, catamarans, small water plane area twin hulls (SWATHs), fixed platforms, hydrofoils and air cushion vehicles (ACVs) are presented. Because most platforms can be characterized by hull shape and physical support, these two subjects form the basis for the organization of platform types within the paper. The platform characteristics investigated include: speed-versus-power, sea keeping (or sea-kindliness), shallow water capability, arrangeable volume, arrangeable deck space, payload capability, shallow water penetration and cost. The paper provides measures of effectiveness (MOEs) for assessing the matching of mission needs with technology applications through platform selection. It is these MOEs which form the basis of the decision-making process embodied in vessel selection and evaluation. A working example of the application of the methodology and the use of the tools set forth in the paper is included. A brief discussion of present and future trends in platform and vessel technology and selection techniques is also presented. (Source: *Marine Technology Society Journal*, 31(4):16-26, 1997)

Superconducting magnetic gradiometers for underwater target detection

Passive magnetic sensors provide one means to conduct mobile area surveys and search operations for the detection of magnetic anomaly targets. Sensors incorporating Superconducting Quantum Interference Devices (SQUIDs) provide the greatest sensitivity for magnetic anomaly detection available with current technology. A superconducting magnetic-held gradiometer developed in the 1980s has been demonstrated in fusion with acoustic sensors to enhance shallow-water sea-mine detection and classification, especially for buried mine detection and the reduction of acoustic false alarm rates. This sensor incorporated niobium bulk and wire superconducting components cooled by liquid helium to a temperature of 4 degrees Kelvin (K). An advanced superconducting gradiometer prototype is being developed to increase sensitivity and detection range. This sensor features all thin-film niobium superconducting components (replacing the bulk superconducting components used in the preceding generation) and a new liquid helium cooling concept. In the late 1980s, a new class of "high Tc" superconductors was discovered with critical temperatures above the boiling point of liquid nitrogen (77 K). The use of liquid nitrogen refrigeration offers new opportunities for this sensor technology, providing significant reduction in the size of sensor packages and in the requirements for cryogenic support and logistics. As a result of this breakthrough, a high Tc sensor concept using liquid nitrogen refrigeration has been developed and a test article of that concept is being fabricated and evaluated. In this paper, these recent advances in sensor development will be reviewed and a current perspective on the role of

magnetic sensors for underwater target detection, classification and localization will be addressed. (Source: *Naval Engineers Journal*, 110(1):139-149, January 1998)

Mid-term sealift—hydrodynamic system improvements for bow and stern

The Mid-Term Sealift Research and Development Program was an ambitious attempt to investigate the potential for integrating new technologies into a commercially viable sealift design. This paper addresses the guidelines followed, the bow and stern designs developed, and their testing and evaluation. Since both bow and stern may be regarded as "hydrodynamic subsystems", they were analysed on a system basis, that is, with regard to their overall contribution for energy savings, producibility and interaction with adjacent subsystems, such as propulsion. These studies resulted in a hull form with significantly improved hydrodynamic performance, which may be used as a parent for future US designs. (Source: *Naval Engineers Journal*, 110(1):151-170, January 1998)

Advanced development and fleet needs—a real-time dilemma—integrated product teams (IPT) and technology windows

The advent of integrated product teams (IPTs), which have been formulated and strengthened by recent acquisition reform initiatives, offers fresh opportunity for managers of modest-sized programmes (below the ACAT level) and their headquarters' sponsors to achieve alignment with today's budgetary realities. Ideally, IPTs bring together all the necessary people knowledgeably involved in various phases of product life-cycle management so that a new design or concept will receive the benefit of their accountability, experience and insight.

While projections of a combat system's use are in decades, technology currently changes every 6-18 months. Can IPTs and planned technology insertion smooth this phase gap? The revolution or upheaval that occurs with technology change must also be within the capacity of the IPT to assimilate and manage successfully. This paper discusses the practical application and utility of IPTs to the delivery of emerging technology that provides practical solutions to urgent fleet problems. The discussion assesses integration of the IPT process with a programme of moderate size in the midst of a sponsor-directed transformation to solve fleet problems in a more responsive and timely manner.

The questions—can the existing universe of IPTs be used to help accomplish the goals of accelerated-development processes, do such processes need an IPT of their own to fine-tune project deliverables and programme direction, or, does the IPT approach lack significance in such applications?—are addressed to clarify the issue of IPT use in developmental programmes of modest size targeting specific fleet needs. (Source: *Naval Engineers Journal*, 110(1):263-276, January 1998)

Ocean colour scheme to analyse sea water

A group of European companies, research centres and universities has set up a consortium that will develop the tools required to study the colour of sea water in the European coastal region. The COASTIOCC Server project will create colour image databases of the region and develop algorithms that will determine the properties of sea water from this data.

The project is planned to coincide with a new generation of ocean-colour satellite-mounted sensors, such as NASA's

sea WIFS sensor, and the European Space Agency (ESA) MERIS sensor scheduled for launch in 1998.

According to the consortium, ocean-colour remote sensing is a well-adapted tool for monitoring coastal systems. Until recently, however, the exploitation of these techniques in coastal regions has been impeded by the limited capabilities of existing instrumentation, namely the Coastal Zone Colour Scanner (CZCS) which stopped transmitting reliable data in 1986. To exploit the improved capabilities of the next generation of space sensors, the COASTIOCC Server project will create a large data set of the optical properties of optically active substances found in European coastal waters. The goal is a data set that covers the Mediterranean, Adriatic, Baltic and North Seas as well as the French and British Atlantic coasts.

The project will also develop new algorithms for the analysis of the data. According to the consortium, no proven algorithms currently exist that will analyse data for all European coastal waters. Its aim is to develop a set of Europe-wide algorithms that can derive the chlorophyll, dissolved and particulate organic matter and mineral content of the coastal waters.

The project will also try to provide ocean-colour information on a video server that would be accessible to all Internet users. The information would be updated daily to serve a wide range of users in science, industry and tourism. (Source: *Scientific Computing World*, November 1997)

Fish discrimination system

The Technology Center of Nagasaki has developed a fish discrimination system based on image processing technology. This system can automatically classify the huge volumes of fish brought into fish markets, and high-speed processing at a rate of three fish/second by applying a detailed discrimination function based on multiple computer processing units (CPUs). Systems are available for discriminating by fish size, but this is the first system for fish discrimination by type.

The system statistically analyses the target fish types (horse mackerel (saurel), mackerel and sardine) and inferentially discriminates the fish type by using five parameters (circumference, area, width, length and height). Nine CPUs are used to analyse the operations of image input, image correction, binary coding, target fish extraction, parameter measurement and real dimensions switching. The bucket relay type pipeline processing technique is introduced for inputting and processing subsequent data immediately upon consummation of processing of preceding images, so that high-speed processing has been realized.

More specifically, an infrared ray sensor first detects the fish supplied continuously from a first-stage fish haul on a conveyor belt, and the image of these fish is captured simultaneously with a CCD camera installed at the upper part of the conveyor system. Next, the image is processed and characteristics parameters effective for fish type discrimination extracted, then compared with a fish type discrimination database to discriminate the specific types of fish. Based on the discrimination results, the classifier is controlled and the fish classified into boxes by type. Subsequently, five types of measured data in connection with fish length, width, circumference, area and height are used as the fish type characteristics parameters in order to clarify the fish type characteristics without relying on fish size and, based on actually measured data, ten kinds of non-dimensional ratio data are computed. Finally, these ratio data are used to discriminate the fish types, and the fish sizes discriminated with actually measured length data.

Desktop experiments confirmed that three types of fish (horse mackerel (saurel), mackerel and sardine) can be discriminated at an accuracy as high as over 90 per cent. The future plan is to commercialize a practical system for use by

- (3) Clarification of the seismotectonics of the region.
- (4) Clarification of the mechanism of material cycles and paleo-environmental changes in the region.

The geological survey vessel Hakurei-Marū is to engage in a geological research cruise to investigate the geological structure by conducting single- and multi-channel seismic surveys, and to collect bottom sediments by a gravity corer or grab to clarify their distribution.

Further information from Agency of Industrial Science and Technology, MITI, Research Administration Division, 1-3-1, Kasumigaseki, Chiyoda-ku, Tokyo, Japan. Tel.: +81-3-3501-1777; Fax: +81-3-3501-7899. (Source: JETRO, September 1997)

Lightweight DUS offers high pressure performance for deep-water drilling

As the search for oil in deep water increases, industry is focusing on new innovations to counter greater weights/sizes of equipment needed. One area under scrutiny is the drilling risers

which, due to the increased water pressure, need to be more robust, thereby increasing wall thicknesses and overall weight. In turn, a riser weight of around 2,500 tons requires large buoyancy modules, which leads to an overall increase in the diameter of the riser package.

One method to reduce the weight of risers is to use composite materials, combined with steel (duplex, super duplex or even carbon), titanium or other metals. The DUS method (design unique system) developed and patented by Dag Thulin involves encasing an inner core of steel with a composite material such as fibreglass.

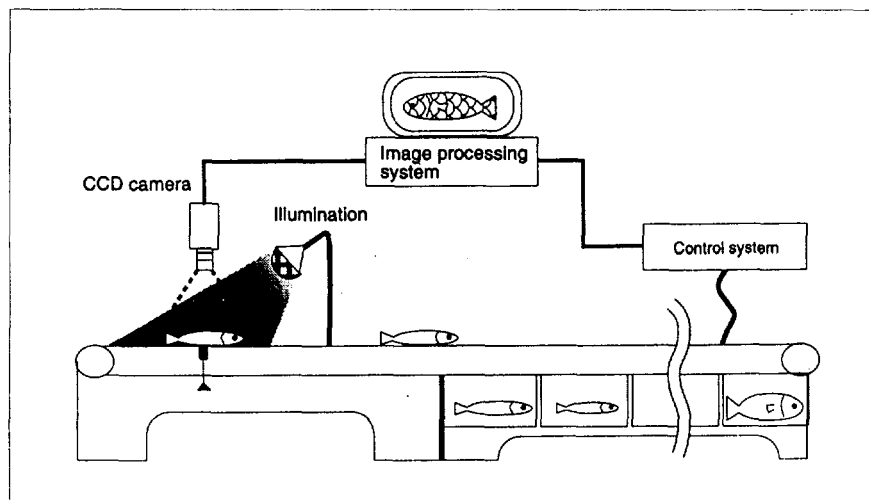
The wall thickness of the inner core varies by 1-8 mm, although for deep-water applications a thickness of 4-5 mm would be preferable. This substantially reduces the amount of steel required, producing a much lighter pipe and reducing the overall cost.

The composite fibre material in a fabric form is wrapped around the steel liner and a number of thin tubes laid within the material along the length of the pipe. An airtight cover is then applied and a vacuum is created by attaching a vacuum pump to the tubes with the pipe in an upright position.

A variety of resins, such as polyester, vinyl ester, or epoxy, is injected into the tubes which are gradually withdrawn as the lower part becomes saturated, keeping their ends below the level of the resin to avoid air being trapped inside. The technique is very simple and accurate. The filaments of the fibreglass are applied at a 90° angle for hoop stress and 0° for axial stress. All the fibres are covered by the resin and the finished product is extremely strong.

Once the resin hardens, the cover is removed and the length of pipe tested by X-ray or ultrasound to ensure that the resin has completely saturated the composite. The pipe then undergoes pressure testing up to the pressure level required for the end use. DNV has conducted blast tests on the DUS pipe up to 1,500 bar pressure, although Dag Thulin asserts that the method is applicable for pipes manufactured to withstand pressure up to 3,000 bar if required.

In addition to its ability to withstand high pressures, the DUS pipe is very light with a dynamic density in water of 1, compared to 6.8 for conventional steel risers. Glass fibre also



Schematic diagram of fish discrimination system

fish companies and to develop a more advanced system to distinguish fish such as genuine saurel, horse mackerel and red saurel. Further information from Technology Center of Nagasaki, Electronic Section, 2-1303-8, Ikeda, Ohmura City, Nagasaki, Pref. 856, Japan. Tel.: +81-957-52-1133; Fax: +81-957-52-1136. (Source: JETRO, April 1997)

Marine geological research in Tokai offshore region

The Tokai offshore region of Japan is believed to be the hypocentral region of the large Tokai earthquake that is expected to occur in the near future. Up to now, several models of earthquake faults have been suggested. However, the mechanism of a submarine earthquake has not been identified, as adequate scientific data around earthquake faults is not available. This Tokai offshore region is also vital for long-term variations in the behaviour of the Kuroshio (a major warm current) as well as the mechanism of material cycles in offshore areas around the Japanese Islands.

The Geological Survey of Japan of the Agency of Industrial Science and Technology has continued to collect and substantiate marine geological information relating to Japan's offshore regions in order to make use of them for the national land preservation, utilization of marine space and exploration of submarine resources. The surveys in the coastal regions around Honshu, Shikoku and Kyushu have already been completed. A similar survey has been conducted in the areas west of Hokkaido since 1994. The Tokai offshore region was not covered by these previous surveys. This is the area in which the Tokai earthquake is expected to occur, and is close to the hypocentral region of the Tonankai earthquake. Hence, collection and substantiation of marine geological information especially on active seabed faults in this region is urgently needed.

The objectives of marine geological research in the Enshu-nada and the Suruga Bay regions may be summarized as follows:

- (1) Clarification of the submarine geological structure and preparation of the marine geological map.
- (2) Clarification of the distribution of bottom sediments and preparation of the sedimentological map.

has very high tensile strength of 4,000 MPa (steel is around 2,000 MPa) and an elasticity module of around 70 by 103 MPa, compared to that of duplex steel at 220 by 103 MPa.

New connection

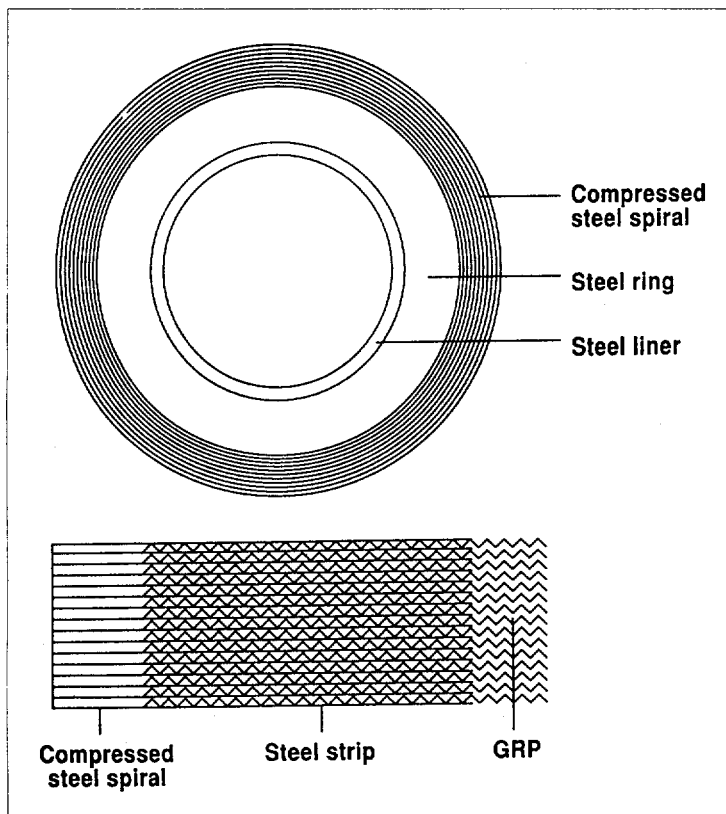
The main drawback of using composite/steel risers was the method of connection which involved joining pipe lengths together by welding the steel wall ends and covering the whole joint with composite material.

For the DUS pipe method, Thulin has now devised and patented the DUS Spiral. A very thin 800-mm wide steel spiral strip is placed between every axial layer of glass fibre for a length of 600 mm at the end of the pipe, tapering off to give an all-steel joint. The steel layers are also subjected to the vacuum process to make them airtight. Since the end of the pipe is now completely constructed of steel, it can be connected by conventional welding techniques.

The steel end is glued on both sides to all the axial reinforcing fibres. By comparison, the connection of filament-wound composite pipe glued between steel and GRP or between GRP and GRP would result in a much lower adhesion level. Certification testing for the DUS spiral connection is due to take place this year.

Low cost

According to test results conducted at Avesta Sheffield, the investment cost for making DUS pipe is very small compared to composite pipes using the filament winder method. As the process of manufacture is so simple, equipment requirements are few, consisting of a winding machine, injection pump and vacuum pump. The pipe can also be produced very rapidly, with the ability to produce 1,000 metres in 24 hours. A 12-metre pipe would take only 12 minutes to wind and a further 2-3 hours to be filled with resin standing in a rack of 20 pipes at a time.

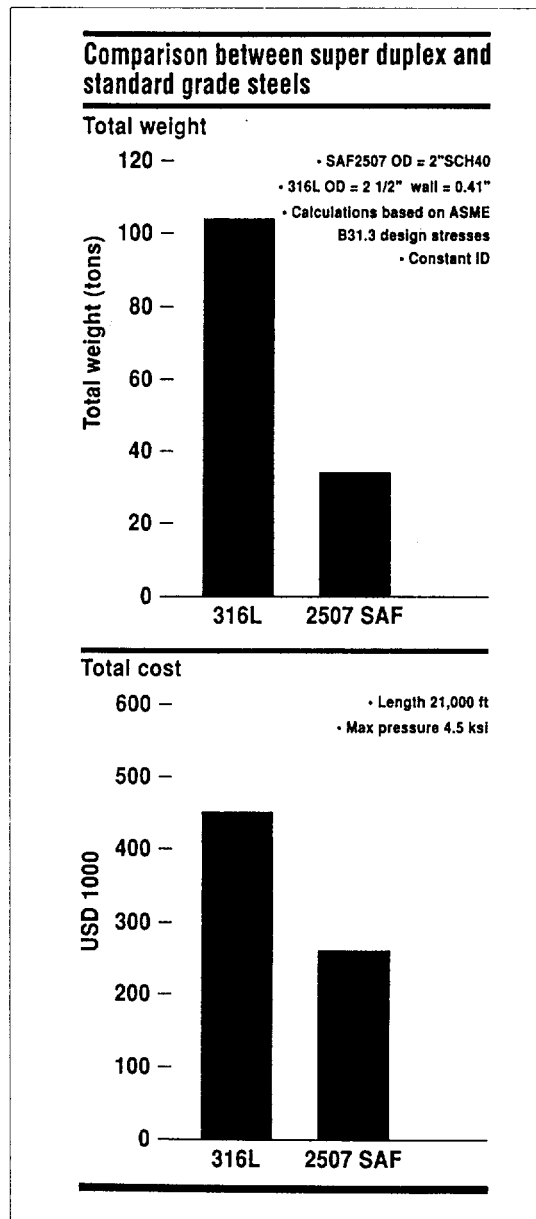


At the end of the glass-fibre coated pipe, steel strips are wound in between every axial layer of glass fibre to make an all-steel joint which can be welded by conventional methods to the flange.

The development work carried out on the DUS pipe was previously a joint venture with Avesta Sheffield, which conducted the first series of test at DNV with encouraging results. The final qualification of the DUS pipe is due to take place later in 1998. For further information please contact Dag Thulin, Maiacs. Tel.: +45 8 663 0390 or Fax: +46 8 611 4446. (Source: *Offshore*, March 1998)

Advanced materials lighten load on deep-water production

Sandvik Steel has introduced duplex stainless steel for hydraulic lines for drilling risers. Having traditionally supplied this market with its 316L standard grade steel, Sandvik believes that the weight and cost savings achieved by using the 2507 (super duplex) and 2205 (duplex) grades will be convincing enough for riser manufacturers to choose these grades in the future.



According to Sandvik, using duplex steel also reduces the size of flotation collars, leading to an overall cost saving of around \$1-2/lb. Perhaps more importantly, as oil production from deeper water depths increases, the weight issue becomes more

important and this, Sandvik believes, will ultimately convince riser manufacturers to look more closely into using the duplex steel. (Source: *Offshore*, March 1998)

Biologists are closing in on marine pests that fight cancer

A chance discovery that a stringy little invertebrate is not always what it seems will help in the development of a promising new anti-cancer drug. Researchers in California have found out why some populations of *Bugula neritina*, a marine fouling organism, produce the drug but others do not. The organism comes in two genetically distinct types.

One form of *B. neritina* makes a chemical called bryostatin-1. This is one of the few drugs extracted from marine animals that shows real promise as an anti-cancer drug, and could eventually form the basis of a market worth \$1 billion a year. Now in advanced trials as a treatment for leukaemia, and at an earlier stage of testing against melanoma, it also shows potential for stimulating the immune systems of breast cancer patients.

"Bryostatin-1 has a unique mode of action against cancer cells, so it would be a useful addition to the armoury", says Margo Haygood of the Scripps Institution of Oceanography in La Jolla, CA. The compound has been licensed to the pharmaceuticals company Bristol-Myers Squibb. CalBioMarine, a small company in California, is perfecting methods of culturing *Bugula* on coastal "ranges".

If ranchers are to produce a steady supply of bryostatin, they need to breed their stock from animals they know make the drug. Haygood and her colleague, Seana Davidson, discovered that there are two "chemo-types" of *Bugula*. They were more interested in a bacterium called *Endobugula sertula* which lives inside the bryozoan, and which they suspect plays a key role in the manufacture of bryostatin-1.

It was only when they sequenced a ribosomal gene from bacteria taken from 10 populations of *Bugula*, from different parts of the US, that they found that there are two distinct types of *E. sertula*. One type occurred in bryozoans that produced bryostatin-1; the other was found only in non-producers.

Interestingly, when the researchers checked where each population of *Bugula* had been collected, they found that all those that produced bryostatin-1 came from water deeper than 10 metres. None of those from shallower water made bryostatin-1.

With such a clear ecological difference, Haygood and Davidson wondered if their hosts were genetically different too. Davidson sequenced a stretch of DNA from *Bugula* and again found two types. "The difference is not trivial", says Haygood. "They may be two different subspecies or even two different species entirely." This does not solve the issue of whether the bacterium makes the chemical, but it gives drug prospectors a better idea where to get the right sort of *Bugula*. (Source: *New Scientist*, 7 February 1998)

Dissolved organic matter plays role in greenhouse effect

Vast amounts of dissolved organic matter in the ocean, once thought to be inert, may play a surprising role in mitigating the greenhouse effect, according to bioengineering researchers at the University of Washington.

These tiny chains, or polymers, of carbon-based molecules comprise a significant portion of all the organic material in the oceans, but were thought to be too small to register on the marine food chain. Instead, they appear to be

spontaneously assembling into molecular networks called polymer gels that would give them a vital role in the carbon cycle, the researchers report. These microgels would provide an unexpected mechanism for dissolved organic matter to either enter the carbon cycle or abandon it and ultimately remove carbon dioxide from the atmosphere.

Microscopic algae in the oceans are among the planet's most important engines of photosynthesis, the process of converting sunlight and carbon dioxide into oxygen and carbon compounds that make up the base of the food chain. During the summer blooms in some coastal areas and in the polar regions, microalgae can produce jelly-like layers comprised mostly of carbon polysugars that cover several square miles. These marine photosynthesized compounds, together with organic material discharged by rivers, get dispersed in the ocean into organic particles of various sizes. Larger polymer clusters, called particulate organic matter, can be colonized by bacteria and re-enter the food chain. But smaller polymers of dissolved organic matter have long been considered minor players in the carbon cycle. (Source: *Sea Technology*, April 1998)

Scientists study organism contaminating shellfish

Oceanographers at the University of Rhode Island in Narragansett are studying blooms of toxic "red tide" organisms with a grant from the National Science Foundation (NSF), according to a spokesman. The microscopic organisms, dinoflagellates in the genus *Alexandrium*, create neurotoxins responsible for paralytic shellfish poisoning, which in turn often lead to closure of shellfish beds. The neurotoxins produced by the dinoflagellates are accumulated by filter-feeding shellfish and are then passed on to humans as "tainted" shellfish.

The Rhode Island team, led by marine scientist Edward Durbin, hopes to determine whether some marine species avoid feeding on *Alexandrium* because of the presence of toxins. Durbin also wants to learn more about possible threats to higher levels in the marine food chain. The researchers will look at "hot spots" along the coast of Maine to determine toxin levels. Each of these locations has a unique set of environmental and oceanographic conditions that determine the timing and extent of its "red tide" bloom. (Source: *Sea Technology*, April 1998)

Low cost method to track pollutant

Scientists at Columbia University's Lamont-Doherty Earth Observatory have developed a new and inexpensive tool to track the flow of waste and the related transport of chemicals, spilled oil, sewage and other pollutants.

The new method uses minute amounts of a non-reactive, synthetic gas called sulphur hexafluoride (SF₆). Scientists inject the gas into water in a controlled way and then trace its spreading and mixing patterns. Costing about a thousand times less than fluorescent dyes—the tracers most widely used today—SF₆ expands scientists' ability to visualize and predict the dynamics of moving water. Using the gas, scientists can track how fast, how extensively, and in what directions soluble materials would flow and mix in water.

According to Lamont-Doherty scientists, SF₆ has a wide range of use for applied environmental research as well as for basic research to study the dynamics of water bodies. The new tool could be used to aid in oil-spill clean-up efforts, to site sewer-waste flows, to reduce pollution risks, or to track the fate of contaminants released into surface water or groundwater. It can be used to study ponds, groundwater, large water bodies, and even in the open ocean. (Source: *INFOFISH International*, June 1997)

Crabs used in human bone repairs

According to a report in *Seafood International*, crabs have been found to contain a mineral that could prove valuable in repairing cracked bones in humans.

UK researchers recently isolated tiny granules of calcium phosphate in crabs' liver cells. They are now investigating its application as a sealant in cracked bones, even in hip replacement operations. (Source: *INFOFISH International*, June 1997)

Sea bass sex change study

A new Australian research project will study how sex changes in the barramundi (the Asian sea bass, *Lates calcarifer*) might be controlled. Wild barramundi change naturally from male to female at about 6-8 years of age, but on farms it can happen as early as 12 months old. The consequent unpredictability poses a serious problem for aquaculturists, who, having set aside males for breeding, cannot be sure they will remain males.

The study, a collaboration between the CRC for Aquaculture, Australian Institute of Marine Sciences, Department of Primary Industry and barramundi farmers, hopes to improve the economic returns of barramundi farmers by finding a way to control the fish's sex changes. It is believed that the sex change occurs because of a complicated process involving stress, nutrition, steroid balance, and environmental and temperature variation.

The barramundi farming industry of Australia, mostly located in north Queensland, is growing rapidly. (Source: *INFOFISH International*, January 1998)

Live shrimp packaging

Researchers in Queensland, Australia, are developing new packaging for the transportation of live shrimp to export markets. The new packaging is expected to reduce mortality by allowing more even temperature distribution inside the boxes and greater protection against external heat.

The design features special ventilation to keep temperature to within one degree, and a built-in compartment for coolant, which can be changed at will during transport. The boxes can also be divided easily into two smaller boxes, allowing buyers to bid for smaller quantities of high-cost product, where previously they might not have bought at all.

The new packaging is being developed by the Seafood Research Group team of the Queensland Department of Primary Industry's Centre for Food Technology. After an initial trial period, the packaging will be produced commercially. (Source: *INFOFISH International*, January 1998)

Developing a super yabby

Scientists in Victoria (Australia) are attempting to produce a yabby (freshwater crayfish) that will grow faster, larger, in brighter colours and with greater reproductive ability. Using a variety of techniques from traditional cross-breeding to state-of-the-art genetic engineering, Deakin University is trying to combine the best characteristics of a variety of species into one.

The university's Dr. Chris Austin was quoted as saying it is only a matter of time before the ideal commercial yabby is perfected. Western Australia is farming 10-20 times more Victorian yabbies than Victoria which, with 30 kinds of yabby, has a greater diversity of species than any other state, including five kinds not found anywhere else in the world. (Source: *INFOFISH International*, January 1998)

Shrimp gene map developed

Australia has developed the world's first shrimp gene map as an initial step to assist farmers produce bigger, faster growing shrimp. Developed by the Commonwealth Scientific and Industrial Research Organisation (CSIRO), the gene map, the first for any crustacean species, will be used by researchers to identify the genes controlling growth rate, flesh quality and disease resistance.

According to the CSIRO, large increases in the rate of genetic improvement of farmed shrimp are possible using the maps as a guide, compared with those that can be made using traditional breeding strategies. An annual increase in growth rates of about 10 per cent can be expected from genetic improvement programmes, thanks to the gene map. (Source: *INFOFISH International*, March 1998)

Isolating disease-fighting gene

A national Research Council (NRC) team in Halifax, Canada, has taken the first step towards isolating a key disease combating protein in Atlantic salmon and understanding how it functions.

The team, based at the NRC's Institute of Marine Biosciences, has identified a number of proteins, called lectins, from salmon blood, and one in particular which binds specifically to the surfaces of a bacterium that causes vibriosis. This is of potential significance as mammalian medical literature has shown this protein to be a pivotal player in fighting infection.

By understanding its specific role in salmon, scientists may ultimately be able to improve disease detection or develop practical methods to enhance the salmon's innate defence mechanisms. The particular bacterium, *Vibrio anguillarum*, remains a problem. It causes a range of systematic infections in salmon and other species and has caused severe losses to salmon farms. Although a vaccine is available, resistance to antibiotics is a serious issue.

Lectins are mannose (sugar) binding proteins found in vertebrates such as fish, reptiles, frogs and humans (and in plants though in a different function). In the presence of pathogens, their levels increase rapidly as part of the immune system's natural defences, and inhibit, directly or indirectly, the pathogen's growth. However, not much is known about their biochemistry or how they contribute to the health of fish.

The team, which includes research scientists Vanya Ewart, Neil Ross and Stewart Johnson, is using its work on the *Vibrio* bacterium as a model to investigate lectin's role generally in the innate immune system of fish. While it is known that the protein recognizes other pathogens in the same manner, what is not known is the range of bacteria that it recognizes.

The research is going to take time because work still needs to be done to determine protein and DNA structure. When that is done, the DNA can be cloned and further work can be done to define the protein's role, how it binds to the bacteria and whether there are differences in fish which are susceptible to the bacteria. (Source: *INFOFISH International*, January 1998)

Tilapia—a potential cure for diabetic children

Canadian scientists are trying to turn genetically engineered fish into donors of cells in their pancreas that could cure childhood diabetes, reports *New Scientist*.

In a child with diabetes, the islets in the pancreas are destroyed and patients survive on daily injections of insulin. It takes three human pancreases to supply enough islets for

one transplant. There are fewer than 10,000 pancreas donors in North America each year, but 3 million diabetic patients.

Even though pig is considered a likely donor, the supply of sufficient cells will be a huge problem. To get the 14 million islet cells needed for a human transplant, you need ten pigs. To treat 10,000 diabetics a year, you need a million pigs. The animals would have to be reared in sterile conditions, for two years. If each pig is given four square metres of space, that equates to 200 pig houses of 20,000 square metres, to treat just 10,000 people. "The costs would be astronomical", says a member of the scientific team undertaking the studies.

Unlike pigs, fish can be raised cheaply at high density in relatively small spaces. Tilapia could also solve some of the other major problems with the cross-species transplantation. The first of these is to find a way to stop the patient's immune system from attacking the animal tissue without resorting to the use of immunosuppressant drugs by encapsulating the islets in gel. For this purpose scientists use gels derived from seaweed, called alginates. Their pores let sugar and oxygen in and insulin out, but exclude the cells and large molecules of the immune system.

In theory, encapsulated islets could be given to young diabetics with little or no immunosuppression, but blood vessels cannot grow into the capsules, and many transplanted cells suffocate. Since tilapia lives in warm ponds with low levels of oxygen, their cells need only one fifth of the oxygen that human cells need. So they should survive encapsulation. Tilapia has two pancreases, one for digestive enzymes and

the other solely for insulin. Because one pancreas is basically an agglomeration of islets, it is much easier to isolate the cells from other tissues.

The scientists have transplanted fish islets into mice and rats, where they successfully produced insulin in response to changing blood sugar levels. But there is still one big obstacle. Fish insulin works poorly because it differs from the human hormone by 17 amino acids. Pig insulin is only one amino acid different.

Scientists have cloned and modified the tilapia gene to produce human insulin and the team is now injecting the gene into tilapia eggs. Previous experience with genetically modified fish suggests that, with enough injecting and screening, some of the animals will express the human gene in sperm or eggs. The team then hopes to breed a stable line of fish that produce only human insulin. (Source: *INFOFISH International*, June 1997)

Ginger—cure for seasickness?

Ginger, a *sine qua non* of oriental culinary preparations, is finding new uses. Research interest has now been directed in a different direction—its ability to cure seasickness. The research is based on the old Chinese fishermen's practice of chewing ginger when they want a comfortable ride on turbulent high seas.

Currently, the US-based researchers are working on a new theory on the efficacy of ginger in combating seasickness. Simulated experiments to test the effect of ginger capsules in reducing seasickness have shown positive results. (Source: *INFOFISH International*, January 1998)

E. ENVIRONMENT

UNEP IE package on accident prevention

The United Nations Environment Programme Industry and Environment (UNEP IE) is pleased to announce the publication, in a limited edition, of "Management of Industrial Accident Prevention and Preparedness—A Training Resource Package". This is one of a UNEP IE series of trainers' resource kits on various aspects of industrial environmental management.

The package is designed to be used in universities and colleges and not in the workplace. Its objective is to provide materials which can be developed, extended, adapted and translated into local languages by those responsible for the education of undergraduate and postgraduate engineers and environmental managers and for the continuing and refresher education of practising professionals. The overall goal is to build industrial environmental management concepts and practices into the education of tomorrow's decision makers, so that the accumulated knowledge and experience of the present generation can be passed on and enhanced.

The package is in six parts, as follows:

1. Introduction
2. Workshop organization and hints for effective training
3. Background papers on accident prevention and preparedness
4. Resource package on APELL,* including primer, transparencies and relevant UNEP IE publications
5. List of references, background documents and audio-visual aids
6. Exercises and case studies.

UNEP IE will supply a copy free of charge to training institutions in developing countries which commit to working with the package and supplying feedback to UNEP IE for the benefit of future editions. Please note that this offer is generally limited to one institution per country and that it accordingly may not be possible to fulfil all requests. (Source: *Ports and Harbors*, May 1998)

Ozone-depleting chemicals continue to increase

Despite the ban on the production of ozone-depleting halons by developed countries, the compounds continue to increase in the atmosphere. Measurements by the National Ocean and Atmospheric Administration's Climate

Monitoring and Diagnostics Laboratory (Boulder, CO) indicate that three bromine-containing extinguishants (halons H-1211, H-1301 and H-2402) are still being released into the atmosphere in crucial amounts.

Scientists are concerned because the halon bromine is 50 times more efficient at depleting ozone in the atmosphere than the halon chlorine (a component of chlorofluorocarbons (CFCs)) because the gases last a long time in the atmosphere. In 1994, China generated 90 per cent of the global production of halons. Continued increases in production in developing countries are allowed within the Montreal Protocol until 2002, at which time countries will have to freeze production at 1995-1997 levels. (Source: *Sea Technology*, May 1998)

Abysal disposal of nuclear materials

The abyssal clays located under the seabed midway between mid-ocean rifts and tectonic zones where the seabed dives under continental plates are experiencing renewed interest for disposal of nuclear materials. A riserless drilling process has been proposed to access these abyssal depths (5 km plus), most of which are located in international waters.

The seabed clays at these mid-ocean sites offer a number of attractive characteristics, determined by testing in the 1980s:

- These zones have remained geologically inert for 50-100 million years;
- Clays have low permeability to water, tend to absorb materials entrained in the mixtures, and sufficient plasticity to fill in fissures;
- Biological life capable of transporting escaping nuclear material to the surface is found only in the top metre of seabed material;
- Sea-bottom currents in these regions are minimal and not likely to uncover sub-seabed materials.

The drilling process proposed for the installation of nuclear materials calls for one trip with a drill string and bottom assembly. First, a drill bit would be lowered to the seabed with a re-entry cone attached. After embedding the re-entry cone, the drill and drill string would continue to drill out the 500-1,000 ft.-deep wells.

At proper depth, the drill bit would be released from the drill string and alternating layers of nuclear waste canisters and mud would be lowered through the drill string by wireline. The top-most container would be located 10-

*Awareness and Preparedness for Emergencies at Local Level.

30 metres below the seabed. The well would be sealed and the cone left in place for re-entry, should the occasion arise.

Scientists calculate the drill string would corrode and dissolve in 1,000 years, releasing the contained materials, although containment of the materials within vitrified glass or ceramics would offer a much longer period of confinement. Calculations based on earlier experiments conducted with the clay indicate a migration of nuclear materials of only one metre outward from the well-bore over a period of 24,000 years, approximately the half-life of plutonium and other transuranic elements.

Reference: C. Hollister, and S. Nadis, "Burial of Radioactive Waste under the Seabed", *Scientific American*, January 1998. (Source: *Offshore*, March 1998)

Effluent treatment for sustainable farming

At a workshop held in Balasore, Orissa, India, in December 1996, the Deputy Director of the Marine Products Export Development Authority (MPEDA) of India, B. C. Behera, gave technical details of an effluent treatment system for sustainable shrimp farming.

The system, suitable for extensive, modified extensive and semi-intensive culture practices, incorporates a reservoir covering 15-20 per cent of the overall farm area at the intake end of the farm and a sedimentation/ biofiltration pond occupying at least 10 per cent of the farm area and receiving drainage water from the grow-out ponds. Along with the dykes and channels, these two components occupy 50 per cent of the total farm area. Fish, weed and oyster species are used in the sedimentation and biofiltration pond to treat and recycle the culture water. (Source *INFOFISH International*, March 1997)

El Niño-related weather causing coral bleaching at Great Barrier Reef

El Niño-related drought and high ocean temperatures in the Pacific Ocean off Australia have resulted in coral reef bleaching around the Great Barrier Reef, raising concern among experts about the future of these fragile ecosystems known as the "rain forests of the sea". NOAA researchers also said corals normally recover from bleaching, unless high ocean temperatures persist for too long a period or become even warmer. Coral bleaching occurs as coral tissue expels *zooxanthellae*, a type of algae that resides in the structure of the coral and is essential to the coral's survival. "Sea surface temperatures have warmed considerably off the eastern coast of Australia during the past few weeks", said NOAA oceanographer Al Strong. "Our research indicates bleaching most likely began in the southernmost region of the Great Barrier Reef and appears to be moving towards the north. From our latest observations, these bleaching conditions appear to have reached New Caledonia (at 21°S, 165°E). Sea surface temperatures from the 1982/83 and 1987 El Niño events were not quite this warm." (Source: *Sea Technology*, March 1998)

Project developing better tools for bioremediation

The National Sea Grant College Program and Texas Instruments Inc. (Dallas) are cooperating on a research project to develop improved tools to monitor bioremediation, the use of micro-organisms to decontaminate polluted areas, according to a spokesperson. Researchers will refine an existing probe with the goal of making it more sensitive, so it can detect smaller quantities of target chemicals, and more stable and robust, so it will function in corrosive marine environments. The three-year fellowship is an extension of previous research funded by the Washington Sea Grant Program.

The sensor measures surface plasmon resonance, minute shifts in the light refraction that occur when a chemical interacts with the sensor's gold-plated optical surface. The probe could be used to measure pollutants in a clean-up area helping scientists determine the types and quantities of micro-organisms to use there. For example, some micro-organisms feed on oil, while others prefer oil by-products. Sensors could also be used to monitor the microbial activity, helping scientists determine the best conditions for bacteria and other micro-organisms to degrade complex, toxic molecules into simple, harmless ones. (Source: *Sea Technology*, February 1998)

NOAA targets coastal pollution under clean water initiative

As part of the Clinton Administration's Clean Water Action Plan unveiled in February, NOAA officials said they are initiating a multi-agency clean water initiative to reduce polluted run-off, a major source of coastal water pollution and a key link in outbreaks of harmful algal blooms such as *Pfiesteria*. NOAA will work with the Environmental Protection Agency to help 29 coastal states and territories complete development of management plans by 31 December 1999 to reduce polluted run-off (also called non-point pollution). Dr. James Baker, Under-secretary of Commerce for Oceans and Atmosphere, said the coastal non-point plans would help empower the states to manage their own marine and Great Lakes resources by including voluntary and incentive-based programmes and state-enforceable policies and mechanisms, coupled with increased federal technical and financial support. (Source: *Sea Technology*, March 1998)

Canada warns ships over illegal spills which kill thousands of sea birds

Canada is stepping up its surveillance and enforcement of illegal discharges of oil to prevent the deaths of tens of thousands of sea birds each year.

In a paper presented to the Marine Environment Protection Committee in March, Canada reported that some 20,000 to 100,000 sea birds die annually as a result of coming into contact with oil—yet this happens when there have been no significant oil spills reported.

However, analyses of several hundreds of samples gathered from the waters and from oiled birds off Newfoundland in the past decade have shown that the majority of samples are heavy fuel oils, many with additions of lubricating and hydraulic oils—suggesting that the greater part of the oil pollution problem arises from illegal discharges at sea of oily wastes from machinery spaces and slop tanks, not leaks of oil carried by crude oil tankers.

The problem is particularly acute over the continental shelf off eastern Canada, where heavy shipping traffic shares the habitat of millions of pelagic sea birds. Even small amounts of oil can be devastating, especially to puffins, murrets and gannets, which spend their lives far from shore. The oil destroys the waterproofing and insulation of the feathers and the bird can die rapidly from hypothermia. As the bird attempts to clean itself, it may ingest the toxic oil. Pelagic sea birds have a low reproductive rate, maturing late and laying only one egg a year, so any reduction in the population can be disastrous.

In an effort to control the incidence of sea bird oiling, Canada has increased its surveillance over the continental shelf off eastern Canada. Ships identified discharging oil are photographed and oil samples are taken of any oil-slick trailing a vessel. Where appropriate, Canada has taken action to charge the vessels concerned or forwarded evidence to the

flag State of the vessel concerned. Canada has warned that this increased surveillance and enforcement will continue as long as necessary to ensure compliance with MARPOL 73/78 discharge requirements and to reduce or eliminate the incidences of oiled birds in the area, and hence protect the sea bird populations. (Source: *IMO News*, February 1998)

The dangers of wheat

In 1998, a ship ran aground on rocks south of Corsica and, after a heavy storm, spilled its cargo. A large area with a protected species of marine plant, *Posidonia oceanica*, was devastated, while people working to recover the cargo experienced nausea, sickness and irritations from toxic hydrogen sulphide fumes. The cargo was wheat.

The pollution problems presented by a spill of wheat are illustrated in a paper presented by France to the 21st meeting of the Scientific Group of the London Convention from 6 to 9 April 1998. The paper gives details of a study carried out by the French research centre CEDRE following the grounding of the Panamanian wheat carrier *Fenes* south of the Lavezzi islands in the Bouches de Bonifacio (Corsica) in September 1996.

The *Fenes* was transporting 2,650 tons of wheat to Albania and the entire cargo was spilled, to a depth of 10 to 20 m, when a heavy storm damaged the holds of the ship a week after it had grounded. The immediate effects were the suffocating of *Posidonia oceanica*, a protected species of marine plant which is important to the local ecosystem. *Posidonia* meadows can only be found in the Mediterranean Sea, and some one to two hectares of the plant were affected.

Later, fermentation of the wheat resulted in the production of hydrogen sulphide gas (due to anaerobic reduction of the sulphates in the sea water). Hydrogen sulphide is extremely toxic to plants, animals and humans.

The paper notes that the massive spilling of wheat led to a pollution problem, linked not only to the physical covering of the marine flora, but also to the high production of hydrogen sulphide, which affected the people involved in clearing the site as well as marine flora and fauna in the area.

The combination of wheat fermentation and sea water created favourable conditions for the production of toxic hydrogen sulphide gas, and the paper says that significant concentrations of hydrogen sulphide dispersed in the sea water could have had direct ecotoxicological effects on the flora and fauna in the area. On the site, recorded concentrations of hydrogen sulphide varied from 3 to 25 parts per million—levels which are lethal to fish. The lowest levels of concentration of hydrogen sulphide needed to cause any noticeable effect are between 0.2 and 0.8 parts per million.

The paper concludes that it is likely that the ecosystems close to where the *Fenes* spilled its cargo of wheat have been seriously affected by the incident. (Source: *IMO News*, February 1998)

Fishing effort in the far northern section cross-shelf closure area of the Great Barrier Reef Marine Park—the effectiveness of area closures

A meta-analysis of available information on the intensity and distribution of illegal prawn (shrimp) trawling is reported from a 10,000 km² cross-shelf area closure in the tropical Great Barrier Reef Marine Park. Northern and southern borders of the closure were subject to edge effects as trawlers overran their hauls, legally started in the adjacent open zones. There was considerable illegal trawling inshore along a north-south navigation channel running through the area closure. The middle and outer regions of the closure were originally denied to trawlers because of "rough ground" but

this is probably no longer the case since the general adoption of advanced navigation aids (GPS). The area least likely to have been heavily trawled is the central mid-shelf section of the closure in a region of uncharted shoal reefs. Many trawlers fish in the accessible sections of the closure on a casual or incidental basis but approximately 47 boats do so on a consistent basis. An estimated yearly total of 3,260 days' illegal trawling occurs, giving an approximate estimate of 69 days' illegal trawling per regular offender. The implications of this level of non-compliance are the probable invalidation of the original objectives of conservation and maintenance of a pristine reference area in all but the central section of the closure. Management of marine world heritage areas requires the acknowledgement that the harvesting of fish, prawns and other living resources may be an established use of the Marine Park but it also requires a combination of education plus the adoption of effective monitoring technology, such as satellite vessel monitoring systems, to stop or at least reduce unauthorized fishing. (Source: *Journal of Environmental Management*, 52(1):53-67, January 1998)

South African integrated coastal management and engineering—converging towards collision or collaboration

The history and development of South Africa has been linked strongly to the sea over the past 500 years, since the first visits by the early Portuguese navigators in the late fifteenth and early sixteenth centuries. The earliest coastal development was associated with the construction of ports and harbours, and the country now has commercial ports equipped with modern facilities, as well as a number of smaller ports used mainly by the fishing fleets. Construction of some of these has presented particular challenges, because of the littoral drift and its impact on adjacent beaches. Since the 1950s, a series of excellent facilities and amenities, including tidal pools and small craft marinas, has been developed for recreation, and the effluent has been managed through the construction of ocean outfalls. On the South African west coast, and extending into Namibia, there are rich coastal and offshore marine diamond deposits, and innovative approaches have been developed to allow their mining. For all of these developments up-to-date, accurate environmental information has been a key input, and appropriate measuring networks and data management techniques and facilities have been developed to allow the use of the information. Worldwide there has been a growing awareness of environmental issues. In 1992, one of the world's largest international environmental meetings took place in Rio de Janeiro. There, coastal states were urged to commit themselves to integrated and sustainable development of coastal areas, so giving impetus to the already growing international trend towards integrated coastal zone management (ICZM). People are adopting and demanding an integrated and holistic approach in the coastal area. South Africa was until recently excluded from the international community. Perhaps the most significant development in ICZM in South Africa is the participatory policy-formulation programme launched in the mid-1990s that will address the shortcomings currently experienced. Indeed, South Africa is poised on the brink of major advances in the field of ICZM. It is predicted that the country will become a major force in the advancement of all spheres of ICZM in both East Africa and the whole African continent. Historically, coastal engineering proceeded with little regard for the environment, in many cases with devastating effects, from environmental, economic and social points of view. As the years went by and information became more freely available, there was a growing awareness that the

environment had to form part of the calculations, formulas and debate of coastal engineers and other interest groups operating in the coastal area. Therefore, over the past 30 years, marine and environmental scientists and coastal engineers in South Africa developed methodologies that allowed a holistic approach to the technological support for judicious development of the coastal and marine resources of South Africa. The path of increasing collaboration was initially fraught with conflict between engineers and environmentally-oriented coastal managers. Recently, the two viewpoints have increasingly converged, and at present it would appear that a new breed of professional, coastal development scientists, consisting of coastal engineers and coastal, marine and environmental scientists, will be playing a key role in the sustainable development of our coastal resources. (Source: *Transactions of the Royal Society of South Africa*, 52 (Part 1):227-252, 1997.

On the level

Much of the long-term changes in sea level in history are just an illusion, physicists in Canada report. They claim the mirage is caused by tiny shifts in the orientation of the Earth's rotational axis which alter the distribution of water.

The best records of how global sea level has changed over millions of years were put together more than a decade ago by geologists working for the oil company Exxon. The records suggested that global sea level fluctuated by about 200 metres over the past 130 million years.

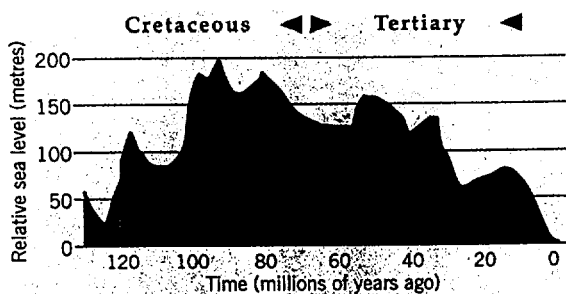
While other geologists have generally accepted the estimates, they have not been able to explain such large fluctuations. Sea level can change by as much as 100 metres as polar ice sheets grow and shrink, but the Exxon data show large variations at times when the planet had no known widespread glaciers.

John Mound of the University of Toronto and his colleague Jerry Mitrovica suggest that a significant fraction of the apparent changes may arise from differences in water distribution arising from changes in the orientation of the Earth's rotational poles.

Over millions of years, the planet's rocky outer mantle and crust slip slightly over the liquid layer covering the metallic core, moving over the rotational pole. This motion, which is called true polar wander, amounts to a fraction of a degree every million years, moving the continents and oceans relative to the equator.

The motion changes the force they experience as the Earth rotates on its axis. Both force and rotational speed increase as you move towards the equator, so moving continents and oceans deform—just as the Earth bulges at the equator.

Mound points out that the fluid oceans respond more than the crust. Some parts of the Earth would see rising oceans, while others would see drops in sea level.



Averaged over the whole planet, this would not change sea-level measurements. But Mound argues that Exxon

geologists collected their data largely from the North Atlantic. His calculations show that between 130 and 50 million years ago, as the North Pole moved from central Greenland to the Arctic Ocean, the average sea level in that region should have risen by over 50 metres, with the trend reversing ever since. The inverse would have happened in the oceans surrounding Japan—but these regions were not well represented in the Exxon data.

The researchers say it is unlikely that sloshing oceans are the whole story, however. Mound's calculations suggest that it accounts for one quarter to two thirds of the apparent change in sea level over the 130 million years he studied. (Source: *New Scientist*, 31 January 1998)

High oxygen content, current speed enhance deep-water corrosion, erosion

Unlike surface conditions, the water environment in abyssal depths was supposed to be relatively barren and quiet, with low current velocities and oxygen content. Structures deposited on the sea floor would last for ever. A different picture emerged, however, as oil and gas exploration and development moved out onto the abyssal slope and ultra-deep water.

Not only was the rate of corrosion surprisingly fast, but anodes were consumed quickly. Engineers responsible for deep-water development in the United States Gulf, Brazil and in the Atlantic Margin had to take a new look at this previously barren topography.

The rate of corrosion on steel in sea water is determined mostly by chloride content, oxygen availability, current speed, temperature and pH.

- Chloride content: Chloride ions provide high conductivity and are able to penetrate metal surface films and coatings. Some cold deep-water bottom currents are supersaturated with chloride ions.
- Oxygen solubility: Oxygen solubility is inversely proportional to temperature, meaning the ability to absorb more oxygen rises as temperature drops. Since sea-floor temperatures in deep water tend to be only 1-2 degrees above freezing, solubility is very high.
- Oxygen availability: Photosynthesis produces oxygen, decomposition absorbs it. Originally, researchers expected to find very little oxygen near the deep-water sea floor because photosynthetic organisms (oxygen producers) simply did not operate without sunlight. What they found was that sea-floor currents, particularly those originating in the Arctic and Antarctic, were loaded with oxygen.
- Reduced pH: High pressures at the seabed level in deep water push pH toward the acid end of the scale. Calcium carbonate and magnesium hydroxide dissolved in sea water tend to be below saturation levels, and will not precipitate out and protect metal surfaces easily. Conditions at the surface are just the opposite, where sea water is supersaturated with base compounds. Thus, in deep water, scale formation on metals is depressed, speeding up anode consumption.
- Current speed: Another discovery in deep water was that instead of the 0.5-2-knot currents expected on the sea floor, speeds of up to 3-4 knots were not uncommon. Fast currents expose steel surfaces to greater volumes of corrosive oxygen. Also, fast currents destroy the rust barrier on steel equipment.
- Suspended sediment: Sediment load in a fast sea-floor current acts as a slow-rate sandblasting operation. Not only are rust barriers eroded, but other forms of artificial protection gradually disappear over time. The higher the sediment load, the faster the erosion rate.

Corrosion rates for steel tend to be lower at great depths than at the surface, but there have been some surprises, due to special conditions at deep-water drilling locations.

In the Pacific Ocean, oxygen content in sea water drops from a maximum at the surface to a minimum at about a depth of 2,000 ft., where oxygen demand from decaying organisms also seems to reach a maximum. At greater depths, oxygen content will depend upon current flow and current origin. In the Atlantic Ocean, oxygen content is fairly uniform through all water depths.

Depth (ft.)	Oxygen content (ml/l)	
	Atlantic	Pacific
0	4.59	5.8
2,000	3.11	0.25
5,000	5.73	1.0

In the Atlantic, oxygen content and current speed in some deep-water areas have led to a projected higher consumption of anodes that would be experienced near the surface. Replacement may be coming sooner than originally planned, in order to prevent metallic erosion.

With costly sea-floor equipment as well as surface systems at the mercy of harsh environmental conditions, subsea and mechanical engineers are taking no chances now. Bottom conditions at proposed drilling and development sites are being sampled frequently, not only to determine dominant conditions, but also environmental extremes. Some large subsea expenditures will depend on these measurements. (Source: *Offshore*, December 1997)

What's killing California's sea otters?

Sea otters in California are dying in the prime of life, apparently because their immune systems have been weakened. Now a group of toxicologists claims the cause is a toxic chemical found in boat paint that was banned on most vessels almost a decade ago.

For several years, dead otters have been washing up on the central Californian coast, killed by parasites and other diseases. Kurunthachalam Kannan of Michigan State University in East Lansing has carried out post-mortems on 35 of the corpses and found that many had high levels of tributyl tin (TBT) in their livers, up to 10 parts per million (*Environmental Science and Technology*, vol. 32, p. 1169). Kannan says that other studies suggest just 1 ppm can kill cultured fish liver cells.

Tributyl tin was added to marine paint to keep boat hulls clear of barnacles and slime, but the United States banned it from any vessel under 25 metres in 1989 after it was found to be a potential immuno-suppressant. Kannan and his colleagues say that in the cool waters off central California, TBT should have a half-life of about 10 years, so concentrations in marine sediments should have dropped since the ban, and thus the bottom-feeding shellfish that otters eat should be accumulating less of it. But judging by the high ratio of TBT to its breakdown products in the otters' livers, says Kanna, it must somehow still be in the environment. "The animals were exposed to TBT very recently", he claims.

Not everyone is convinced that TBT is killing the otters, however. Mark Stephenson of the California Department of Fish and Game says that studies have shown TBT does not

travel far from harbours—which most otters shun. (Source: *New Scientist*, 23 May 1998)

Pure paint

French company Laboratoire International Marine claims to have developed a revolutionary anti-fouling paint to protect ship hulls from living organisms.

Biomarine contains no heavy metals, toxic products or silicon, and repels organisms without killing or intoxicating them. The paint uses special acrylic resins to produce a self-polishing polymer with good antistatic properties. It can be applied to all types of surface—steel, cast iron, aluminium, polyester, wood and concrete. (Source: *Engineering*, February 1998)

Garbage: the menace nobody knows about

Whenever a tanker is involved in an accident leading to oil pollution there is a major public outcry and the claims for compensation can run into millions and sometimes billions of dollars. Yet another threat to the environment attracts relatively little public comment, even though it can be just as deadly to marine life—the dumping of garbage into the sea.

The practice is controlled by Annex V of the MARPOL Convention. The Annex is voluntary and by the end of 1997 had only been ratified by 87 countries whose fleets represented 82 per cent of world merchant tonnage.

The greatest danger comes from plastic, which can float for years. Fish and marine mammals can in some cases mistake plastics for food and they can also become trapped in plastic ropes, nets, bags and other items—even such innocuous items as the plastic rings used to hold cans of beer and drinks together.

A good deal of the garbage washed up on beaches comes from people on shore—holiday-makers who leave their rubbish on the beach, fishermen who simply throw unwanted refuse over the side—or from towns and cities that dump rubbish into rivers or the sea. But in some areas most of the rubbish found comes from passing ships which find it convenient to throw rubbish overboard rather than dispose of it in ports where reception facilities are often inadequate or costly to use.

Surveys carried out in the United States each year have produced up to 10 tons of rubbish per mile of coastline, a record that can probably be matched in many other parts of the world. Plastic forms the biggest single item found.

Persuading people not to use the oceans as a rubbish tip is a matter of education—the old idea that the sea can cope with anything still prevails to some extent, but it also involves much more vigorous enforcement of regulations such as Annex V.

IMO and the World Bank have cooperated in a major project to solve the garbage disposal problems in the Caribbean—called the Wider Caribbean Initiative on Ship-generated Waste (WCISW) Project. The Wider Caribbean region is a magnet for the cruise-shipping industry which has grown in popularity during the last few years. Cruise-liner passengers like to visit a different port each day, and a cruise ship with 3,000 people or more on board generates as much garbage as a small town.

In theory the ship should be able to dispose of this when it reaches port—but in practice the island States of the Caribbean do not have the resources to cope with such a deluge. When the project started in 1993, many of them had not ratified Annex V of MARPOL because they were unwilling to provide reception facilities for cruise ships'

rubbish when the cruise ships themselves do not make a great contribution to local tourism income.

Yet if ships cannot dispose of their rubbish in ports, the danger is that some of them will be tempted to do so—illegally—at sea. And this could lead to immense damage being caused to the pristine environment that attracts tourists to the Caribbean in the first place.

The result of the project was that six more countries ratified MARPOL and it is anticipated that all 29 countries in the area will have done so by 2001. The next stage will be ensuring the infrastructure is actually in place (i.e. reception facilities) to meet the “special area” status of the region. (Source: *Focus on IMO*, March 1998)

Special areas

Pollution of the seas, whether it results from routine operations such as tank cleaning or an accident, tends to be most serious when it is close to land. A major oil spill in the middle of the ocean normally has little impact upon the environment since there is little wildlife to be endangered and the oil itself is soon dispersed by natural causes.

But even a minor incident can have disastrous consequences if it occurs in an area where the environment is more vulnerable—such as a land-locked marine area or a region where marine life is very sensitive to pollution, such as corals.

The MARPOL Convention recognizes that such regions deserve extra protection and so a number of “Special Areas” have been recognized where discharge regulations are much stricter than elsewhere. Under Annex I, for example, the discharge of oil in Special Areas is completely forbidden: elsewhere it is permitted under strictly controlled conditions.

The Special Areas recognized by the Convention are listed below.

- Annex I (oil): the Mediterranean Sea, the Baltic Sea, the Black Sea, the Red Sea, the Gulfs area, the Gulf of Aden, the Antarctic.
- Annex II (liquid chemicals): Baltic Sea and Black Sea.
- Annex V (garbage): Baltic Sea, Mediterranean Sea, Black Sea, Red Sea, Gulfs area, North Sea, Antarctic, Wider Caribbean region.
- Annex VI (air pollution): Baltic Sea—as a sulphur emission control area (not yet in force).

(Source: *Focus on IMO*, March 1998)

Biological treatment of fish farm effluent

Hydro Seafood GSP Ltd., one of the largest salmon farmers in Europe, has set up a new effluent treatment plant at its processing plant near Oban on the west coast of Scotland. The effluent plant was designed and installed by Envirobac Ltd. of Scotland and was based on the patented EnviroBAFF (biological aerated fixed film) system. The new EnviroBAFF system handles 150 m³/day of waste with a biochemical oxygen demand (BOD) of 3,000 mg/l.

The waste undergoes primary screening, aeration and separation, before the liquid waste enters the EnviroBAFF. This measures 2.5 m wide x 7 m long x 4 m high and contains 53 m³ of patented high surface area-to-volume matrix. The specially designed void spaces within the matrix allow maximum air flow and effluent mixing, without blocking. Oxygen for the large biomass that grows is supplied by a patented air diffuser system covering the underside of the matrix. This prevents blocking, creates perfect mixing, achieves extremely high oxygen transfer and causes excess biomass to slough off, keeping the biofilm thin and active.

The matrix is divided into three chambers with the liquid effluent passing through each one before entering the final lamella settler. This separates the surplus biomass from the clean water which flows to the sea and the remaining solids are pumped to the sludge-holding tank.

The combined sludge from the primary separation and the lamella settler is aerated in the sludge-holding tank, transferred once a day to a dewatering unit, thickened and finally pumped to the gut skip.

The EnviroBAFF is much more compact than other more conventional systems and can be the solution to on-site effluent treatment when space is at a premium. Its size also means a low capital cost, and savings of over 50 per cent can be realized over comparable systems. Low power requirement and simple automated operation, which requires only part-time supervision, contribute to very low running costs. The system does not require dosing with chemicals, which not only saves operator time, but also money.

For details, contact Envirobac Ltd., Inglewood Invergordon, Scotland IV18 0PW, United Kingdom. Tel.: +44 1349 852944; Fax: +44 1349 854099. (Source: *TECH MONITOR*, September-October 1997)

F. COUNTRY NEWS

Abu Dhabi

Tideland solar units for channel marking

Tideland Signal, the Surrey-based aids to navigation specialist has won two contracts to supply solar-powered equipment to Abu Dhabi, including Sola-Chan units, buoys and marine lanterns.

Twelve Tideland Sola-Chan units fitted with ML-155 lanterns will mark the navigational channel around the island of Abyadh and two solar-powered ML-155 lanterns with solar panels and batteries will be installed on Tideland SB-37 Sentinel buoys to mark the underwater pipeline leading to the desalination plant at Ras Al Khaimah.

Sola-Chan units are factory pre-assembled and specially designed for fast, easy installation and reliable, low-maintenance operation in remote sites. They incorporate a pedestal-mounted marine lantern equipped with Tideland's TF-3B MicroPower flasher lampchanger and powered from a solar module charging a battery housed in an integral battery box.

The SB-37 buoy is rotationally moulded from self-coloured, UV-stabilized polyethylene with a core of closed cell foam. This lightweight construction combines strength and exceptional stability with long service life, minimal maintenance requirements and resistance to all forms of marine growth. The SB-37 buoy has a diameter of 900 mm and a focal plane height of 1,945 mm. (Source: *Ports and Harbours*, April 1998)

Australia

Fish standards to be tightened

The Australian Government plans to upgrade its procedures for inspecting fish imports and fish products by accepting the recommendations of the Report of the National Task Force on Imported Fish and Fish Products. The aim is to raise the quality of both domestic and imported fish. According to the Minister for Primary Industries and Energy, the Government would provide A\$ 7 million to implement the report's recommendations on quarantine, and the risks associated with fish imports, and fish health. In addition, another A\$ 38.7 million would be spent over the next four years to upgrade fish health inspection at airports, mail centres and shipping terminals. The issue of poor quality fish being sold to the public as a superior product is becoming a major worry in the country. (Source: *INFOFISH International*, January 1998)

Bangladesh

Jamuna multi-purpose bridge

The Jamuna river is the world's fourth river in terms of peak discharge and second in terms of sediment load. It is an untamed braiding river, consisting of a number of channels continuously changing their course. This channel shifting takes place within a 15 to 40 km-wide braid belt. The river separates Bangladesh effectively in two parts.

Following 10 years of extensive studies, the construction of the first bridge across the river, the 5 km long Jamuna multi-purpose bridge, commenced in 1994. The studies, detailed design and supervision of the construction were carried out by a consortium of NEDECO (The Netherlands), Randall-Palmer-Triton (UK) and BCL (Bangladesh). The river training works needed to fix the river banks near the bridge were one of the largest of their kind in the history of river engineering and required the use of advanced technologies from the offshore construction industry. The project is in its final phase. The first cars and trains are scheduled to cross the Jamuna River in May 1998.

- Dredging and civil engineering contractors: HAM-Van Oord ACZ, Hyundai, SAM WHAN Corporation
Total construction costs: US\$ 970 million
Unusual techniques or equipment:
 - Use of advanced offshore technologies for river training works;
 - Side stone dumping vessels for slope protection works;
 - Dredging and slope trimming in milcacious sands with cutter-suction dredgers to a depth of 30 m (30 mln m³ of hydraulic fill).

The project was financed by the Government of Bangladesh, ADB, World Bank, OECF. (Source: *The Dock & Harbour Authority*, vol. 79, No. 886, 1998.

Master plan for port system

Mott MacDonald has been appointed to prepare a master plan up to the year 2017 for the Bangladesh Port System. The study, funded by the World Bank, will provide a phased programme for developing and operating the ports of Chittagong, Mongla and Dhaka and examine ways of improving efficiency of port and port-related activities.

Terms of reference will include port administration, management and staff organization, customs procedures and cargo handling. The study will also examine hydraulics,

dredging and navigation aspects plus assessment of pollution and development of prevention measures.

Mott MacDonald is leading the study in association with USA-based Louis Berger and the United Kingdom's Portia Management Services, along with Pathmark Associates, Engineering Consultants and Associates and Development Planners and Consultants Limited of Bangladesh. (Source: *The Dock & Harbour Authority*, January/February, 1998)

Canada

Swath sounding initiatives in Canada

Over the past 50 years, the hydrographic community has progressed from the humble lead line for single spot depths to sophisticated multibeam sounding systems capable of charting the entire sea floor. Canada now extensively uses this technology in its surveying operations. There are many benefits to using the latest swath systems, especially in the coastal margins and inland waters where, for instance, channel monitoring and dredging raise safety, economic and environmental issues. Utilizing multibeam systems reduces survey time, extends bottom coverage and contributes to conserving survey resources.

Multibeam systems are expensive and the complexity of the system often requires high maintenance. In addition, the software used for acquiring, processing and displaying the collected information is still maturing. Data cleaning algorithms to accommodate data collection rates that at times exceed 3,000 data points per second are required.

Canada has been dealing with those aspects of swath sounding for a decade now. Continuous research and development in the subject gave birth to new technologies and new acquisition and processing techniques. This paper summarizes the Canadian experiences in swath sounding and discusses its future developments and direction within the Canadian Hydrographic Service. (Source: *International Hydrographic Review*, 75(1):65-80, March 1998)

China

Farmers find European eel culture more lucrative

Most of the Chinese eel farms are reported to be switching from growing Japanese eel (*A. japonica*) to European eel (*A. anguilla*) due to lower mortality rates of European eel in their farms that use cool well water. About 200 mt of elvers, almost twice the previous season, are being stocked in ponds and nearly 50,000 mt of live European eels are expected to be produced next year.

European eels have been imported into China increasingly following poor catches of Japanese eel elvers and their huge increase in price. However, the high mortality rates before stocking in aquaculture ponds and the high water temperature during summer inhibited the success of eel farming in China.

But, after good results in highland farms using cool well water, European eel farming has spread to three districts, centred on the Fujian area. During 1993/94, 30 mt of eel larvae was imported, 80 mt in 1994/95, and 120 mt in 1995/96. The high price of Japanese glass eels spurred European eel imports to a new high. (Source: *INFOFISH International*, June 1997)

China an alternative to EU market

The EU ban on Indian seafood in August 1997 has led seafood producers to look for alternative markets and to make changes to their export plans. Most of the seafood

processing plants in both the east and west coasts of India find China a suitable alternative market to the EU, especially with its recent open market policy. It is now one of the largest consumers of shrimp, cuttlefish and squid. India's main export to China in the past was ribbon fish, a low-priced flat fish which was exported by container loads every year. Now China has emerged as one of the major importers of a variety of high-priced seafood.

Despite the change in the marketing strategy by Indian seafood producers, the Indian Government has in the meantime assumed responsibility to offer expertise on the EU quality requirements as well as screen plants which are willing to follow EU regulations. Teams were also sent to inspect these factories and assist them in implementing compliance measures. (Source: *INFOFISH International*, January 1998)

Egypt

Egypt goes into sea farming

Fish farming has expanded rapidly in Egypt in recent years, with output reaching 65,700 mt in 1995, some 16 per cent of the total national fish production of 407,000 mt. Ten years ago it was 36,700 mt or less than 13 per cent of total fish production.

Aquaculture is largely practised in ponds, tanks, cages and paddy fields within the Nile delta where government and private farms are established. In 1997, freshwater ponds produced 20,000 mt of fish. However, due to a shortage of fresh water, future expansion will depend on the development of marine aquaculture. Preliminary efforts in this direction are reported to be showing promising results. Various species of shrimp, sea bream, mullets, sea bass, rabbitfish and grouper are being farmed. (Source: *INFOFISH International*, April 1998)

Germany

Hamburg: Maritime trade with China increasing

Hamburg not only boasts a long tradition of maritime trade with China but also a current market that is still growing despite the economic crises in Asia. Although the leaps in growth of recent years are not expected now, substantial growth is still expected both in imports (with a growing proportion of finished goods) and exports via the port of Hamburg.

Although foreign trade with China is still partly dependent on official approval, i.e. with centralized decisions and controls, there are clear signs of moves towards a market economy, for example in linear reductions of import duties. In the fourth quarter of 1997, import duties for about a third of all goods categories were reduced. Average duty fell from 23 to 17 per cent and the highest rates were also cut. Further reductions have been announced.

Trade with China and Hong Kong is one of the most important contributory factors to the port of Hamburg's container turnover. In 1997 Hamburg's container terminals handled around 450,000 TEUs of outgoing and incoming cargoes. In the past five years the volume of cargo handled has increased by 50 per cent. There are direct or indirect sailings from Hamburg to more than 60 ports in China while more than 30 regular services call in at Shanghai and Hong Kong, the main ports for incoming cargoes. Hamburg offers an ideal frequency of sailings to Chinese destinations and a broad range of shipping lines, including several sailing under the Chinese flag. (Source: *Ports and Harbors*, June 1998)

Ghana

First fish-processing plant opened

Divine Seafoods, the first fish-processing plant in Ghana situated inside the Tema fishing harbour opened for business in September 1997. It has an annual production capacity of 3,500 mt of value-added frozen seafood products and 2,500 mt of chilled fish and live lobsters for export, in addition to supplying more than 3,000 mt of fish for local sale and consumption. Divine Seafoods, established with assistance from DANIDA, the Danish Overseas Development Agency, and the Commonwealth Development Corporation, claims to meet the latest EU and USFDA hygiene requirements, and operates under HACCP procedure. With 200 local employees and a technical management arrangement with Nordic Seafoods of Denmark, the new factory is able to process and add value locally to the country's abundant fish resources, instead of the previous practice of exporting to other countries to process them. (Source: *INFOFISH International*, February 1998)

India

Vadhavan

The Indian Government wishes to develop a new all-weather port on the west coast of India, north of Mumbai (Bombay) to act as an alternative to Mumbai port and relieve traffic in the Mumbai area. The development of the new port has been let to P&O Australia Ports Pty Ltd. (P&O Ports) as a private investment initiative in partnership with the Maharashtra State Government. As a first stage in the development, P&O Ports commissioned Halcrow to carry out a technical feasibility study of the proposed port which is to be located at Vadhavan point, about 100 km north of Mumbai.

The proposed development is expected to be built on a greenfield site offshore from the present shoreline and on reclaimed land protected by breakwaters constructed in water up to 20 m deep. The port is to handle all types of cargo including containers, general break bulk and liquid and dry bulks. It is envisaged that the port will be developed in phases involving the opening up of additional dock basins and reclamation of additional back-up areas as trade grows.

Phase 1 is to be designed for a total throughput of about 20 mt, including 1 m TEU of containerized cargo. The entrance channel is to be dredged to 15 m and the berths will have at least 15 and 17.5 m of water alongside to cater for the largest container vessels and bulk carriers up to 150,000 dwt respectively. An innovative scheme for excavating the harbour basin and berths within temporary coffer-dams has been proposed. The main reason for this solution is that the seabed in this area comprises solid bedrock, which is expensive to remove by conventional dredging methods. Inside the temporary coffer-dams the rock will be blasted and excavated using quarrying techniques.

Vadhavan lies about 15 km from the main railway and 35 km from the main highway to the north of Mumbai. The provision of adequate road and rail links between the port and the main railway and highway, including preliminary surveys and route finding, was included in the feasibility study carried out by Halcrow. (Source: *The Dock and Harbour Authority*, April 1998)

Sea ranching venture

Thanks to a scientific research cooperation programme, India's first multi-species fish stock enhancement programme, combining aquaculture, capture fisheries and environmental management technologies, is set for launch.

The Indo-Australian venture, involving sea ranching, will be fully funded by the Australian Government under the Australia-India New Horizons Initiative.

The programme is aimed mainly at five depleted species: lobster, shrimp, grouper, pearl oyster and sea cucumber. It envisages establishment of multi-species hatcheries at Vizhinjam, near Thiruvananthapuram, and the release of genetically marked seeds in an area of about 3 million hectares along a coastal length of 300 km.

The Government of Australia is examining the programme which has been jointly prepared by scientists from the Central Marine Fisheries Research Institute (CMFRI) and the South Australian Research and Development Institute (SARDI). Besides SARDI and CMFRI, the Department of Science and Technology in New Delhi, and the Department of Fisheries, Thiruvananthapuram, will participate in the programme.

The target area of the project is the 300-km stretch on the peninsular tip of India bordering inshore waters of the Cochin-Cape Comorin coast, the Gulf of Mannar and the lagoons of Minicoy island and Lakshadweep. The target area is characterized by intense up-welling during the southwest monsoon season and is considered best in the Indian seas for its biological productivity at all trophic levels.

A large variety of littoral finfish and shellfish species inhabit this area and they contribute substantially to the seafood resource. Large concentrations of oil sardine, mackerel, whitebait and threadfin bream are found between Kochi and Kollam. The programme will be spread over five years and its successful completion is expected to result in considerable additional income.

Currently facing depletion of several commercially important finfish and crustacean varieties, Australia will share their experience with their Indian counterparts in fish stock enhancement technology and establishment of programme models. (Source: *INFOFISH International*, April 1998)

Prospects for pearl culture in India

Pearl culture presents opportunities for the economic advancement of coastal communities, employment generation and foreign exchange earnings. There is a need for cooperation between farmers, entrepreneurs, researchers and financiers to make the industry self-sustaining.

In the Indian context, early attempts in culturing pearl oysters started as early as 1956 in Gujarat. The country's premier fisheries research centre, the Central Marine Fisheries Research Institute (CMFRI), initiated a research project on pearl culture in 1972 at Tuticorin. A breakthrough in this field was achieved when the first spherical cultured pearl was produced on 25 July 1973, heralding the development of pearl culture technology in India. Further developments included open sea farming, adopting the raft, rack and cage culture techniques.

Pearl oysters occur in many regions in India such as in the Gulf of Mannar, Palk bay, off Trivandrum, the Andaman and Lakshadweep Islands and the Gulf of Kutch. Among these areas, the Gulf of Mannar and Gulf of Kutch are the most productive regions in terms of abundance. Six species of pearl oysters—*Pinctada fucata*, *P. margaritifera*, *P. chemnitzii*, *P. sugileata*, *P. anomioides* and *P. atropurpurea*—are found in Indian waters. Of these *P. fucata* is the most dominant.

Pearl oyster farming is picking up worldwide. It is an important foreign exchange earner for developing countries, with promising markets in Europe and North America, where there is a great demand for cultured pearls which are cheaper than wild pearls. In 1990, over US\$ 900 million worth of

pearls were produced in the world. French Polynesia deserves special mention as it is considered to be among the world leaders in culture pearl production.

Field trials conducted by the Central Marine Fisheries Research Institute have revealed that a profit margin of 55-60 per cent can be generated from 6 x 6 m raft, after taking into account a post-operative mortality rate of 22 per cent. For a venture to be economically viable, Class A and Class B pearls should account for about 60 per cent of the total production.

The National Bank for Agriculture and Rural Development (NABARD) is establishing the first commercial pearl oyster farm on the east coast of India. The hatchery and the grow-out technology in the Indian context have been standardized by CMFRI. (Source: *INFOFISH International*, June 1997)

Italy

Turning the tide

Venice is turning to new technologies to save its medieval cityscape from destruction through erosion and pollution. Satellites, robots and advanced marine engineering are being deployed to preserve the finest and most romantic historical city in the world.

The heart of the 21st century rescue plan is the Venice Arsenal. Four hundred years ago it was the largest industrial complex in the world, employing 3,000 people on a production line, building ships for the merchants and navies of the Mediterranean. The wealth it generated helped to fund the development of the remarkable city.

Now the Arsenal has become home to a sophisticated suite of laboratories, research facilities, engineering workshops and training centres which will help not just Venice but all cities built beside water. Called Thetis, it has received backing of more than £7 million from the European Union, the local and regional governments and a consortium of industrial partners. It will grow to have a permanent staff of 40 scientists and engineers.

The Thetis consortium believes that a crucial aspect of its activity is the decision to operate in a frontier area between experimentation and technology transfer, with an emphasis on translating important scientific and methodological theories into products and solid experience.

Thetis opened its Arsenal headquarters in 1997, six years after the organization was created. Already projects which make imaginative use of modern technologies are coming to fruition. The four threats of rising sea level, land subsidence, water pollution and erosion of buildings are driving research and innovation.

The largest project is an attempt to minimize the damage to buildings caused by boats. The wake of speeding boats along the canals and lagoons is a significant factor in the destruction of Venetian buildings.

Now the municipality is turning to global positioning system (GPS) technology. There are plans to fit a thousand boats with GPS receivers which will check their location against the constellation of US military satellites every few seconds. An on-board radio will transmit this data to a control room inside a 17th century tower at the Arsenal which was originally used to install masts into wooden fighting ships. The raw GPS data may only be accurate to within a few metres so the control tower also receives data from a static, land-based GPS unit of known location. By comparing the signal of this benchmark signal in real time with that from the boats, an error calculation can be made

and accuracy is improved to within a few centimetres. This will satisfy the courts that must administer fines.

The radio signal from each boat will also carry a data fingerprint so that the police can identify speeders remotely.

Another project to reduce the effects which the wash of boats has on buildings has been completed by the naval engineering school at the University of Trieste. Its task has been to design a new hull for public transport vehicles which minimizes the disturbance of the water. It studied the most popular hull designs currently used, came up with new designs and tested them on tanks in the university's department of naval architecture. Now the designs have been handed to the local authority which is considering whether they should be implemented.

A third project which Thetis has already launched is a revolutionary dredging machine. After 40 years of neglect Venice has embarked on a 20-year programme to dredge all of its canals. Traditionally the Venetians have drained sections of the canals and then excavated the mud—a combination of sediment from the lagoon and domestic sludge—with mechanical diggers. The Venetian engineering company Tecnomare Industriale was charged with designing a submersible vacuum cleaner that sucks up the muck from the bottom of the canals and spews it into a barge which is towed out of the city for dumping. The mud-eating vacuum cleaner is so quiet that it has even been operating on a canal outside the walls of a hospital.

The suction head has a housing for a screw and centrifugal pump mechanism which sucks sludge to the surface through a flexible hose. The screw and the pump are powered by hydraulic engines.

In order to increase the extraction capacity and reduce to a minimum the amount of disturbed sludge becoming suspended in surrounding water, the head is shaped so its opening forms an interface with the material to be dredged. Rubber containment panels at the back of the suction head fulfil a similar function.

The dredging head is connected to the support vessel by a structural frame which enables it to remain horizontal with respect to the ground as it completes successive passages until the required depth of excavation is reached. The mud is discharged through a flexible hose into a shuttle boat which carries it away.

The pump dredger has now been enlarged so that it can work on larger deposits that have accumulated away from the narrow canals, in the lagoons. For these operations it has been attached to a submersible robot specially developed for Thetis but with potential for the offshore oil and gas industry. It is a sea tractor with tracked wheels which is equally at home in shallow water as in depths up to 50 m. Measuring 6 m long and 4 m wide, the amphibious vehicle can be controlled via an umbilical cord or by radio.

Apart from helping with dredging, the robot can also help to treat the sediment in the stagnant lagoons of Venice. It can carry a plough device and dig through the sediment, helping it to become re-oxygenated so that polluted material is broken down. The tractor can also lay cables along canals and across lagoons so that Venice will be wired for the next millennium.

After successful trials using the tractor to dredge the lagoon it will be used in the canals. The mud it recovers will be dumped on islands in the lagoon that have been eroded by the tide. It was traditional practice to maintain these islands but over the years they have been neglected. By rebuilding them Thetis hopes to recreate a morphology that offers the city better protection from the water. (Source: *Engineering*, November 1997)

Japan

Japan fishery: production and outlook

Japanese fisheries production has been undergoing great changes as a result of the establishment of the 200 nautical mile Exclusive Economic Zone by maritime nations.

Japan's demand for marine products on the other hand has been increasing, while facing limited supply of quality fish from the domestic fishery. Japan has been one of the world's largest importers of fishery products.

The production of fish by inland fishery is insignificant, accounting for only 2.2 per cent of the total national fishery production in 1995. Therefore, marine fisheries play an important role in the national fishery production.

The total fish production in 1995 was 7.49 million mt of which 7.32 million mt was derived from marine fisheries and only 0.17 million mt were from the inland fisheries.

From 1989 to 1995, Japan's total fishery production has been on a declining trend. In 1995, it decreased by 8 per cent from the previous year. This was due to a decline in fisheries production from offshore fisheries and distant-water fisheries. The distant-water fishery is affected by the declaration of 200-mile exclusive economic zones by many maritime nations.

Table 1: Marine fishery production by type of fish, 1994-1995

	(in 1000 mt)	
	1994	1995
Total	6 590	6 007
Tuna, marlin	375	366
Skipjack and frigate mackerel	324	336
Salmon, trout	240	282
Sardine and anchovy	1 505	1 016
Japanese pilchard	1 189	661
Jack mackerel and scad	374	385
Mackerel	633	470
Saury	262	274
Yellowtails	54	62
Flounders, halibuts, soles	78	83
Cod and pollack	445	395
Alaska pollack	379	339
Sea bream	25	27
Squid and cuttlefish	589	547
Common squid	302	290
Others	1 684	1 765

Source: "Annual Statistic of Fishery and Aquaculture Production", Ministry of Agriculture, Forestry and Fisheries, Japan.

Table 2: Change of number of fishermen

	1994	1995
Total	312 890	301 430
Coastal fishermen	263 890	254 240
Offshore and distant-water fishermen	49 840	47 200
sex - male	257 430	247 200
- female	55 460	54 230

Source: "Fishery Census" Annual Report on Dynamic Statistics of Fisheries, Ministry of Agriculture, Forestry and Fisheries.

Catches of salmon and Japanese anchovy have increased while the catch of Japanese pilchard decreased by

528,000 mt. Mackerel and squid catches also decreased. The total fishery production (including whales) in 1995 decreased by 5 per cent from 1994.

Fishing vessels

The fishing fleet of Japan has been continuously decreasing during past years. In 1995, there were about 386,067 fishing boats, of which 96.2 per cent are marine fishing vessels, and the rest inland water fishing vessels. Most of the fishing boats are less than 10 mt.

Outlook

The Japanese distant-water fisheries have been phased out in many foreign waters which has resulted in a decrease in the number of fishing vessels. The sector may benefit from greater government/industry assistance with regard to the conservation of fisheries resources on the high seas, possibly through collaboration with international fisheries organizations. In addition, their efforts for more joint ventures in fisheries involving technical and financial assistance may be needed.

In terms of age, the majority of fishermen are middle-aged and older generation, as the sector does not seem attractive to younger people. This will result in a steady decline in the number of fishermen in the future, which may in turn affect the Japanese fishery production.

The fisheries industry in Japan, as in other parts of the world, is greatly dependent on the environment. Environmentalists have been actively demanding the protection and conservation of natural resources and ecosystems. The role of oceans as sources of food supply will become even more significant and thus there is need to ensure that Japanese fishery practices are in harmony with the environment. (Source: *INFOFISH International*, January 1998)

Kazakhstan

Aktau

Posford Duvivier, initially in collaboration with Profabril of Portugal and subsequently in collaboration with HASKONING (Consulting Engineers) of Holland, were appointed by the European Bank for Reconstruction and Development (EBRD) to carry out the detailed design and preparation of tender documents for the rehabilitation of the Port of Aktau on the Caspian Sea.

The project includes 550 m of new quay wall comprising steel sheet piling combined with a reinforced concrete relieving slab supported on bearing piles. The quay is designed to support travelling cranes, railway wagons, grain unloaders and mobile cranes.

The land-side works include the raising and reclamation of a 20 ha terminal area, heavy-duty port paving has been designed together with surface foul water drainage systems, railway tracks, M & E services and communications systems. The land-side works also include extensive new port buildings including offices, vehicle maintenance workshops, transit shed, amenities buildings and stores buildings.

An environment impact assessment (EIA) for the port rehabilitation works was carried out by Posford Duvivier in accordance with EBRD's environmental procedures. The EIA identified the existing environmental quality, the natural resources (e.g. fisheries) and their significance for the Caspian Sea, and other land uses, the current environmental legislation requirements and the port's environmental management practices and future needs. The potential impacts from the construction and operation phases of the port development activities on the natural and human environment, and other sea/land users (e.g. power station water-intake channel) were assessed. Mitigation measures for the identified impacts and environmental quality protection

and improvement measures for both the construction contractor and port authority were recommended. The port's future environmental management needs were identified (e.g. waste reception facilities for visiting ships) and recommendations put forward. The overall project value is £45 million and is being jointly funded by EBRD and the Government of Kazakhstan (Source: *The Dock and Harbour Authority*, January/February 1998)

Kiribati

Problems with pearl culture

Some problems must still be overcome to make pearl farming in Kiribati commercially successful. According to a Fisheries Division report, spawning was successful, but the majority of the pearl oysters kept in the sea were killed by marine creatures and fish. However, more than 2,000 survived and are now being cultured in land-based tanks.

Options for the best way of cultivating the pearls are being researched. One of these is to farm the oysters at sea in iron cages while another is to rear them in tanks on land. Consultants from the James Cook University, Australia, will be assisting the fisheries officers with research into the pearl project. (Source: *INFOFISH International*, April 1998)

Lebanon

Beirut

High-Point Rendel is helping to put war-torn Beirut back on the maritime map.

The company has been commissioned by SOLIDERE, a Lebanese company masterminding development and reconstruction of the city's Central District, to review designs for a US\$ 229 million new seafront infrastructure.

High-Point Rendel is reviewing the design and will later be supervising the work of a French design and building contractor, Bouygues/ Bouygues Offshore, which will construct a 1.6 km-long sea defence line, enclosing a marina at its western end and providing recreational access along the seafront.

The marina will be protected by a conventional armoured rubble mound breakwater and the seafront area will be protected by an artificial submerged reef and a line of twin-lobed caissons constructed onshore and floated into position.

The new sea defence infrastructure will make possible the reclamation of more than 600,000 m² of land from the sea. This will allow significant new development and enable the Central District to regain its traditional role as a maritime centre.

The 100-m wide seafront, running from the bay of St. Georges to the first basin of the port, will have three pedestrian pathways on three different levels. The marina, facing St. George's Hotel, will have the capacity for about 600 yachts.

Beirut is the country's principal port. The coastal strip north of Beirut, between Nahr Beirut and Nahr Antelias, is presently utilized as an industrial area with a poor road system and almost non-existent infrastructure. In addition, this coastal strip is highly polluted. The present situation has prompted the Government to begin a rehabilitation scheme for this area, focusing on commercial, residential and touristic purposes. (Source: *The Dock and Harbour Authority*, January/February 1998)

Malaysia

Malaysia promotes open-sea culture

In an effort to increase national fish production and to develop the country's aquaculture industry more efficiently and productively through technology transfer, the Malaysian Government is promoting the setting up of open-sea cage culture farms for marine fish. Following the Malaysia Inc. concept, the initiative calls for the involvement of the private sector together with the Government in realizing its goals.

Currently, Malaysia's marine cage industry is confined to sheltered coastal waters and utilizes traditional net-cages suspended from wooden platforms. The industry, which began in the 1970s, has expanded rapidly. In 1995, it produced 5,762 mt of marine fish, representing more than 90 per cent of the farmed marine fish produced in the country. The traditional cage culture industry has taken up almost all available sheltered waters and this is another reason why open-sea cage culture is being promoted.

The new cage culture initiative involves the utilization of deep-water cages such as the polar-Cirkel type. A farm unit of 12 cages, each measuring 15.8 m in diameter and 10 m depth, is estimated to be capable of producing 528 mt of fish a year. The species that has been targeted for production initially is the Asian sea bass, *Lates calcarifer*. The Government will provide assistance to private-sector parties interested in the project. (Source: *INFOFISH International*, March 1997)

The Netherlands

More industrial space for port of Amsterdam

The port of Amsterdam has permission to expand, with the Amsterdam City Council giving its final approval for the construction of a new dock basin, the Afrikahaven, which will be 1,900 m long, 350 m wide and 15.5 m deep. Business sites totalling 375 ha will be made available in the surrounding area.

Activity in the Port of Amsterdam has been expanding rapidly. Goods trans-shipments have risen strongly over the last five years to a 1997 total of almost 57 million tonnes. This, and the healthy interest in the port as a business location, have caused the number of available port sites, in particular those on deep water, to drop considerably. Over recent years, an average of 25 ha annually have been leased to new companies or for the expansion of existing ones.

Following the construction of the Afrikahaven, the port will ultimately have access to sites totalling 375 ha and 3,600 m of quay suitable for trans-shipment companies, port-bound industry and distribution operations. As a result, goods trans-shipment capacity will increase by some 10 million tonnes.

The first companies are expected to move in as early as 1999. The new port area should be fully ready for water-bound operations by the year 2001. (Source: *Ports and Harbors*, April 1998)

Nigeria

Nigeria merges marine agencies

Nigeria has merged its two marine safety agencies to form a new body to oversee shipping regulation, a local port agent said recently according to Reuters.

Elder Dempster Agencies (Nigeria) Ltd. said the Nigerian transport ministry had merged the National

Maritime Authority with the Maritime Inspectorate Division to form the Marine Safety Department.

Its responsibilities include ship registration, flag state administration, port state control, marine pollution prevention, search and rescue, and training certification, the agent said. (Source: *American Metal Market*, 1 May 1998)

Peru

New aquaculture plan

Peru has put together a new aquaculture plan which will allow companies to set up farming facilities by granting authorizations and concessions. Authorizations will be granted to private companies for projects including reseeding programmes. Concessions will be granted through a bidding system and will cover projects in marine or continental waters and on government land previously identified by the Ministry of Fisheries. The duration of each project will be established as the bids come in. Concessions will last a maximum of ten years and will be renewable only in already exploited areas. (Source: *INFOFISH International*, April 1998)

Largest fish canning factory opened

Pesquera Austral, Peru's second largest fishmeal producer, has officially opened what it claims as the world's largest fully automatic fish canning factory at Paíta, on Peru's far northern coast. The US\$ 35 million factory has been designed and built with a capacity to process 1,500 mt per day of raw material, which will produce 60,000 boxes or 1.44 million half-kg, or 500 gr. cans a day. The plant's products include sardine and mackerel in tomato sauce and brine, and skinless, boneless mackerel while production of flaked sardine and tuna are expected to start soon.

Austral, which exports fishmeal to 45 countries, is expected to use this network to market its canned fish. It is also looking to the East to expand market outlets. With marketing offices already existing in Thailand and Indonesia, it expects to open new offices in Singapore and South Africa.

Apart from the US\$ 35 million canning factory, Austral has invested US\$ 25 million in a can manufacturing plant and another US\$ 25 million on refrigerated boats to supply raw materials to the canning factory. According to the company's board chairman the diversification into high-tech canning operation is aimed at increasing added value to Peru's industrial catch. (Source: *INFOFISH International*, January 1998)

Foreign tuna vessels banned

The Government has banned foreign tuna vessels from fishing in its territorial waters, thus rescinding a law that allowed foreign tuna boats to purchase fishing permits within its 200-mile zone. The ban was imposed in an effort to promote tuna fishing by local boats. The cost of a six-month fishing permit was also reduced to US\$ 150 for each net registered tonne of the fishing vessel from the previous cost of US\$ 500 per net registered tonne, which was exorbitant for the locals. The Government aims to take advantage of the migratory stocks often fished off Ecuador, Colombia and Venezuela which are expected to move south to the Peruvian coast, due to the higher ocean temperature in the northern region brought by El Niño.

The fisheries ministry, when awarding licences, will give preference to long liners and to systems which release dolphins after encirclement with tuna, so that the catches can be considered for dolphin-free certificate for export to the US and Europe. The vessels must also be equipped with a satellite system for authorities to keep track of their position. (Source: *INFOFISH International*, January 1998)

Philippines

New seaweed farming technique

About 80 per cent of the world's seaweed-based and seaweed products are supplied by the Philippines. With the advent of new seaweed farming technology called the net tube, seaweed farmers in the Philippines can expect increased production. The technology was developed by a Philippine company called FMC Marine Colloids Philippines Inc in 1997. The tube system prevents the loss of up to 30 per cent in production due to plant fragmentation. The net tube system has been proven successful through trials by The Growth with Equity in Mindanao (GEM) in the Philippines. (Source: *INFOFISH International*, March 1998)

Singapore

Changi Airport

The figures speak for themselves: 200 million m³ of dredged sand, required to reclaim 2,000 ha of land. Extending Singapore Changi Airport is a major undertaking that has been in progress for several years already and will continue through to the next century.

The land reclamation currently taking place will enable a third runway to be built. The work is being carried out in phases, the first of which (1 a) was started six years ago and is now nearly completed.

The second phase (1 b) is scheduled to be finished during 1998. The main contractor for this phase is Korea's Hyundai Engineering and Construction who subcontracted some 30 million m³ of the sand supply to Boskalis International (BKI).

The third phase (1 c) is now also in progress and BKI is once again involved, working with Hyundai as the main contractor. With them in the joint venture is contractor Koon. Some 70 million m³ of dredging will take place during phase 1 c works, half of which is BKI's responsibility. BKI has two separate areas to reclaim. It started work in September 1996 on the larger, northerly area.

For BKI, the bulk of the dredging will have taken place during 1997 and 1998, although phase 1 c as a whole will take six years to complete. (Source: *The Dock & Harbor Authority*, April 1998)

Electronic chart for safe navigation

To further enhance navigational safety in Singapore waters, the Maritime and Port Authority of Singapore (MPA) has produced the Singapore Electronic Navigational Chart (Singapore ENC) for commercial use.

The Singapore ENC is a digital database which contains hydrographic chart information necessary for safe navigation. Singapore is among the first in the world to release for commercial use ENC data that is compliant with the International Hydrographic Organisation S57 Edition 3 Standard.

The Singapore ENC also contains supplementary information not available in paper charts. It is used with the Electronic Chart Display and Information System (ECDIS). ECDIS is approved by the International Maritime Organization (IMO) as a paper chart equivalent. Therefore, vessels equipped with ECDIS need not carry paper charts for their voyage as required under the Safety of Life at Sea (SOLAS) Convention.

The Singapore ENC is a powerful navigational tool. For the maritime community at large, the benefits of using this electronic tool are many. When interfaced with navigational sensors such as the Differential Global Positioning System (DGPS) and the ECDIS software, it is able to provide:

- Real-time information on the actual position of a vessel.
- 24-hour operations in all weather conditions, night and day. This would increase a mariner's confidence in navigation, especially in confined waterways such as the Singapore Strait.
- Anti-grounding warnings.
- Anti-collision warnings when interfaced with Automatic Radar Plotting Aid (ARPA) radar.
- Capability to carry out route planning, route monitoring and estimated time of arrival (ETA) computation.

All this greatly enhances safety to navigation and therefore helps to protect the marine environment.

The Singapore ENC has been tested on board ships plying between Singapore and Southampton and Singapore and Hong Kong under a programme called the Singapore-Hong Kong Admiralty Raster and ENC Demonstration (SHARED). The programme was jointly undertaken by the MPA and the United Kingdom Hydrographic Office. The SHARED programme has been successfully demonstrated on board container ships and car carriers, and has led to an extension of the programme to the region. The MPA is now working out the details of the SHARED extension programme with the participating Hydrographic Offices in the region.

The Singapore ENC is available on CD-ROMs and may be obtained from authorized distributors. The ECDIS hardware and software are available commercially. (Source: *Ports and Harbors*, June 1998)

Taiwan

Taichung

The port of Taichung, a man-made port carved from a barren stretch of open seashore on the central west coast of Taiwan, is a new international port, about 110 nautical miles from both older ports of Keelung to the north and Kaohsiung to the south.

The port of Taichung was projected to cope with the fast-growing needs of the national economic development. Foreign trade had rapidly increased and the two existing ports of Keelung and Kaohsiung gradually became imperative. After several years of study and surveys, the port of Taichung was finally chosen to be constructed as a new international port not only to take pressure off the two existing shipping centres, but also provide a gateway to central Taiwan to promote a balanced regional development in the whole area.

According to its master plan, the Taichung port project calls for a commercial port, an industrial port and a fishing port.

At present, there are 36 deep-water wharves that have been completed. These include five container wharves, 15 general cargo wharves, two bulk cargo wharves, six liquid cargo wharves, three cement wharves, two grain wharves, one waste iron wharf and two coal wharves. The warehousing facilities include 14 transit sheds, 2 grain silos, 20 cement silos, eight storage areas, 3 container yards, 224 liquid cargo storage tanks. The stevedoring and warehousing businesses in the terminals are open to investment by private firms, and are equipped with automated unloading and warehousing, and high-efficiency handling.

The future development project—a commercial port expansion plan and an industrial port development plan—will be carried out according to the pace of international marine transportation development. The ultimate goal of the Taichung port project is to make it a multi-purpose port that includes a commercial port with 88 deep-water berths. (Source: *Ports and Harbors*, May 1998)

Tanzania

Dar es Salaam port

WSP (incorporating Coode Blizard) have just completed a comprehensive redevelopment study of the Lighter Wharf Area of Dar es Salaam port which services coastal, local and cruise trades. The project was funded by the World Bank and proposes a master plan for redevelopment, including both rehabilitation of existing infrastructure and new works for ro-ro facilities and a passenger terminal. The Tanzania Harbour Authority have also asked WSP to undertake the design and construction supervision of the redevelopment of the West Ferry Kigamboni Terminal, which will replace the facility removed during the recent widening of the port access channel. The work includes installation of permanent navigation aids for channel marking and sector lights to enable 24-hour port operation. WSP's work in the port of Dar es Salaam also includes a proposed signal station at the harbour entrance and supervision of onshore work in connection with the entrance channel dredging project. (Source: *The Dock and Harbour Authority*, January/February 1998)

Thailand

Consortium for shrimp industry

A consortium has been formed to address the problems of Thailand's shrimp culture industry. Called the Shrimp Culture Research and Development Co. Ltd., the consortium was set up in 1996 by the National Centre for Genetic Engineering and Biotechnology (BIOTEC) under the National Science and Technology Development Agency (NSTDA), the Thai Marine Shrimp Farmers Association, the Thai Frozen Food Association and a group of leading Thai and international private shrimp business firms.

The formation of the consortium results from the recognition that the ailing Thai shrimp culture industry needs prompt and dynamic measures to revive it. The industry provides employment to more than 200,000 people in the country's 25,000 farms, over 1,000 hatcheries and other related businesses. While Thailand's farmed shrimp production peaked at 250,000 mt in 1994, the industry has in recent years been plagued by disease and environmental problems which have caused production to drop drastically.

The consortium coordinates and supports R&D projects that are relevant to both the short- and long-term needs of the shrimp culture industry. It aims to make the industry sustainable, profitable, and environmentally responsible. The immediate priorities include shrimp domestication and health, disease prevention and control, and the development of better and environmentally friendly management systems. The consortium will promote human resource development and technology transfer and serve as an information centre. (Source: *INFOFISH International*, June 1997)

Viet Nam

Cai Lan

In order to sustain and further develop the booming economic growth in northern Viet Nam, the Government has decided to develop a new deep-water port at Cai Lan, located some 25 km north-east of the port of Haiphong. Cai Lan port is located in the well protected deep waters of Bai Chay Bay, which is connected to Ha Long Bay and the open sea by an 11-km navigational channel of 7.5 m depth and 105 m width.

In October 1997, Nippon Koei Co. Ltd., together with NEDECO (represented by HASKONING), was awarded the contract "Cai Lan Port Expansion Project" to provide

consultancy services. The contract comprises the design and reinforcement of existing berths, design and construction of new wharves, including onshore facilities and dredging of the navigation channel and port basin. The work includes feasibility study review, detailed design, tendering assistance, equipment procurement, supervision of construction, maintenance inspection and implementation of various training programmes. Construction is envisaged to commence in early 1999 and be completed early 2001. (Source: *The Dock & Harbour Authority*, January/February)

Yemen

Container terminal

Posford Duvivier were appointed by Yemen Investment and Development International Ltd. (Yeminvest) as designers of a new US\$ 190 million trans-shipment container terminal at Aden comprising 700 m of quay and 60 ha of reclamation.

The project forms part of the Aden Free Zone development for which Yeminvest are the sole and exclusive developer/concessionaire. The Free Zone and container terminal are located on the northern shore of the harbour.

The terminal is designed to accept the next generation of container ships, with provision for up to 16 m of water depth alongside the quay. The existing entrance channel will be dredged to -15.5 m initially to allow access to the largest container ships at all times.

The initial development, phase 1, includes 700 m of container berth, 28 ha of paved storage area, dredging of 11 m³ from the 6-km-long channel and 3-km-long harbour area to a depth of -15.5 m, offices, container freight station, workshops and other ancillary business, and improvements to the access causeway. The terminal is due to open in March 1999. (Source: *The Dock & Harbour Authority*, January/February 1998)

G. INTERNATIONAL NEWS

Search and rescue and GMDSS—an update

The development of worldwide, integrated systems to respond to shipping emergencies is being instituted through the implementation of the 1979 International Convention on Maritime Search and Rescue (SAR Convention) and the global maritime distress and safety system (GMDSS), contained in chapter IV of the International Convention for the Safety of Life at Sea (SOLAS), 1974, as amended in 1988.

GMDSS—which will become fully effective from 1 February 1999—is essentially a worldwide network of automated emergency communications for ships at sea. It means that all ocean-going passenger ships and cargo ships of 300 gross tonnage and upwards must be equipped with radio equipment that conforms to international standards as set out in the system. The basic concept is that search and rescue authorities ashore, as well as shipping in the immediate vicinity of the ship in distress, will be rapidly alerted, through satellite and terrestrial communication techniques, to a distress incident so that they can assist in a coordinated SAR operation with the minimum of delay.

The 1979 SAR Convention was designed to provide a global system for responding to emergencies and GMDSS was established to provide it with the efficient communication support it needs. Both GMDSS and SAR are crucial to the future of maritime safety; when both are fully operational, any emergency at sea will result in an automatic distress call and the response to that call will be immediate and effective. The days when a ship can vanish without trace should then be ended.

A major element of the SAR Convention is the implementation of regional search and rescue agreements. Under the Convention, the world's oceans were divided into 13 search and rescue regions and within each region individual countries have been working together to establish and delimit country-based search and rescue regions, so that, in the event of an incident, rescue efforts can be coordinated efficiently. A series of IMO-sponsored GMDSS and SAR conferences have been held in most of the various regions, and the global SAR network is expected to be completed by the end of 1998.

Table 1 provides an update of the status of SAR regions in each area.

Table 1. Global search and rescue regions

<i>Search and rescue area</i>	<i>Status of regional SAR plans*</i>
1. North Atlantic	Provisional search and rescue regions were finalized at an SAR and GMDSS conference in Lisbon, Portugal, in 1994.
2. North Sea	Provisional SAR plans have been completed for the region.
3. Baltic Sea	Provisional SAR plans have been completed for the region.
4. Eastern South Atlantic	Provisional SAR plans have been completed for the region.
5. Western South Atlantic	
6. Eastern North Pacific	Provisional SAR plans for the Pacific Ocean were agreed at the IMO Pacific Ocean Conference on Maritime SAR and GMDSS held in Seoul, Republic of Korea, in April 1997. This major conference involved participants from 33 Pacific Ocean IMO Member States plus two Associate Members.
7. Western North Pacific	
8. Eastern South Pacific	
9. Western South Pacific	
10A. North-West Indian Ocean	Provisional SAR plans for the entire Indian Ocean are expected to be completed at a conference to be held in Fremantle, Australia, in September 1998.
10B. South-West Indian Ocean	
10C. East Indian Ocean	
11. Caribbean	SAR plans have been completed for the region.
12A. Mediterranean	Provisional SAR plans were discussed at a conference held in Valencia, Spain, in September 1997. The limits of individual search and rescue regions are expected to be finalized through bilateral discussions.
12B. Black Sea	
13. Arctic Ocean	SAR plans not yet prepared.

*Provisional SAR plans are subject to alterations as may be deemed necessary following bilateral agreements between neighbouring States.

Revised SAR Convention

IMO's Maritime Safety Committee (MSC) adopted a revised annex to the SAR Convention during its 69th session. It is hoped that more governments will ratify the revised version, which will enter into force under tacit acceptance on 1 January 2000. At present, the 1979 SAR Convention has been ratified by 57 countries, representing less than 50 per cent of the world's fleet by tonnage.

Implementing GMDSS

GMDSS was introduced by means of amendments to SOLAS which were adopted in 1988 and entered into force on 1 February 1992. It will become fully operational by 1 February 1999. By that date Morse Code will be phased out and all passenger ships and all cargo ships of 300 gross tonnage and upwards on international voyages will be required to carry equipment designed to improve the chances of rescue following an accident, including satellite emergency position-indicating radio beacons (EPIRBs) and search and rescue transponders (SARTs) for the location of the ship or survival craft. (Source: *IMO News*, February 1998)

The IMO and international conventions

The industrial revolution of the eighteenth and nineteenth centuries and the upsurge in international commerce which resulted led to the adoption of a number of international treaties related to shipping, including safety. The subjects covered included tonnage measurement, the prevention of collisions, signalling and others.

By the end of the nineteenth century suggestions had even been made for the creation of a permanent international maritime body to deal with these and future measures. The plan was not put into effect, but international cooperation continued in the twentieth century, with the adoption of still more internationally developed treaties.

By the time IMO came into existence in 1958, several important international conventions¹ had already been developed, including the International Convention for the Safety of Life at Sea of 1948, the International Convention for the Prevention of Pollution of the Sea by Oil of 1954 and treaties dealing with load lines and the prevention of collisions at sea.

IMO was made responsible for ensuring that the majority of these conventions were kept up to date. It was also given the task of developing new conventions as and when the need arose.

The creation of IMO coincided with a period of tremendous change in world shipping and the Organization was kept busy from the start developing new conventions and ensuring that existing instruments kept pace with changes in shipping technology. It is now responsible for 35 international conventions and agreements and has adopted numerous protocols and amendments.

Adopting a convention

This is the part of the process with which IMO as an organization is most closely involved. IMO has six main bodies concerned with the adoption or implementation of conventions. The Assembly and Council are the main organs, and the committees involved are the Maritime Safety Committee, Marine Environment Protection Committee, Legal Committee and the Facilitation Committee. Develop-

ments in shipping and other related industries are discussed by Member States in these bodies, and the need for a new convention or amendments to existing conventions can be raised in any of them.

Normally the suggestion is first made in one of the committees, since these meet more frequently than the main organs. If agreement is reached in the committee, the proposal goes to the Council and, as necessary, to the Assembly.

If the Assembly or the Council, as the case may be, gives the authorization to proceed with the work, the committee concerned considers the matter in greater detail and ultimately draws up a draft instrument. In some cases the subject may be referred to a specialized sub-committee for detailed consideration.

Work in the committees and subcommittees is undertaken by the representatives of Member States of the Organization. The views and advice of intergovernmental and international non-governmental organizations which have a working relationship with IMO are also welcomed in these bodies. Many of these organizations have direct experience in the various matters under consideration, and are therefore able to assist the work of IMO in practical ways.

The draft convention which is agreed upon is reported to the Council and Assembly with a recommendation that a conference be convened to consider the draft for formal adoption.

Invitations to attend such a conference are sent to all Member States of IMO and also to all States which are members of the United Nations or any of its specialized agencies. These conferences are therefore truly global conferences open to all governments who would normally participate in a United Nations conference. All governments participate on an equal footing. In addition, organizations of the United Nations system and organizations in official relationship with IMO are invited to send observers to the conference to give the benefit of their expert advice to the representatives of governments.

Before the conference opens, the draft convention is circulated to the invited governments and organizations for their comments. The draft convention, together with the comments thereon from governments and interested organizations is then closely examined by the conference and necessary changes are made in order to produce a draft acceptable to all or the majority of the governments present. The convention thus agreed upon is then adopted by the conference and deposited with the Secretary-General who sends copies to governments. The convention is opened for signature by States, usually for a period of 12 months. Signatories may ratify or accept the convention while non-signatories may accede.

The drafting and adoption of a convention in IMO can take several years to complete although in some cases, where a quick response is required to deal with an emergency situation, governments have been willing to accelerate this process considerably.

Entry into force

The adoption of a convention marks the conclusion of only the first stage of a long process. Before the convention comes into force—that is, before it becomes binding upon governments which have ratified it—it has to be accepted formally by individual governments.

Each convention includes appropriate provisions stipulating conditions which have to be met before it enters into force. These conditions vary but, generally speaking, the more important and more complex the document, the more stringent are the conditions for its entry into force. For example, the International Convention for the Safety of Life at Sea, 1974, provided that entry into force requires

¹The vast majority of the treaty instruments adopted under the auspices of IMO are "Conventions". A few are called "Protocols" or "Agreements". The term "Convention" is used in this publication to refer to all such treaty instruments.

acceptance by 25 States whose merchant fleets comprise not less than 50 per cent of the world's gross tonnage; for the International Convention on Tonnage Measurement of Ships, 1969, the requirement was acceptance by 25 States whose combined merchant fleets represent not less than 65 per cent of world tonnage.

When the appropriate conditions have been fulfilled, the convention enters into force for the States which have accepted—generally after a period of grace intended to enable all the States to take the necessary measures for implementation.

In the case of some conventions which affect a few States or deal with less complex matters, the entry into force requirements may not be so stringent. For example, the Convention Relating to Civil Liability in the Field of Maritime Carriage of Nuclear Material, 1971, came into force 90 days after being accepted by five States; the Special Trade Passenger Ships Agreement, 1971, came into force six months after three States (including two with ships or nationals involved in special trades) had accepted it.

For the important technical conventions, it is necessary that they be accepted and applied by a large section of the shipping community. It is therefore essential that these should, upon entry into force, be applicable to as many of the maritime States as possible. Otherwise they would tend to confuse, rather than clarify, shipping practice since their provisions would not apply to a significant proportion of the ship they were intended to deal with.

Accepting a convention does not merely involve the deposit of a formal instrument. A government's acceptance of a convention necessarily places on it the obligation to take the measures required by the convention. Often national law has to be enacted or changed to enforce the provisions of the convention; in some cases, special facilities may have to be provided; an inspectorate may have to be appointed or trained to carry out functions under the convention; and adequate notice must be given to shipowners, shipbuilders and other interested parties so they may take account of the provisions of the convention in their future acts and plans.

At present IMO conventions enter into force within an average of five years after adoption. The majority of these instruments are now in force or are on the verge of fulfilling requirements for entry into force.

Amendment

Technology and techniques in the shipping industry change very rapidly these days. As a result, not only are new conventions required but existing ones need to be kept up to date. For example, the International Convention for the Safety of Life at Sea (SOLAS), 1960, was amended six times after it entered into force in 1965—in 1966, 1967, 1968, 1969, 1971 and 1973. In 1974 a completely new convention was adopted incorporating all these amendments (and other minor changes) and was itself modified (in 1978, 1981, 1983, 1988, 1990 and 1991).

In early conventions, amendments came into force only after a percentage of contracting States, usually two thirds, had accepted them. This normally meant that more acceptances were required to amend a convention than were originally required to bring it into force in the first place, especially where the number of States which are Parties to a convention is very large.

This percentage requirement in practice led to long delays in bringing amendments into force.

To remedy the situation a new amendment procedure was devised in IMO. This procedure has been used in the case of conventions such as the Convention on the International Regulations for Preventing Collisions at Sea, 1972, the International Convention for the Prevention of

Pollution from Ships, 1973, and SOLAS 1974, all of which incorporate a procedure involving the "tacit acceptance" of amendments by States.

Instead of requiring that an amendment shall enter into force after being accepted by, for example, two thirds of the Parties, the new procedure provides that an amendment shall enter into force at a particular time unless, before that date, objections to the amendment are received from a specified number of Parties.

In the case of the 1974 SOLAS Convention, an amendment to most of the annexes (which constitute the technical parts of the Convention) is "deemed to have been accepted at the end of two years from the date on which it is communicated to Contracting Governments ..." unless the amendment is objected to by more than one third of contracting governments, or contracting governments owning not less than 50 per cent of the world's gross merchant tonnage. This period may be varied by the Maritime Safety Committee with a minimum limit of one year.

As was expected the "tacit acceptance" procedure has greatly speeded up the amendment process. The 1981 amendments to SOLAS 1974, for example, entered into force on 1 September 1984. Compared to this, none of the amendments adopted to the 1960 SOLAS Convention between 1966 and 1973 received sufficient acceptances to satisfy the requirements for entry into force.

Enforcement

The enforcement of IMO conventions depends upon the governments of member parties. The Organization has no powers in this respect.

Contracting governments enforce the provisions of IMO conventions as far as their own ships are concerned and also set the penalties for infringements, where these are applicable.

They may also have certain limited powers in respect of the ships of other governments.

In some conventions, certificates are required to be carried on board ship to show that they have been inspected and have met the required standards. These certificates are normally accepted as proof by authorities from other States that the vessel concerned has reached the required standard, but in some cases further action can be taken.

The 1974 SOLAS Convention, for example, states that "the officer carrying out the control shall take such steps as will ensure that the ship shall not sail until it can proceed to sea without danger to the passengers or the crew".

This can be done if "there are clear grounds for believing that the condition of the ship and its equipment does not correspond substantially with the particulars of that certificate".

An inspection of this nature would, of course, take place within the jurisdiction of the port State. But when an offence occurs in international waters the responsibility for imposing a penalty rests with the flag State.

Should an offence occur within the jurisdiction of another State, however, that State can either cause proceedings to be taken in accordance with its own law or give details of the offence to the flag State so that the latter can take appropriate action.

Under the terms of the 1969 Convention Relating to Intervention on the High Seas, contracting States are empowered to act against ships of other countries which have been involved in an accident or have been damaged on the high seas if there is a grave risk of oil pollution occurring as a result.

The ways in which these powers may be used are very carefully defined, and in most conventions the flag State is

primarily responsible for enforcing conventions as far as its own ships and their personnel are concerned.

The majority of conventions adopted under the auspices of IMO or for which the Organization is otherwise responsible fall into three main categories.

The first group is concerned with maritime safety; the second with the prevention of marine pollution; and the third with liability and compensation, especially in relation to damage caused by pollution. Outside these major groupings are a number of other conventions dealing with facilitation, tonnage measurement, unlawful acts against shipping and salvage. (Source: *Focus on IMO*, October 1997)

New world organization in the making

A new global industry-oriented organization is being formed to represent aquaculture in the international arena dealing with issues like trade, public relations and the environment. The groundwork for the association was laid at the World Aquaculture Society's annual conference in Seattle in February 1997 when 56 people from 12 countries met and agreed on the need for such an organization. Likely to be called the "Global Aquaculture Alliance", the new association will probably be structured as a flexible collection of alliances of various species groups with an overall governing board consisting of the president and vice-president of each species group.

The organizing committee of the association met in Orlando, FL, and agreed that its functions would be to practise environmentally and socially responsible aquaculture production and respond to world demand for increasing volumes of safe and wholesome aquaculture products. The association will promote effective, coordinated policies for international trade and government regulation and improve production and marketing efficiencies to provide aquaculture products to larger segments of the world's population. It will also articulate the importance of aquaculture as a source of food and employment, and its compatibility with communities and the environment.

Meanwhile, work has begun on the first GAA Code of Practice—that pertaining to shrimp aquaculture in relation to coastal mangrove forests. The work is the first step in GAA's long-term goal of developing a comprehensive set of standards to further environmentally acceptable aquaculture.

Further information may be obtained from acting chairman George Chamberlain, Director of Aquaculture, Ralston Purina International, Checkerboard Square, 11 Tower Building, St. Louis, MO 63164, USA. Fax: +1-314 982 1613. (Source: *INFOFISH International*, March 1997)

Fish log age daily?

Every year, French IFREMER fisheries research teams analyse more than 40,000 samples of the 17 main commercial fish species (anchovies, cod, whiting, hake, saithe, angler, etc.) as well as scallops. The extension of fisheries activities to the deep oceans has generated specific research on two target species, the emperor and the grenadier. Fish age is usually estimated through the analysis of otoliths, i.e. small calcium carbonate growths in the inner ear which present daily and seasonal marks of both internal and physical fluctuations, thus enabling the identification of life cycles as well as ephemeral phenomena such as pollution and climatic anomalies. The recent discovery of daily marks, using a high-powered electron or photon microscope, greatly increases research possibilities, notably in tropical species which are not subjected to seasonal changes. Methodologically, the study also establishes international standards for analyses and new software for the estimation of fish age as well as new techniques for decoding chemical data.

External tagging operations, combined with the injection of fluorochrome, a non-toxic colouring substance, are an integral part of some IFREMER studies. This is then followed by an examination of otoliths and vertebrae. Three tagged fish have so far been recovered, including a complete individual found in the stomach of another fish! Fishermen who manage to retrieve tagged fish can earn a FFr 200 (\$36.81) reward for their vigilance, reports *Seafood International*. (Source: *INFOFISH International*, June 1997)

United Nations Fish Stocks Agreement

The United Nations Fish Stocks Agreement, negotiated two years ago to set new standards for managing fish stocks in a sustainable manner, is yet to become effective as only 15 fishing nations have signed and ratified the treaty. Although 59 nations have signed the agreement, the landmark treaty needs 30 countries to ratify it before it can be enforced, while 8 of the top 20 fishing nations have not even signed. Among the 15 nations that have ratified the agreement only 4 countries are among the top 20 fishing nations, i.e. USA, Russia, Norway and Iceland, while the 8 countries among the top 20 that have not signed are: Chile, Peru, India, Thailand, North Korea, Mexico, Malaysia and Viet Nam.

The World Wide Fund for Nature (WWF) has urged the United Nations General Assembly to reactivate and speed up the process to enforce the agreement. It needs to seek the active commitment of all concerned nations to accordingly sign and ratify the agreement.

Overfishing and inadequate management of resources have pushed many fish species to an all-time low, while fishing fleets would continue to over-exploit the high seas with little or no control.

The United Nations agreement requires fishing nations to adopt the precautionary approach which places conservation before exploitation. It also requires nations to cooperate with each other and regional organizations in managing fisheries, promote the use of non-destructive fishing gear, opens fisheries management bodies to public scrutiny and has a mechanism to avoid conflicts in fisheries. (Source: *INFOFISH International*, February 1998)

AQUA 2000: major event of the next millennium

From 2-6 May 2000, the city of Nice on the Mediterranean Coast of France will be host to the first major aquaculture event of the third millennium, dubbed AQUA 2000. Building on several decades of experience in organizing major aquaculture conferences and exhibitions, the world Aquaculture Society (WAS) and the European Aquaculture Society (EAS) are combining their annual meetings for the year 2000 to create a landmark event to mark the beginning of the new millennium.

Members of WAS are familiar with its annual meetings, which attract several thousand participants and provide the main international showplace for aquaculture equipment, aquafeeds and health management tools, and services to an industry set to expand threefold within the next 40 years. The society held a highly successful meeting in Bangkok in 1996 (World Aquaculture '96) and plans to return to Asia for its annual meeting in 2002. It has major events lined up in Las Vegas in 1998, Sydney in 1999 and Nice in 2000. EAS also brings extensive experience in organizing major aquaculture events into its collaboration with WAS for AQUA 2000. EAS conducted successful meetings in 1996 in Martinique (jointly with WAS), Budapest, Verona and Trondheim.

The central theme for AQUA 2000 will be "Responsible Aquaculture in the New Millennium". While the conference will have several concurrent sessions to provide a full-spectrum coverage of the interests and concerns of

aquaculturists, there will be a special session running throughout the conference on the central theme. It is intended to invite speakers of international repute to participate in this thematic session and, together with the chairmen of the concurrent sessions, to draw up recommendations for the future development of aquaculture. FAO has been invited to take a major role in the organization of this session. FAO participation in this major aquaculture event of the third millennium will be particularly appropriate, since its pioneering work in organizing the FAO Technical Conference on Aquaculture in Kyoto, Japan, a quarter of a century ago set the scene for the international explosion in aquaculture production which has since occurred. (Source: *INFOFISH International*, January 1998)

Eco-labels for fish

Fish products will soon carry "environmentally friendly" labels certifying that they have come from "sustainable" fisheries, under a major global project initiated by Marine Stewardship Council (MSC), to harness consumer power to conserve fish stocks. The project has been initiated by MSC, which started in 1996 as a conservation partner with the World Wide Fund for Nature (WWF) and Unilever, a major frozen fish producer, and is now an independent organization. The MSC is seeking the widest possible involvement from individuals and organizations, committed to seeking new solutions to the challenges faced by marine fisheries and securing the future of these important resources. Its new chairman, The Rt. Hon. John Gummer MP, former UK Secretary of State for the Environment and Minister of Agriculture, Fisheries and Food, will be at the vanguard of this initiative. The proposed scheme aims to give consumers the opportunity to select fish and fish products bearing "eco-labels" certifying that they have come from sustainable fisheries. This extends to human consumption fisheries, the joint action by WWF and Unilever which led to the latter being joined by other major producers banning products derived from the catch of North Sea industrial boats.

A former fisheries expert with OECD, Carl-Christian Schmidt, was recently appointed manager of the new project. According to Mr. Schmidt the project is purely voluntary and stressed that MSC is an independent, non-profit-making, non-governmental body. It will establish a broad set of principles for sustainable fishing and set standards for individual fisheries. Only fisheries meeting these standards will be eligible for certification by independent, accredited certifying firms appointed by MSC. Products from certified fisheries will eventually be marked with an on-pack logo allowing consumers to select those fish products which come from a sustainable source. (Source: *INFOFISH International*, February 1998)

Imports from approved countries only

The European Commission decided on 22 April 1997 that after 1 July 1998 fishery products from only authorized countries can be imported into the EU. The original list has been revised by the EC on 6 November 1997 and at present it covers 28 "EC harmonized" countries. The names of approved countries are: Albania, Argentina, Australia, Brazil, Canada, Chile, Colombia, Ecuador, Faroe Islands, Gambia, Indonesia, Ivory Coast, Japan, Madagascar, Malaysia, Morocco, Mauritania, New Zealand, Peru, Philippines, Russian Federation, Senegal, Singapore, South Africa, Republic of Korea, Taiwan, Thailand and Uruguay.

Apart from the above approved countries, the EC has determined that imports can also be authorized from "provisionally approved countries" for which each EU member state can impose its own specific import conditions. Each EU member state can have its own list of approved

establishments from the 27 provisionally approved countries, which may differ from one member state to another. (Source: *INFOFISH International*, March 1998)

EU fish ban slammed

The EU ban on fresh fish imports from several eastern African countries, imposed in December 1997 has been severely criticized by the United Nations Food and Agriculture Organization of the United Nations (FAO). The ban on imports from Tanzania, Uganda, Kenya and Mozambique, imposed because of an epidemic of cholera affecting these states, is regarded by FAO as not an appropriate action. The EU should instead call for improvements in hygiene, safe water supply, processing and storage.

The EU has been the main market for these countries and their fish exports totalled about 55,000 mt worth US\$ 250 million in 1996. While the EU currently requires frozen fish products from eastern Africa to be checked at ports of entry to control possible microbial contamination, FAO maintains that microbiological testing of end-products has serious limitations as a control option. It also claims that banning fish products from affected countries will not prevent the transmission of cholera, and the World Health Organization has not documented any significant outbreak of cholera from commercial food trade.

While the EU action is condemned as inappropriate, FAO on the other hand called on the affected fish exporting countries to upgrade landing, processing and storage facilities to deal with food safety problems. (Source: *INFOFISH International*, March 1998)

Shipboard garbage management plans made compulsory

From 1 July 1998, all ships of 400 gross tonnage and above and every ship certified to carry 15 persons or more will have to carry a garbage management plan, to include written procedures for collecting, sorting, processing and disposing of garbage, including the use of equipment on board. The garbage management plan should designate the person responsible for carrying out the plan and should be in the working language of the crew.

The regulation is important because it requires ship operators to track their garbage and take notice of what happens to it.

Garbage is covered by Annex V of the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 (MARPOL 73/78), which entered into force on 31 December 1988. The most important features of the Annex are the total prohibition of the disposal of plastics anywhere into the sea, and severe restrictions on discharges of other garbage from ships into coastal waters and "special areas". The Annex also obliges Governments to ensure the provision of facilities at ports and terminals for the reception of garbage.

Garbage includes all kinds of food, domestic and operational waste, excluding fresh fish, generated during the normal operation of the vessel and liable to be disposed of continuously or periodically.

In accordance with regulation 9 of Annex V, which was adopted on 14 September 1995, all ships of 400 gross tonnage and above and every ship certified to carry 15 persons or more, and every fixed or floating platform engaged in exploration and exploitation of the seabed, must provide a Garbage Record Book to record all disposal and incineration operations. The date, time, position of ship, description of the garbage and the estimated amount incinerated or discharged must be logged and signed. The books must be kept for a period of two years after the date of the last entry.

Administrations may exempt fixed or floating platforms while engaged in exploration and exploitation of the seabed from providing a Garbage Record Book.

Regulation 9 of Annex V of MARPOL 73/78 came into force for new ships from 1 July 1997, but from 1 July 1998 all applicable ships built before 1 July 1997 also have to comply.

Every ship of 12 m or more in length must also display placards notifying passengers and crew of the disposal requirements of the regulation; the placards should be in the official language of the ship's flag State and also in English or French for ships travelling to other States' ports or offshore terminals.

MEPC/Circ. 317 gives guidelines for the development of garbage management plans and an appendix to Annex V of MARPOL gives a standard form for a Garbage Record Book. (Source: *IMO News*, February 1998)

ISM Code becomes mandatory

The International Safety Management (ISM) Code becomes mandatory on 1 July 1998 for all tankers, bulk carriers, gas carriers, passenger ships and cargo high-speed craft of 500 gt and above. It will be extended to other ships in 2002.

The Code was made mandatory by means of amendments to the International Convention for the Safety of Life at Sea (SOLAS), 1974, which were adopted in 1994.

SOLAS has been accepted by 135 States whose combined fleets of merchant shipping represent more than 98 per cent of world tonnage. Administrations and shipping companies were given four years in which to make the preparations necessary to implement the Code.

The ISM Code will have a major impact on management and will require shipping companies to make considerable changes to their company structures. It has been generally welcomed because it emphasizes the role of sound management in safety and pollution prevention and will compel the operators of sub-standard ships to improve their ships and management systems.

Many Governments have already announced that they will implement the Code rigorously, which means that ships without the necessary certification could be barred from entry into foreign ports. Many protection and indemnity clubs have said that they will regard compliance with the Code as a condition of cover. (Source: *IMO News*, February 1998)

Committee agrees to ban toxic antifouling paint

The Committee agreed to draft mandatory regulations to phase out and eventually prohibit the use of toxic antifouling paints containing organotin compounds such as tributyltin (TBT). It instructed a working group to draw up draft regulations to effect the phasing out of organotins as antifoulants and propose a time schedule for their prohibition.

Antifouling paints are used to coat the bottoms of ships to prevent sea-life such as algae and molluscs attaching themselves to the hull—thereby slowing down the ship and increasing fuel consumption. In the early days of sailing ships, lime and later arsenic was used to coat ships' hulls, until the modern chemicals industry developed effective antifouling paints using metallic compounds.

The compounds slowly "leach" into the seawater, killing barnacles and other marine life that have attached to the ship—but studies have shown that these compounds persist in the water, killing sea-life, harming the environment and possibly entering the food chain. One of the most effective antifouling paints, developed in the 1960s, contains TBT, which has been proven to cause deformations in oysters and sex changes in whelks.

The working group will also prepare a draft Assembly resolution, for adoption at the 21st Assembly in 1999, which would urge Member States to encourage the use of alternatives to organotin antifouling systems pending the entry into force of a mandatory instrument.

The harmful environmental effects of organotin compounds were recognized by IMO in 1990, when the MEPC adopted a resolution which recommended that Governments adopt measures to eliminate the use of antifouling paint containing TBT on non-aluminium-hulled vessels of less than 25 m in length and to eliminate the use of antifouling paints with a leaching rate of more than 4 µg of TBT per day. Some countries, such as Japan, have already banned TBT in antifouling paint for most ships.

Alternatives to TBT paint include copper-based coatings and silicon-based paints, which make the surface of the ship slippery so that sea-life will be easily washed off as the ship moves through water. Further development of alternative antifouling systems is being carried out. Underwater cleaning systems avoid the ship having to be put into dry dock for ridding the hull of sea-life, while ultrasonic or electrolytic devices may also work to rid the ship of foulants.

Options for a mandatory legal instrument to prohibit organotins in antifouling paint include adopting a new annex to the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 (MARPOL 73/78). (Source: *IMO News*, February 1998)

Harmful aquatic organisms in ballast water

An MPEC working group on ballast water reported progress in developing draft new regulations for ballast water management. It is intended to include these in a new annex to MARPOL, to be adopted at a conference provisionally scheduled for the year 2000. Implementation guidelines for the proposed annex are also being developed, which are expected to be included in a code related to the new annex.

The proposed new Annex VII is aimed at addressing the environmental damage caused by the introduction of unwanted aquatic organisms in ballast water, used to stabilize vessels at sea. Globally, it is estimated that about 10 billion tonnes of ballast water are transferred each year.

The water taken on board for ballasting a vessel may contain aquatic organisms, including dormant stages of microscopic toxic aquatic plants—such as dinoflagellates, which may cause harmful algal blooms after their release. In addition, pathogens such as the bacterium *Vibrio cholera* (which causes cholera) have been transported with ballast water. As ships travel faster and faster, the survival rates of species carried in ballast tanks have increased. As a result, many introductions of non-indigenous organisms in new locations have occurred, often with disastrous consequences for the local ecosystem—which may include important fish stocks or rare species.

The MEPC approved a questionnaire to be sent to Member States to obtain information on current domestic laws and regulations on ballast water management. It is intended that the new internationally binding regulations would avoid a situation whereby individual governments adopted their own rules to prevent contaminated ballast water affecting their local ecosystems. Meanwhile, the MEPC noted the different options for introducing the proposed regulations. The new annex to MARPOL, as originally proposed, could be adopted via a Protocol to add a new annex to MARPOL 73/78, or it could be adopted as a new annex via amendments to MARPOL 73/78, a simpler process. Another option is for a diplomatic conference to adopt a new convention on ballast water management, under

which the terms for entry into force would be determined by the conference, instead of having to comply with existing entry-into-force terms established by MARPOL 73/78. The MEPC agreed to consider a legal framework for the new regulations at its next session. (Source: *IMO News*, February 1998)

IMO acts to combat piracy

IMO is to send expert missions to selected countries to discuss the prevention and suppression of piracy and armed robbery against ships. The missions will be followed by regional seminars planned to be held for selected countries in South-East Asia, South and Central America, West Africa and the Indian Ocean.

The overall aim is to find measures to reduce the number of attacks reported each year through promoting regional cooperation. In 1997, a total of 252 piracy attacks were reported to IMO, an increase of 24 over the figure for 1996.

IMO first addressed the problem of modern piracy in 1983, after a number of Member Governments and international organizations expressed concern about the increasing incidents of piracy and armed robbery against ships in some ports of the world. At the time, IMO adopted a resolution on measures to prevent acts of piracy and armed robbery against ships, which urged Governments to take, as a matter of the highest priority, all measures necessary to prevent and suppress acts of piracy and armed robbery against ships in or adjacent to their waters. Member Governments were also requested to inform IMO of all attacks that occurred.

Since 1984, the total number of reported incidents or piracy has risen steadily. The Malacca Strait and South China Sea remain problem areas, although the number of attacks in the region, reported to IMO, fell to 109 in 1997 compared with 133 in 1996. However, increased numbers of attacks have been reported in the Indian Ocean area (41 attacks in 1997, up from 30), East Africa (11, up from 7), West Africa (30, up from 21), South America (45, up from 32) and the Mediterranean and Black Sea (11, up from 4).

Most of the attacks worldwide were reported in territorial waters while the ships were at anchor or berthed. In many of the reports received, the crew were violently attacked by groups of five to ten people carrying guns.

The planned missions organized by IMO follow consultations with the Governments of the countries concerned, and it is intended that the experts involved will, alongside national experts, assess the problem and look at how IMO recommendations and guidelines on dealing with piracy and unlawful acts can be applied.

The regional seminars will be aimed at assisting governments and officials in the countries concerned to enhance their capability for preventing and suppressing piracy attacks in their waters. (Source: *IMO News*, February 1998)

West and Central African nations agree to establish port state control regime

Nineteen West and Central African nations have agreed to work towards establishing a port state control (PSC) regime in the shortest possible time in order to eradicate sub-standard ships from the region.

The nations, at a meeting in Accra, Ghana held from 17 to 20 February 1998, agreed on a preliminary draft text of a Memorandum of Understanding (MOU) and a draft training

programme. They also agreed to make every effort to put in place competent maritime administrations where they do not already exist, and to strengthen existing maritime administrations, in order to implement an effective PSC regime.

Representatives from Angola, Benin, Cameroon, Cape Verde, Congo, Côte d'Ivoire, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Equatorial Guinea, Liberia, Mauritania, Namibia, Nigeria, Senegal, South Africa and Togo signed a joint declaration on establishing the PSC regime following the First Preparatory Meeting on the Development of Flag and Port State Capabilities in the West and Central African Region. Also present were representatives from IMO, the International Labour Organization, the United Nations Development Programme, the Economic Commission for Africa, the International Association of Classification Societies, the International Transport Workers Federation, the Communauté Economique et Monétaire de l'Afrique Centrale and other regional organizations.

The meeting follows the successful establishment of other regional PSC agreements in different parts of the world. The first was established by the Paris in 1982 and since then others have been formed in Asia and the Pacific, Latin America, the Mediterranean and the Caribbean. The First Preparatory Meeting towards establishing a PSC regime in the Indian Ocean was held in October 1997.

The Accra meeting agreed to consider in detail the draft MOU, and to discuss the location of a Secretariat and Information Centre, at a Second Preparatory Meeting to be held during September 1998 in Guinea. A third and final meeting during 1999 is expected to adopt the agreement.

With the planned adoption of the Indian Ocean MOU in June 1998 and the West and Central African MOU in 1999, most of the world's oceans will soon be covered by a global network of regional port State control agreements. Countries in the Persian Gulf region have agreed informally on the need to establish a similar regime, but no date has yet been set for a first preparatory meeting.

PSC is seen as a crucial step towards the eradication of sub-standard ships. In effect, by allowing the inspection of foreign-flagged vessels, it can act as a safety net when shipowners, classification societies, insurers or flag State administrators have in one way or another failed to do their job. (Source: *IMO News*, February 1998)

Neptune

However many research projects are carried out, they are valueless until the new knowledge is applied in practice. How can the gap between research and development and implementation be bridged?

One answer is NEPTUNE, the Association of European Maritime Research Institutes, which was developed under an initiative from the European Commission's Directorate-General for Transport (DGVII), which is also providing initial financing.

NEPTUNE was established to create a network of European universities and research institutes engaged in research, training and education in the area of waterborne transport. This network will create a framework for cooperation between these institutions and for organized knowledge transfer to users, particularly to small and medium-sized enterprises.

For more information about the work of NEPTUNE or to enquire about membership, please contact the NEPTUNE Office, Maritime House, 68 Avenue Michel Ange, 1000 Brussels, Belgium. Tel.: +32-2-742 9637; Fax: +32-2-736 6325. (Source: *IMO News*, February 1998)

EC proposes new fast ferry safety measures

The European Commission has proposed that member states "shall ensure by means of inspection that all passenger ferries and high-speed craft operating out of and into ports of the European Union should apply the international safety rules laid down by the International Maritime Organization".

As the EC points out, "The proposal, which must be approved by the European Council of Transport Ministers and the European Parliament to become law, marks an important departure from the current practice, whereby it is only the flag state that is responsible for issuing safety certificates and conducting accident enquiries (although specific requirements in the national law of some countries override this general provision)."

According to the EC, "The proposed legislation establishes a safety regime that is common to all Ro-Ro ferries and high-speed passenger craft sailing regularly to or from EU ports, irrespective of the flag they fly. Before launching a regular service, operators must fulfil a range of strict safety conditions affecting the integrity of the ship and its equipment.

"In addition, vessels would have to be fitted with a voyage data recorder that records information in case of accident. Companies would also have to ensure that the ship's master is provided with appropriate information of shore based navigational guidance systems and other information schemes to assist him.

"Other requirements include:

- A guarantee by the company that the master may, especially in severe weather and heavy seas, take any action which in his professional judgement is necessary for safe navigation and operation.
- A record of navigational activities and incidents is to be kept by the master.
- Prompt reporting to both the flag state administration and the host state of any damage or deficiencies to shell doors.
- An up-to-date voyage plan is to be made available before the departure of the ship.
- A general information scheme about the service and assistance to elderly and disabled persons is to be made known to passengers.

"The proposal also foresees a regime for verifying and inspecting compliance with all conditions, including operational conditions, for Ro-Ro passenger ships and high-speed passenger craft prior to their entry into service and then at regular intervals.

"Another important provision of the draft legislation is that it ensures the participation of host member states in any investigation of maritime accidents or casualties.

"At present, under international law, the responsibility for accident investigation falls exclusively on the flag state of the vessel concerned when an accident occurs outside territorial waters." (Source: *Fast Ferry International*, April 1998)

Leading multinationals vote confidence in Asia

Results released of a worldwide survey of leading multinational companies find that overall confidence in East and South-East Asia as a destination for foreign direct investment (FDI) remains unshaken, despite the financial crisis in the region.

One in four of the companies polled said it plans to increase direct investments over the short and medium term, while 62 per cent are continuing with their existing plans. Almost all firms covered by the survey make a positive long-

term assessment, taking the view that direct investment prospects are either unchanged (81 per cent) or have improved (13 per cent).

The results are based on replies from 198 firms of 500 polled—an impressive response rate of 40 per cent—in a joint survey by the United Nations Conference on Trade and Development (UNCTAD) and the International Chamber of Commerce (ICC). The survey was conducted in mid-February 1998.

Announcing the outcome of the survey at a news conference on 18 March, UNCTAD Secretary General Rubens Ricupero said: "The results clearly show that multinational corporations are keenly interested in the region for direct investment in the production of goods and services. This augurs well for recovery in the region."

ICC Secretary General Maria Livanos Cattai said: "This is a resounding vote of confidence in the economic fundamentals of East and South-East Asia and the region's long-term prospects. Business still sees enormous investment opportunities to be derived from the projected growth of Asian markets in the 21st century."

Responses are remarkably consistent, both by main business sectors and also by home regions—Europe, North America, Japan and developing Asia. An overwhelming majority of respondents from each of the regions and the main sectors—primary, manufacturing and services—report that their long-term views remain unchanged.

Among European firms in particular, 34 per cent are actively seeking to increase their operations in Asia. The comparable figures for North America and Japan are 19 per cent each, and 10 per cent for developing Asian countries. Karl P. Sauvart, senior UNCTAD investment expert, said: "In the short and medium term, lower costs for multinationals in the most affected countries—including the effect of devaluations—create immediate incentives for additional direct investment. They also open up additional export opportunities, helped by the privileged access to the regional and global distribution networks of their parent firms."

Mr. Sauvart added: "Most important, however, is that the principal determinants for direct investment in Asia ensure that long-term prospects for such investment in the region remain excellent."

At the same time, he noted that a contraction in growth would reduce demand in some Asian domestic markets. In the short to medium term, that could slow down inward flows of FDI to industries oriented to domestic markets.

This is borne out by the UNCTAD/ICC survey, which shows that 12 per cent of all responding companies intend to reduce one or more of their investment projects over the short and medium term. For service companies, which in most cases are heavily dependent on domestic sales, the comparable figure is 18 per cent. Looking at the long term, only 6 per cent of companies indicate that their confidence in FDI profitability in Asia has diminished.

Another finding is that the direct investment intentions of most Asian firms will remain focused in Asia itself. The crisis is likely to restrict the financial ability of some of these companies to invest abroad. Devaluations make it more expensive for firms from the most affected countries to finance their foreign operations.

The survey further showed that—independently of their continuing commitment to Asia—37 per cent of the firms consulted contemplate increasing direct investments in Latin America. Some 27 per cent look to increased FDI to Central and Eastern Europe, while 18 per cent expect to step up their direct investments in South Asia.

"Emerging markets in general continue to be viewed by large multinationals as good prospects for FDI. This is in line with a trend that began in the mid-1980s and has led to developing countries now attracting close to 40 per cent of the world's direct investment flows of some \$350 billion," Mr. Sauvant commented.

ICC Secretary General Cattani said that the survey underlined a key distinction between the reactions of direct investors and those of portfolio investors and banks, whose decisions about international financial capital movements have so far been the centre of attention during the Asian crisis.

UNCTAD figures show that, while foreign portfolio equity investment and bank lending to the most affected Asian countries reversed direction during the latter half of 1997, flows of FDI to the region are estimated to remain close to pre-crisis levels.

UNCTAD Secretary General Ricupero pointed out that direct investment flows have a moderating effect on the volatility of total private capital flows.

The complete analysis of the survey is contained in a background note which can be obtained from UNCTAD or ICC. The analysis, together with the accompanying press release, is also published on the ICC and UNCTAD Web sites: www.iccwbo.org and www.unctad.org (Source: *PORTS AND HARBORS*, June 1998)

ESPO welcomes EC's Green Paper on Ports

The European Sea Ports Organisation (ESPO) has welcomed the European Commission's Green Paper on Sea Ports and Marine Infrastructure, its exposure of the issues facing ports and its acknowledgement of their vital role to the EU.

In its response published on 12 March 1998, ESPO has said that where public funding is seen as being necessary, it must be transparent. Guidelines should also be put in place as to where aid is permissible.

This is one of the key issues. The degree of state aid to individual ports must be made public to ensure fair and undistorted competition.

In welcoming the preparation of the Green Paper, ESPO says the quality of the performance of Europe's ports can influence the whole transport chain and with it the economy of the European Community.

ESPO also supports the paper's proposals to promote intermodal transport, including short sea shipping and the simplification of controls and procedures, provided that they do not unfairly distort competition between modes. It emphasizes that ports and port services should not just be seen as an integrated part of the maritime transport system. As the predominant link in intermodal transport, the ports' comprehensive involvement in transport logistics must be taken into account in any policies that might emerge. (Source: *PORTS AND HARBORS*, May 1998)

Future for krill

The Food and Agriculture Organization of the United Nations (FAO) has identified krill as the largest single untapped source of harvestable marine protein, for aquaculture feed, human consumption and, potentially, pharmaceutical products. "Krill fisheries have a great potential to increase the world's harvest from the oceans", but "they also have a considerable potential to cause unpredictable harm to marine ecosystems", says FAO in a report, *Krill Fisheries of the World* by Stephen Nicol of Australia and Yoshihari Endo of Japan. It states that there will be greater emphasis on fishing for species such as krill from both inshore areas and

distant waters such as Antarctica. "Developments in food technology may result in more rapid cost-effective forms of krill for human consumption", and in the near future krill harvest may become economical, claim the authors. (Source: *INFOFISH International*, January 1998)

Worst El Niño for 150 years

Peruvian and Chilean fishermen who used to catch about 9 to 12 million mt of anchovies between 1967 and 1991, are now in for bad times. The abundance of anchovy resources is now said to have disappeared, due to the climatic phenomenon El Niño. This warm water temperature around the west coast of South America is reported to have driven away anchovies to cooler waters. In 1972, due to El Niño, anchovy catches dropped to only 4.5 million mt compared to 12 million mt in 1971. In 1982 catches dropped from 3.2 million mt to 1.3 million mt in 1983. However in 1994 the catches reached the 10 million mt level. El Niño experts agree that the climatic change takes place every 2 or 3 years and it is especially strong every 11th or 12th year, and this time around it is expected to be the worst in 150 years. The threat of the El Niño is expected to severely affect the feed manufacturing sector and fish-farming activities with high feed costs around the world. (Source: *INFOFISH International*, January 1998)

Exports face stiff challenge

Recent changes in quality control demands are posing a stiff challenge for fishery products exporters in developing countries, according to FAO.

FAO posted the warning in a study it prepared for a recent meeting of the Sub-Committee on Fish Trade in Bremen, Germany, attended by representatives from 60 countries and several international organizations. The meeting took place against the background of last year's import embargoes by the EU on seafood from India, Bangladesh and Madagascar, and on fresh seafood from four east African countries.

The impact of these measures was severe on the seafood industry of the exporting countries, creating loss of employment and foreign exchange earnings of several hundreds of millions of US dollars.

The investments needed to upgrade a fish processing plant to the new standards are substantial, and many companies feel that the implementation of the new regulations on fishery products is de facto a non-tariff measure against value-added products from developing countries.

FAO fisheries expert Erhard Ruckes added that schemes such as certification of fish products could erect another barrier to trade. "There is a danger that small-scale fishermen in developing countries may be disadvantaged by difficulties to certify their fish production", he said, adding that net exports of fish products by these countries rose from US\$ 5.2 billion in 1985 to US\$ 17.2 billion in 1996. (Source: *INFOFISH International*, June 1998)

Seafood shortage expected in 2010

In the year 2010, global demand for seafood could outpace supply by 10-40 million mt, according to an FAO estimate. FAO estimates that demand for seafood in 2010 will be 110-120 million mt. In 1996 worldwide seafood productions stood at 90 million mt. With wild fisheries levelling off during the past 10 years, growth in seafood production came almost completely from aquaculture. FAO says with better management of the oceans there is room for growth in wild fisheries. Amongst other things, it says fishing capacity should be reduced, offshore fleets must be

controlled and limit state subsidies. This would allow 60-70 per cent of world fish stocks in trouble to rebuild for future harvest. (Source: *INFOFISH International*, June 1998)

Fish, pigs and poultry

The Pacific waters bordering Chile and Peru teem with fish, especially the jack mackerel. Chilean fishermen catch them in huge quantities, but mackerel are the sort of fish that are financially unrewarding to process for human consumption, or make ready for export purposes. As a result, the fish are caught and processed mainly as fish-meal, and Chile is one of the largest producers and exporters of fish-meal in the world. The high protein level of fish-meal makes it a perfect additive for pig and poultry food. In 1995, Chile produced over 1.2 million tonnes of fish-meal, accounting for over 4 per cent of the country's total exports. But processing of fish-meal has its down side. Because over half of the production is concentrated in Chile's region VIII, centred at Concepción, 600 km south of Santiago, the three bays in the area are forced to accept over 65,000 tonnes of chemical oxygen demand annually, contributing to considerable environmental degradation.

Methods of processing vary, but essentially the procedure is to unload the fish using centrifugal pumps, grinding, cooking by steam injection, pressing in continuous screw-type apparatus, heat drying and packaging. This is followed by separating the oil from suspended protein material and is completed by evaporating it (the product is now called "stick water") and returning it to the drying process. Government legislation to protect the environment meant action was necessary to reduce the organic effluent to meet the proposed standards, and UNIDO was given additional funds early in 1995 to cooperate with the University of Concepción in a joint project to investigate the possibilities for waste minimization and greater processing efficiency. UNIDO's consultants studied the problem and advised the University of the options available and directed the orientation of the changes that were necessary.

A new system using vacuum pumps for unloading the fish was introduced, which resulted in less damage and less organic waste. A switch to a new drying system with indirect heat, and the installation of processes to recover solid organic waste, recycling it and incorporating it into the centrifuge, evaporation and drying process all contributed to reducing chemical oxygen demand from 31.5 kg per tonne of fish processed to 6.4 kg per tonne, while fish-meal yields increased a the same time by 4 per cent. Tests are still under way to see if after the remaining organic matter in the water has been treated, the water can be fed back into the system. Methane produced by the digestion of the matter could also be utilized, and preliminary results indicate that an 80 per cent reduction in the chemical oxygen demand as a result of recycling raw materials that would otherwise have been discarded should have a significant and positive impact on the local environment. For more information regarding this document please contact: UNIDO Public Information— unido-pininfo@unido.org (Source: UNIDO, 7 March 1997)

Safety at sea—saving Africa's fishermen

Subsistence fishermen all over the world risk their lives every day trying to feed their families. A team of specialists at the Vienna-based United Nations Industrial Development Organization (UNIDO) is devising a scheme to help save fishermen from storms off the East African coast. Based on experience gained in Asia, UNIDO will design simple technology for early warning systems and make them available to African fishermen.

"This is the beginning of a project similar to one in South-East Asia where we were struck by the huge loss of life amongst fishermen", explains Cahit Guerkok. As in South-East Asia, the East African coast is also subject to sudden typhoon-level storms. "Even in perfect conditions these people are in danger. Just by leaving their village, they are taking a risk", he adds.

In a three-pronged approach, UNIDO will work with local meteorological bureaux, with shore-based broadcasters and even commercial broadcasting systems. And the fishermen will be supplied with a simple pager or receiver to warn them of oncoming storms.

The Asian project took off shortly after a violent storm had claimed over 1,000 lives, so it was not difficult to convince fishermen to carry the new device. Cahit Guerkok says that winning the confidence of the local people and their support is crucial to the project's success.

Although the receivers will probably be solar-powered and incorporate the simplest possible technology, UNIDO donor countries will still have to provide them to the fishermen. But as the project is looking at the fishing industry as a whole it means more than saving lives. After introducing improvements in early warning and rescue methods, UNIDO teams will help improve boat building techniques, equipment and engine maintenance in a project spread over a number of years that could eventually help other fishermen off the African coast.

"Increased safety means increased efficiency and productivity and it will help increase food production", Cahit Guerkok says. "From our point of view, solving engineering and technology problems can no doubt have a commercial and business dimension for these people. When they are catching more than they need, the commercial aspects will come into play, including processing of the fish."

Although UNIDO, a United Nations specialized agency, is primarily concerned with promoting industrialization through technology dissemination, it also develops human resources by involving local people and training them to pass on their knowledge and skills.

Provided a cheap receiver can be produced, the initial early warning system could come into effect within six months.

According to Guerkok, UNIDO can learn a lot from this type of project. You have to deal with the target beneficiary. You have to go to the field and break the resistance. There, I think, one not only realizes how important this issue is, but also how important it is to be patient and promote the actual use of equipment. You achieve your target when the fishermen are using the equipment and saving their lives by doing so". For more information regarding this document please contact: UNIDO Public Information—unido-pininfo@unido.org (Source: UNIDO, 7 March 1997)

Seafood imports from developing countries

There is an entire section in the Hazard Analysis and Critical Control Points (HACCP) regulations dealing with imported fish and fishery products to the USA. This is to ensure the imported seafood products are produced under the same standards and controls that the US domestic products are produced. An importer can either (1) import from a country that has an active Memorandum of Understanding (MOU) or similar agreement with the FDA or (2) provide written verification procedures for ensuring that the fish or fishery products offered for import into the US were processed in accordance with the requirements of the HACCP regulations.

The MOUs are very complex agreements; therefore, it may take along time for many countries to qualify for an

MOU. At the time this article was written there have been no MOUs signed with any countries, although reportedly some agreements are close. Consequently, at the start of HACCP implementation, all seafood will have to be imported under the second alternative which requires written verification that the imported seafood was processed under HACCP standards including the sanitation requirements.

If an MOU is in place, the inspection system in that country is responsible for enforcing the HACCP regulations or their equivalents. If no MOU is in place for a particular fishery product for a particular country, the importer will continue to be responsible for verifying that the fishery products were processed in accordance with the HACCP requirements. Exporters to the US should be in regular contact with their government food agencies to follow negotiations and ensure that an MOU is eventually signed with the US.

In practical terms, there will be no real difference to the seafood processing plant in a developing country whether or not an MOU is in force. Every seafood processing plant anywhere in the world that wants to export seafood to the USA must, at a minimum have (1) conducted a hazard analysis, and (2) developed an HACCP plan, if needed, and (3) developed and implemented sanitation control procedures.

Either the country's inspection system or the importer will require it.

The importer verification procedures must provide (a) product specifications that are designed to ensure that the product is not adulterated and (b) affirmative verification steps that may include any of the following:

- Obtain from the foreign processor the required HACCP and sanitation monitoring records for the specific lot of seafood imported;
- Obtain either a continuing or lot-by-lot certificate from an appropriate foreign government inspection authority or competent third party certifying that the imported seafood is or was processed under HACCP requirements;
- Regular inspection of the foreign processors facilities to ensure that the imported seafood is processed under HACCP requirements;
- Maintain on file, a copy in English, of the foreign processor's HACCP plan and a written guarantee from the foreign processor that the imported seafood is processed under HACCP requirements;
- Periodically test the imported seafood, as well as maintain a copy, in English, a written guarantee from the foreign processor that the imported seafood is processed under HACCP requirements; or
- Other verification measures as appropriate that provide an equivalent level of assurance of compliance to HACCP requirements.

The end result of all these is that product specifications must be drawn up for every imported fishery product offered for sale, and an HACCP plan needs to be followed when that product is processed. As listed above, there are several ways the importer can provide verification that the seafood in question was processed under HACCP procedures, but all seafood must be processed under HACCP procedures to be imported into the United States.

Several importers have general verification plans to:

- Develop their own detailed product specification designed to ensure the product is not adulterated and is harvested and processed correctly;
- Obtain the HACCP plan for each fishery product, for each processing facility, for each supplier;

- Obtain a letter of continuing guarantee, in English, from the exporting supplier;
- Conduct an on-site inspection once a year by their own personnel or competent third party inspector; and
- Inspect the incoming product;

The United States-based National Fisheries Institute (NFI) and the Swiss-based Société Générale de Surveillance, S.A. (SGS) have formed a partnership to provide HACCP support and verification services for USA importers and processors in many of the seafood exporting countries. This programme was developed to provide a competent third party to train people, assist in the hazard analysis, develop HACCP plans, if needed, and provide audit functions. Many importers are planning to use this programme. The NFI/SGS seafood group has developed a register of HACCP approved foreign suppliers and will maintain that register so that their members can call the NFI office and determine if a foreign supplier has been HACCP-certified.

Penalties for non-compliance

If a domestic processor fails to have and implement an HACCP plan whenever it is necessary, the seafood will be considered adulterated. An importer must present evidence that all seafood products entering into the United States have been processed under conditions that comply with HACCP regulations. If this evidence is not presented at the time of inspection, the product will be considered adulterated and will be denied entry.

The FDA is planning to maintain two separate detention lists for non-compliance of imported seafood products: one consisting of importers that do not perform adequate verification for the products imported and one for foreign suppliers that do not have an HACCP plan or do not comply with HACCP requirements. This means that if a foreign processor that has an adequate HACCP plan in place but sells its product to an importer that does not provide adequate verification, the processor can still have his product detained without examination. For time-and-temperature sensitive products, this could be financially devastating for the foreign supplier and the importer.

This also suggests that both the importer and foreign supplier may want to evaluate their business relationship to be certain that both parties will hold their end of the verification procedure. The processing plant must be certain that it complies with HACCP procedures, keeps accurate records, follows the proper procedures, and provides the required documentation. The importer must provide the proper verification for the product imported. If either party fails to perform its duty, and if the product is inspected by the FDA, it will be detained.

Calibration of measuring instruments—thermometers

An important requirement of operating under HACCP principles is to properly and accurately calibrate the measuring instruments and keep accurate records of the calibrations. One of the most important instruments to calibrate is the thermometer.

While inspecting a fish processing and freezing plant, one of the authors watched the operator attempting to rapidly chill and partially freeze large tuna using a refrigerated brine tank. The brine did not seem as cold to the touch as it was supposed to be, and the tuna did not float in the brine as they should in a dense brine. This indicated that the level of salinity was quite low, so any attempt to lower the temperature would ice up the freezing coils, which was happening. When the operator checked the brine temperature the dial thermometer indicated about -12° C. But that reading could not have been right given the other conditions, such as the

apparent low salinity, because the fish were not floating. The dial thermometer was tested in an ice water bath, and the thermometer reading was 12° C too low. Thus, the operator thought the brine was cold enough when in reality it was 0° C. The end result was that the operator was not freezing the fish at all in the brine tank, thus forcing his cold storage to take much too long to freeze the fish, and slowing down his whole processing cycle.

On another occasion, at a tuna cannery in Latin America, tuna was being unloaded from the purse seiners at -10° C. This tuna was then put into the brine tanks to freeze it further before being put into the cold storage. Because of a thermometer calibration error, the brine was actually kept at -7° C, so instead of freezing the fish more, it was actually being thawed, again putting much more work on the cold storage equipment and affecting the processing of the fish.

These examples show the need to calibrate the measuring instrument on a regular basis (each day, or each week, depending on the circumstance), and re-calibrating any time there is a question about the instrument's accuracy. If there is any question or disagreement about temperature, the very first thing to do is to calibrate the thermometer so that there is no argument about the accuracy of the instrument.

Some final thoughts

It is important to emphasize that exporters must work closely with their US-based importers, and this can be very important to strengthen relationships or expose weak working relationships with the US importers. HACCP compliance on the part of the exporters will give them an absolute competitive advantage over their non-compliant competitors. This should create a "shake-out" in the seafood industry between those processors capable of complying with the US market regulations and those that will be excluded. For many processors in developing countries, maintaining a diversified export market is crucial. Once a processor in a developing country complies with the US HACCP requirements, it is likely that compliance with additional markets will be easier.

A major hurdle that many developing countries will have to overcome, to comply with HACCP requirements, is the development of dependable sources of potable water for sanitation and making ice. This may be a very serious problem for some of the small coastal communities or small island nations with poor water treatment facilities. Making enough ice to properly chill large amounts of seafood may require more potable water than the community can provide.

A major question that has not yet been tested is the impact on a domestic or foreign firm's liability if there are any illnesses or deaths associated with seafood produced while operating under an HACCP plan. Will the US system equate their HACCP regulations with the United Kingdom's due diligence policy? This question may not have been tested in court as yet, but it will be interesting to see the effect of HACCP inspections on product liability.

In summary, HACCP is a very powerful system of critical controls for food safety that operates to minimize the likelihood of health hazards from seafood (or other) products. The HACCP system is not directly operated by the US Government but by the seafood processors themselves with government oversight. The techniques of hazard analysis are very powerful risk-management tools. Controlling hazards can minimize economic risks and improve profits. Proper controls can mean the difference between success and failure in business. The implementation date of HACCP standards is the beginning of a new era of seafood safety. Consumers of seafood products in both the domestic and international marketplace demand a state-of-the-art safety system which the HACCP system provides. Now, FDA, through its HACCP plan verification inspections, can

provide both the industry and consumers assurances that HACCP plans are or are not working. Seafood product safety is the goal. (Source: *INFOFISH International*, January 1998)

International trade in aquaculture products

International seafood exports reached US\$ 53 billion in 1996, up from US\$ 35.8 billion in 1990. The share of exports from developing countries has grown from 44 per cent in 1990 to 50 per cent in 1996 and net receipts of foreign exchange rose from US\$ 10.4 billion to US\$ 15.5 billion in the same period. The rapid growth in aquaculture production has made the sector important to the economies of many developing countries and, in the case of some traded aquatic products, the sector has become either an important source of supply or the main supplier. In these cases, fluctuation in production of farmed products has significant impact on price trends. In general, however, aquaculture products have helped to stabilize supplies of traded products and to bring down prices over the years. This has made what was previously luxury products available at lower prices and helped expand markets.

The extent of regional and international trade in aquaculture products is difficult to analyse because trade in many aquaculture products is not yet well documented in the main producing countries, and since international trade statistics do not distinguish between wild and farmed origin. Thus, the exact breakdown in farmed and wild origin in international trade is open to interpretation. This situation will change gradually, as producers associations emerge in main producing countries and begin to keep records, and in response to various trade regulations/pressures which distinguish between farmed and wild shrimp.

The main products traded from aquaculture in 1996 were shrimp and prawns, salmon and molluscs. Other species showing strong growth in trade are tilapia, seabass and seabream. (Source: *INFOFISH International*, April 1998)

Challenges facing the African ports in the next millenium

The conclusions and recommendations of previous deliberations in the 1990s on challenges facing African ports in the next millenium go hand in hand with what ECA categorized as the main challenges in the next millenium.

The sea ports of developing Africa are noted for their low output, high operating and maintenance costs and generally poor quality of services to users. Such poor quality port services and their high costs are an impediment to the expansion of external trade.

The overall sub-Saharan Africa's performance had continued to be characterized by low productivity, management problems, failure to diversify from a limited production and export base and high vulnerability to the external economic environment. In 1995, however, economic developments were made favourable, with exports expanding by 14.3 per cent in value and 7.5 per cent in volume over 1994 and imports increased by 11.8 per cent in value and 5.6 per cent in volume.* At the same time, real GDP was estimated to have risen by about 5.0 per cent.** These overall positive sub-Saharan African developments cannot conceal considerable differences in economic performance of individual countries. Statistical figures exist which give proof

*UNCTAD report on Review of Maritime Transport 1995.

**Total trade in goods and real GDP, IMF, World Economic Outlook, October 1995.

of the difficulties—sometimes due to external failures—experienced by a number of African economies, including some of the largest ones among them, and also experienced by the region's transport sector including ports.

The challenges which the ports sub-sector is facing in the next millennium are discussed below within the framework of the overall difficulties which African countries themselves are facing. The main challenges categorized under eight-sub-headings are as follows:

- (i) Promotion of institutional development for ports;
- (ii) Development of regional and sub-regional cooperation;
- (iii) Improvement of the efficiency of port management;
- (iv) Improvement of port technical services;
- (v) Improvement of the maintenance of port assets and infrastructure;
- (vi) Promotion of human resource development;
- (vii) Strengthening of relations between ports and their hinterlands; and
- (viii) Adoption to new technological changes in maritime transport.

(Source: *PORTS AND HARBORS*, April 1998)

Cholera and export of fishery products

Cholera annually affects several hundreds of thousands of people in Africa, Latin America and Asia. In 1997, some 30 countries were reported to be affected by this disease. It has been generally believed that water was the main vehicle for transmission, however, an increasing number of epidemiological studies have shown that foods are equally an important route of transmission. Sudden large outbreaks are, however, usually caused by contaminated water supply. Cholera is spread from place to place largely by infected persons, most of whom have no signs of illness, sometimes referred to as "healthy carriers" of the illness. Most contamination arises from direct or indirect transfer to *Vibrio cholerae* 01 from faeces of infected persons to food and waters; only rarely is cholera transmitted by direct person-to-person contact. In cholera-affected areas, fish harvested from or kept in contaminated water; raw shellfish and undercooked crustaceans have been implicated in the transmission of the disease.

Cholera and fishery products

Vibrio species are common in coastal and estuarine environments and numbers can depend on such factors as water depth and tidal levels. They are also found as part of normal flora of brackish water and are often associated with algal blooms (plankton), which are influenced by water temperature and nutrient levels. They are particularly prevalent in warm tropical waters and can be found in temperate zones during summer months. As *Vibrio* species are natural contaminants of coastal and brackish water tropical environments, they represent an unavoidable part of the natural flora of fish harvested from these areas. Similarly, they may be found in products in temperate zones during warm summer months and in sub-tropical areas. Shellfish may be persistently or intermittently contaminated with *Vibrio cholerae* 01, even in the absence of recent exposure to human faecal material. Molluscan shellfish are filter-feeders and can bioaccumulate the organism to much higher levels than present in the surrounding water.

Control and prevention

In general, prevention of foodborne transmission of cholera is based on the following principles:

- Preventing faecal contamination of food and water;
- Preventing multiplication of *Vibrio cholerae* 01;
- Eliminating *Vibrio cholerae* 01 in food and water that has been contaminated;

- Avoiding the harvesting of fish and edible seaweed for raw consumption from areas that have been identified as environmental reservoirs for *Vibrio cholerae* 01.

In countries or areas where hygienic excreta disposal is not always possible, prevention of foodborne cholera is based on the second and third principles. The fourth principle should be observed in all countries where coastal waters may have become reservoirs for *Vibrio cholerae* 01.

Hazards from *Vibrio* spp. associated with fishery products can be controlled by thorough cooking (all parts of the food should reach at least 70° C); preventing recontamination of cooked products through good personal hygiene, avoiding contact with contaminated hands, surfaces, raw foods, or contaminated water. Health risks can also be reduced by rapidly chilling products after harvest, thus eliminating the possibility of proliferation of these organisms. While refrigeration and frozen storage both limit the multiplication of the cholera organisms, survival may also be prolonged. Freezing is ineffective in killing *V. cholerae* 01, which can survive in frozen products. Growth will be inhibited in acidic products, such as lactic fermented and pickled fishery products and irradiation (minimum dose 1 kGy) will also kill the organism. In addition, no risk of cholera is to be expected from dried fishery products, with water activity (Aw) below 0.95.

Cholera and trade in fish and fishery products

Epidemiological data suggests that the public health risk of cholera from imported fish or fishery products, other than raw or partially cooked molluscan shellfish, is negligible. Cases of cholera that have been related to imported foods have been associated mainly with foods that have been imported by individual travellers. WHO believes that the best way to deal with food imports from cholera-affected areas is for importing countries to agree with food exporters on the measures for implementing Good Hygienic Practise (GMP), based on the Codex International Code of Hygienic Practices. GMP needs to be followed during fish handling and processing to prevent, eliminate or minimize the risk of any potential contamination. The application of food safety assurance programmes based on the principles of the Hazards Analysis and Critical Control Point (HACCP) system during fish processing permits a systematic approach for minimizing food safety hazards.

Testing of food for *Vibrio cholerae* 01 can be carried out for verification of the efficacy of the implemented measures, as part of the HACCP programme. However, it should be realized that such a testing may be of limited value since this particular organism has been found in the aquatic environment in a dormant and non-culturable state, and if present in a food in this state, it will not be detected by the traditional microbiological methods of testing. In addition, since the pathogen will not be evenly distributed in the food, from a statistical viewpoint a negative result will not guarantee the absence of the pathogen, and may even promote a false sense of security. This limits the effectiveness of testing samples at the port of entry as a method of food safety assurance.

The Codex Code of Ethics for International Trade in Foods stipulates that "international trade in food should be conducted on the principle that all consumers are entitled to safe, sound, and wholesome food and to protection from unfair trade practices". Concerning microbiological contaminants, the Code stipulates that "all food should be free from microorganisms and parasites in amounts harmful to man ...". While recognizing the duties and rights of national governments to protect their consumers from being exposed to *Vibrio cholerae* 01 via foods, the World Health

Organization (WHO) urges Member States not to apply to cholera-affected countries restrictions that cannot be justified on public health grounds, in particular as regards importation of products from the countries concerned. WHO has for long maintained that trade restrictions between countries or different areas within a country do not prevent the spread of cholera. WHO recommends that agreement should be reached between exporting and importing countries on the most appropriate public health measures to prevent transmission.

With respect to international trade in foods, the Agreement on the Application of Sanitary and Phytosanitary Measures (SPS) of the World Trade Organisation stipulates that sanitary measures are applied only to the extent necessary to protect human health, that these are based on scientific principles and not maintained without sufficient evidence. WHO recognizes that although there is a theoretical risk of cholera transmission associated with some food commodities moving in international trade, this has rarely proved significant and authorities should seek other means of dealing with it other than an embargo on importation. One such measure, provided for in the SPS Agreement, is the provision of technical assistance to developing countries to achieve the appropriate level of sanitary protection in their exports. Such assistance, in the form of health education is essential for cholera control, as is the assistance with the implementation of food safety assurance programmes based on the HACCP principles in the production and processing of fish and fishery products for export. (Source: *INFOFISH International*, February 1998)

Oceans at risk?

IMO/FAO/UNESCO-IOC/WMO/WHO/IAEA/UN/UNEP Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP) is a group of marine scientists providing advice on marine environmental protection issues to United Nations agencies. Since the establishment of GESAMP in 1969, IMO has acted as its Administrative Secretariat.

GESAMP, at its annual sessions, exchanges views on matters of particular concern regarding the state of the marine environment. A statement summarizing such views expressed since 1993 was issued by GESAMP at its 28th session (Geneva, 20-24 April 1998) as shown below. The views expressed by the Group may not correspond with those of its sponsoring agencies.

Degradation of the oceans continues on a global scale, despite progress made during the last three decades in some places and on some issues. This impedes development and diminishes human welfare. A fundamental solution to many of the sea's environmental problems lies in scientifically informed management that integrates the range of uses of the marine environment to ensure that their benefits are sustained. Such management regimes, when effectively implemented, have produced concrete benefits for society and the environment, but they have not been widely applied. This is largely due to a lack of informed constituencies, appropriate institutional structures, and political will.

The problems: pollution in context

Changing circumstances, better information, and a broader global perspective have given us a much better appreciation of the comparative threats posed by different human activities. Where marine environmental concerns once centred on pollution, we now recognize that pollution is neither the only nor necessarily the most severe threat to the health of oceans and coasts.

Marine pollution

Several decades ago a series of incidents gave global prominence to the problem of marine pollution. After tracing a crippling, sometimes fatal, disease in Japan to industrial mercury discharges, scientists discovered that, even in the open ocean, large fish sometimes contained high levels of mercury. The crash of certain seabird populations was found to result from widespread pesticide pollution. Major spills in the United States and Europe focused public attention on the problem of oil pollution. Many other marine pollution issues have since been raised.

Pollution-control initiatives have focused on regulating pollution sources, banning the use of certain chemicals, such as PCB's and prohibiting the ocean disposal of entire categories of waste, including industrial waste and radioactive materials. Most countries have also entered into agreements for regional and global marine environmental protection measures.

Successes

These measures, when applied and enforced, have often succeeded in curbing marine pollution. Reducing lead in automobile fuel, for example, has led to lower levels of lead in ocean surface waters, especially in the North Atlantic. International maritime regulations have greatly reduced operational discharges of oil from ships. Many localities have controlled their sewage and industrial discharges, giving them safer seafood and bathing waters, cleaner beaches, and healthier coastal habitats. Seabird populations decimated by pesticides have made dramatic recoveries, and in some places levels of contamination in marine life have fallen. Stringent controls on discharges and bans on atmospheric testing and ocean disposal of radioactive waste have reduced radionuclide contamination of the marine environment.

Continuing pollution problems

Nonetheless, pollution continues to damage the marine environment. Despite gains in some regions, sewage is still a major problem, especially when it includes industrial wastes. In some countries, particularly developing ones, sewage is the single largest source of coastal contamination. Many contaminant chemicals are inadequately regulated, and the regulations that exist are frequently violated. New chemicals are produced faster than their environmental risks can be assessed. Some, such as those that disrupt animal hormone systems, may result in long-term effects on marine organisms that are as yet poorly understood. Marine litter continues to be a problem.

The threats to the ocean posed by land-based activities, including agriculture, forestry, coastal construction, urban development and tourism, are sometimes overlooked. Such activities are major sources of plant nutrients and sediments, which are not widely recognized outside of scientific circles as major threats to the health of marine and coastal environments. They are also sources of more widely publicized contaminants such as pesticides and oil.

Improved scientific perspective

Sometimes new information has allayed concerns. Mercury in large oceanic fish, for example, was found to come mostly from natural sources. More importantly, improved scientific knowledge has allowed us to evaluate the relative threats posed by different pollutants. We now recognize, for example, that sewage discharge and the runoff of nutrients, sediments, and pesticides present greater risks to human health and the marine environment than radioactivity and heavy metals, given existing controls.

Other activities that threaten the marine environment

Better understanding also enables us to place marine pollution in the broader context of the range of human

activities. As severe as pollution may be, the routine modification and exploitation of marine and coastal environments, and the widespread habitat damage and loss that result, probably pose even greater threats.

Coastal development

We are increasingly a coastal species. Some 44 per cent of the world's population lives within 150 km of the coast—more people than inhabited the entire planet in 1950. Mass migration to the coasts will continue in the decades ahead. This population growth is concentrated in large coastal cities.

Coastal population growth and the activities that accompany it not only increase pollution, they radically alter coastlines. Clearing, land reclamation, and channelization of flood and tidal waters destroy coastal wetlands. Port development, road building, coastal construction, and the mining of beach sand for construction material obliterate shoreline habitats. These activities often increase coastal erosion and damage habitats, such as seagrass beds and coral reefs, away from the development site. In some countries, mining of coral reefs has destroyed them. Exotic species introduced with ships' ballast water and by other means threaten human health, marine ecosystems and fisheries.

Coastal and marine tourism is one of the largest and fastest-growing sectors of the global economy. Like other forms of development, tourism brings population pressure and physical changes. The impacts can be especially severe, however, because developers often build tourist facilities too close to the water and other attractions. Areas attractive for tourism are often highly vulnerable. Visitor numbers frequently exceed the carrying capacity of the environment, for example water supplies, available space, and the ability of habitats to absorb visitor impacts and provide an enjoyable experience. Coastal erosion, pollution, habitat destruction and social decay are common consequences.

Tourist boats, curio collectors, reef walkers, snorkellers and scuba divers have damaged coral reefs in many tropical countries. Operators may even destroy ecologically important habitats (including seagrass beds, mangroves and wetlands) that they consider unattractive to tourists. On the other hand, in a market that is increasingly aware of environmental issues and demands pristine habitats, tourism can create strong economic incentives for, and subsidize the cost of, effective environmental management.

Mariculture, the farming of shellfish and finfish, can contribute to coastal degradation by destroying habitats and producing waste. Shrimp culture in particular has often led to the indiscriminate destruction of mangrove forests. This practice has declined, but persists in several countries.

Both at the coast and in upstream catchment areas, water is diverted for power generation, urban and industrial development and irrigation. This alteration of freshwater flows can result in increased coastal erosion, the loss of critical habitat, salt intrusion and other environmental problems.

Over-exploitation of renewable resources

Coastal population growth and development bring not only the direct physical destruction of coastal habitats, but enormous pressure on renewable resources. Increased demand for fish, and often more fishers, has led to the over-exploitation, often severe, of most coastal fisheries. Industrial fishing fleets have heavily exploited stocks farther offshore, and the majority of the world's fishery stocks are now fully or over-exploited.

Associated with over-fishing are problems of by-catch and destructive fishing methods. The total global by-catch (the incidental harvest of non-target organisms) is some 29 million tonnes, about a third as much as the global marine

catch. Largely in response to public concern, by-catch of seabirds, marine mammals and turtles has been significantly reduced, though it still occurs. Of greater concern now, perhaps, is the mass by-catch mortality of less charismatic but ecologically important marine organisms, including the juveniles of many commercially important species. Destructive techniques ranging from the small-scale use of explosives and poisons to inappropriate industrial gears and methods destroy the very habitats and stocks that support the industry.

Over-exploitation is not limited to fisheries. Large commercial enterprises destroy mangroves and other coastal forests, for example, on a massive scale. In many countries these forests are also cut down by poor people seeking farm land, timber and firewood. Much of the world's mangrove forest has been lost, and the loss continues at a worrying pace.

Why should we care?

We should care about the continuing environmental degradation of our oceans and coastal areas because it is detrimental to human health, economic development and our planet's store of biodiversity.

Human health

The contamination of seafood and seawater with harmful micro-organisms and chemicals is an important cause of disease in many coastal communities. There is growing concern that eutrophication—algal growth in response to elevated nutrient input—may be causing increases in toxic or otherwise harmful phytoplankton blooms on a global scale.

Economic costs

Marine environmental degradation often results from short-term economic considerations, but at great long-term cost. Degraded fisheries mean lower catches and lost revenue. Investment in excess fishing capacity to harvest a declining catch, often driven by politically expedient subsidies, costs tens of billions of dollars annually. Seafood contamination reduces the value of many catches, or even render them worthless. Coastal erosion, flooding, saltwater intrusion, and other consequences of short-sighted coastal development impose high costs in damages and mitigation. Habitat degradation threatens tourism in many countries, sometimes at the hands of the tourist industry itself. Alleviating the poverty and disease that result from environmental degradation also imposes costs upon society.

Food security

Poverty is the primary threat to food security and economic losses due to marine environmental degradation engender poverty. Beyond this, reduced catches resulting from over-fishing, habitat destruction and pollution threaten the food security of coastal populations that depend upon seafood for dietary protein. These are often the poorest of coastal people, with few alternatives. Seafood contamination is another threat to global food security.

Loss of ecosystem functions and services

Coastal and marine habitats also provide indirect benefits such as filtering nutrients and sediment, detoxifying certain contaminants, and providing barriers to storm damage and coastal erosion. Wetlands and coral reefs are critically important as spawning and nursery grounds for valuable finfish and shellfish species. Marine and coastal environments also have great aesthetic and recreational value, and support much of the planet's biodiversity. These and other intrinsic services are worth some \$20 trillion annually, more than the entire global GDP.

What can we do?

Scientists believe that many answers to the oceans' environmental problems lie in expanded public

environmental awareness and integrated, sustainable management based on sound scientific information.

Examples of management successes

A quarter-century ago, Jacques Cousteau predicted the imminent demise of his beloved Mediterranean Sea. Had nothing changed, he may have been right. The United Nations, however, in partnership with countries bordering the Sea, adopted an aggressive plan—the Mediterranean Action Plan. While acute problems remain and continuing action is needed, the severe overall degradation of the Mediterranean that Cousteau predicted has been averted, or at least postponed. Similar action has led to marked environmental improvement in Chesapeake Bay and other large estuaries. Improved environmental quality in the River Thames in England, Boston Harbor in the United States and Xiamen Harbour in China show that determined, coordinated action can produce benefits even in large urban areas, where development and population pressures are concentrated.

Such successes are not confined to the industrialized world. In Namibia, for example, innovative management measures appropriate to local circumstances have enhanced the sustainability of the hake fishery and its economic benefits. Coastal communities on Apo Island in the Philippines have established marine reserves, leading to better catches for local fishers.

A constituency for the oceans

A common feature of these success stories is the existence of a constituency that is aware of the issues and committed to a collaborative process of solving environmental problems. Building this constituency requires clear communication and sharing of information among Governments, industry, the international community, scientists, and most importantly the public. New technologies increasingly empower individuals and organizations to inform themselves and express their views, if they wish to do so.

Governance, institutions, and political will

Unfortunately, the implementation of sound sustainable management of oceans and coasts remains the exception rather than the rule. Sometimes critical scientific information is lacking, or it is available but poorly communicated and not used. Without a clear understanding of the sources, severity, and distribution of environmental problems it is impossible to make wise, realistic policy decisions.

Governance issues are a more common barrier. Successful coastal management requires integrated, collaborative action by national and regional agencies, the participation of local citizens and industry, and even agreements among nations. When, as often happens, this collaboration is viewed as an infringement of institutional or national sovereignty, rational environmental management suffers. Even when collaborative agreements exist there may be little will to implement them.

While the resolution of these issues is neither simple nor easy, in most cases the nature of the ocean's environmental problems is understood, the knowledge needed to solve them is available, and the necessary management tools exist. What is lacking is the determination and political will to act. The active involvement of an aware, informed citizenry can be a powerful force for change on behalf of the oceans.

GESAMP can provide in-depth, authoritative, scientific analysis of the state of marine and coastal environments, of the relative threats posed by various human activities, and of the management options available to address these threats and rectify past damage. GESAMP welcomes increased dialogue with Governments, non-governmental organizations, and the public in order to foster improved measures to protect the oceans for contemporary society and future generations. (Reprinted from *IMO News*, March 1998)

H. SOFTWARE

Telemedicine systems expand offshore

Offshore platforms are necessarily remote facilities. On those occasions when more than first aid is necessary, and a physician should be consulted, the process often involves a long boat ride or an expensive helicopter ride. Telemedicine is the answer to all but the worst medical situations.

Telemedicine is the transfer of still photographs or live video, sound, and biomedical information to a doctor when there are none close by. This may be by e-mail or real-time teleconferencing.

The Hibernia platform off Newfoundland acquired a telemedicine system, similar to one deployed on some platforms in the Gulf of Mexico and linked to the Houston Medical Center. Unlike the Gulf of Mexico, however, there are registered nurses on the Hibernia platform. The Hibernia telemedicine system involves:

- Direct telephone service from the platform to an onshore, on-call physician at any time;
- General camera made by Andries Tek and an ear, nose, and throat probe made by American Medical Development;
- A videoconferencing system for emergencies.

Photographs of external medical conditions, such as a rash, eye infection, or skin laceration are taken with special lenses on a digital camera, and are then e-mailed, along with audio commentary, if desired, to a physician for review. A basic system, suitable to most emergency room needs, would cost about \$45,000, before communication equipment, according to Ron Williams, Vice-President, Sales, for Andries Tek. However, telemedicine packs can often be integrated into existing communications systems.

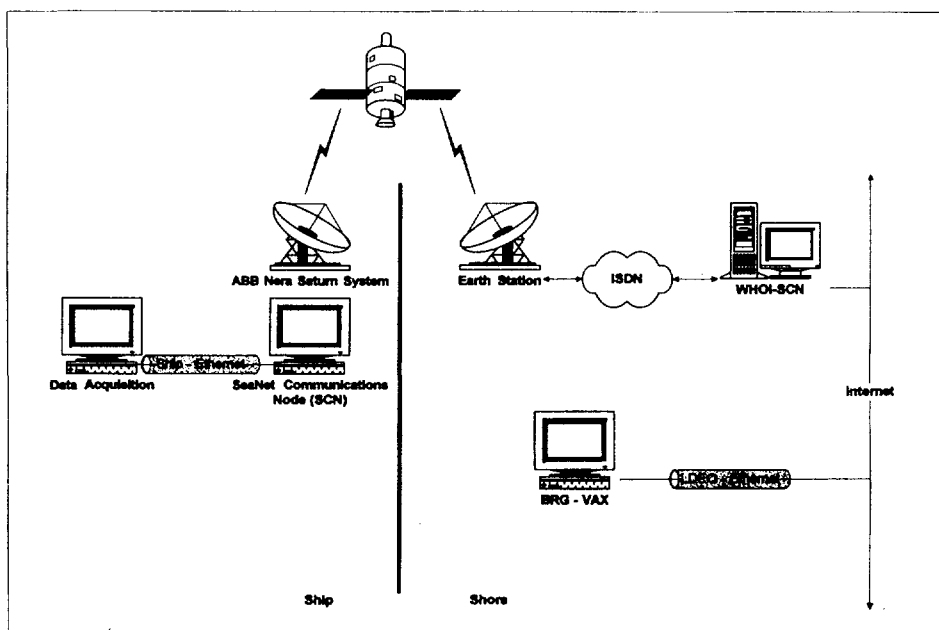
Another telemedicine provider, Krug Life Sciences, recently flew its own system with the US space shuttle Endeavor. Krug's system is about the size of a large overnight bag. Astronauts conducted medical exams, including video of the eye, ear, nose, mouth, throat and skin; biomedical feedback including electrocardiogram, blood pressure measurement, and per cent oxygen saturation; and audio of the heart and lung. The system was designed for minimally trained operators. (Source: *Offshore*, March 1998)

Software predicts storm impact

Harbour, shoreline and shallow water impacts from storms at sea, can be predicted on a computer program developed by the Technion-Israel Institute of Technology (Haifa, Israel). The program amplifies wave forecasting, incorporating a deep water-to-shallow-water wave and surge conversion formula that describes the resulting wave types and impacts on shoreline facilities. (Source: *Offshore*, March 1998)

SeaNet—ship/shore communications

The Internet has insinuated itself so rapidly and pervasively into the scientific community and has become such a standard tool that many scientists already take it for granted. But not scientists working on research vessels in remote seas. For them, great expanses of ocean create a barrier for "logging on". A mundane task like retrieving e-mail whenever you want is not so routine when your office, temporarily at least, is bobbing in the Indian Ocean.



Basic hardware configuration employed for the testing effort.

Today the vast amounts of data collected each day at sea by modern research vessels (not to mention the expense of operating these ships) exponentially increases the value of rapid, even near real-time, ship-to-shore data transmission.

To meet this challenge, the SeaNet project was launched, a collaborative effort to extend the usefulness of demonstrated oceanographic communication techniques through the application of standard-based network technologies. SeaNet's main purpose is to integrate communications technologies that have already proved useful to the oceanographic community, rather than to develop new communications links. A primary goal is to facilitate an infrastructure, or mesh, of communications links over (and through) the ocean using Internet protocols (IP), so that a combination of various telemetry methods can eventually be used to provide user-transparent links to at-sea computing platforms, or nodes. Using transmission control protocol (TCP)/IP protocols over an INMARSAT B link, the SeaNet Lite project developed and operated a working prototype that demonstrated on-demand Internet connectivity in remote ocean regions. The researchers are now working to extend the Internet to the oceanographic research fleet. (Source: *SEA TECHNOLOGY*, May 1998)

Martin 200 AUV development—accuracy in navigation

An extremely accurate navigation and positioning system tested for the Martin 200 AUV is the result of a close cooperation between the Danish company Maridan and US-based Kearfott Guidance & Navigation Corp.

Kearfott is providing its advanced technology SEANAV™ inertial navigator for use onboard the Martin 200 AUV from Maridan. It will be the prime positioning system of the AUV in combination with updates from doppler sonar and differential GPS.

"The adoption of the high-precision Kearfott system has enabled us to solve one of the major positioning problems facing the industry for this type of AUV", says Jens Pind, marketing and sales manager for Maridan. "For the first time the survey industry can control and determine both the trajectory and the position of the AUV to an extremely high precision without the need for externally applied signals or dedicated tracking on the surface by a mother ship."

The SEANAV™ inertial platform is based on Kearfott's advanced ring laser gyro technology and is the result of the company's widely based experience in the development of inertial guidance and navigation systems for the military and space industries. From an initialization and precalibration routine performed on the surface with the aid of differential GPS, the SEANAV™ continuously computes all altitude, heading, position, and navigation data required by the Martin 200 mission without aid or control from external signals.

The software has been developed in close cooperation with Technical University of Denmark and the Danish National Laboratory, Ris. (Source: *SEA TECHNOLOGY*, May 1998)

Scanning sonar system

As subsea development moves into deeper water, there is increasing requirement for a local navigation system that allows easy use and interpretation. Imagenex Technology Corp. (Port Coquitlam, British Columbia, Canada) engineers answered this problem with a development of the company's existing scanning sonar system. According to a Scantron Ltd. spokesman (which an Aberdeen firm represents Imagenex in Europe), Imagenex engineers combined a high-resolution, 200-metre-range scanning sonar with an "intelligent" acoustic transponder that sets its acoustic level to suit its range.

While most navigational systems produce images only showing relevant subsea transponders, the Imagenex system gives a clearer view of the subsea environment by combining this with a high-resolution sonar image.

Separate frequencies are used for transponder communications, avoiding the acoustic interference sometimes seen in more basic systems. Each individual transponder has its own icon on the sonar display, range, and bearing to these transponders—and the system's movable cursors—is also displayed. This information can also be sent via an RS-232 link to an external computer for further processing. This type of system has a wide range of uses in construction and other subsea tasks. These include mid-water moorings, or objects, that can be marked and located; targets that can be marked for easy location, especially small or acoustically poor targets; the system can be used to aid AUV navigation; and targets can be located in "cluttered" areas. (Source: *SEA TECHNOLOGY*, June 1998)

Database on fisheries/aquaculture studies

Since 1978, the European Commission has been supporting various studies and research projects that are being used to assess the impact of the Common Fisheries Policy (CFP), collect data useful for stock assessment, and prepare the future of CFP. At the end of 1996, a total of 318 projects were completed or still ongoing. These studies are very diverse in nature, and encompass all aspects of fisheries and aquaculture (policy, gear design, ecology etc.) in the various fishing areas of the member States.

With financial support from the European Commission, COFREPECHE, a consultancy company based in Brest, France, has prepared a database of these projects and released it on the Internet at URL:<http://www.ifremer.fr/cofrepeche/moteur/>. Upon logging in, the user is prompted to enter search parameters such as the year, author's name, key words and geographical area. A list of studies matching the search criteria is displayed and the user can find more about them with simple clicks.

The information on the content of the study is either in French or English, depending on the original language used. Contact details of the coordinator of the project are shown to foster scientific cooperation and, if still available, to obtain copies of the final reports. (Source: *INFOFISH International*, January 1998)

Project OXYGEN

Project OXYGEN™ was originally conceived as a global fibre-optic undersea cable network, spanning about 300,000 kilometres and linking 265 landing points in 171 countries that will connect every continent except Antarctica. It will comprise 38 self-healing loops. The first of two phases will see rapid construction of a 119-segment (plus 10 terrestrial), 158,000-kilometre backbone network on the most heavily trafficked international routes, while the second phase will increase regional connectivity to the core network. Because of numerous requests to bring the system on-line earlier than initially planned, a two-phase construction plan was decided upon to accelerate construction. The first phase will cater to about 90 per cent of the current traffic around the world. Once the first phase is complete, the project will keep on building not only to complete the original configuration, but satisfy customer's need for more bandwidth. Project OXYGEN will be a "living network".

CTR Group Ltd. (Woodcliff Lake, NJ) created Project OXYGEN. A new company called Project OXYGEN Ltd. will build and operate the OXYGEN Network. CTR was founded by Neil Tagare, who played a key role in the creation and implementation of the FLAG (Fiberoptic Link Around the Globe) project, an undersea cable stretching from Europe through the Middle East and South-East Asia to Japan.

Until the advent of Project OXYGEN, all undersea cable systems connected two distinct end points, sometimes with

intermediate drop-offs along the way. International carriers who wanted to send their traffic to other parts of the globe over such cables had to buy or lease separate circuits for every segment along the way. To send calls from North America to Indonesia, a carrier would have to purchase capacity from, for example, North America to Japan, then from Japan to Singapore and Singapore to Indonesia. Separate negotiations/deals for capacity on each of the cable segments required significant investments of time, personnel, and money. It also required payment of transit fees to a local carrier every time the traffic moved from one cable to the next. Since fixed circuits are traditionally purchased for 25-year usage, carriers had to predict years in advance the destinations and volume of their traffic.

As a network, Project OXYGEN customers can send their traffic from any of its landing points to any others with no difference in cost. They can also change the points between which they send their traffic, and the amount they send, at will.

Of the 158,000 kilometres of Phase-I cable, approximately 8,000 kilometres will be on terrestrial routes with the rest undersea. The first phase will be built in four parts. Major trans-Atlantic and trans-Pacific routes, as well as a terrestrial link across North America, will be completed in late 2000. Northern Europe will be connected in early 2001, while the Mediterranean, the Middle East, India, and both coasts of South America will be connected in late 2001. Australia and Central America will be linked in early 2002, completing the first phase. The first phase will have 101 landing points in 74 countries and cost about \$8 billion.

The second phase will result in a system of approximately the size and geographical coverage as initially planned for.

Technology

Project OXYGEN Network will be based on ATM (asynchronous transfer mode), optical switching, and synchronous digital hierarchy (SDH) transmission. The ATM switches, located in the terminal stations at the landing points, will accept all inbound International Telecommunication Union (ITU) standardized digital traffic from the domestic network. Customers will provide the interface cards that will feed their traffic into the ATM switches. Network management centres in Spain, the US West Coast, and Singapore will jointly oversee and operate the network, and an engineering support centre will provide technical assistance and training as needed for operating, modifying, and upgrading the network.

The cables that make up OXYGEN Network will have four fibre pairs on long-haul (at least 350 kilometres) undersea segments, which require optical amplifiers, and 12 fibre pairs on terrestrial and shorter submarine segments. Use of dense wavelength division multiplexing (DWDM) technology will allow each fibre pair to carry 16 frequencies, each frequency transporting 10 gigabits/second of data, for a total capacity of 160 gigabits/second per fibre pair. Thus throughput will be 640 gigabits/second for long-haul submarine routes, and 1.92 terabits/second for terrestrial and shorter undersea segments. United States-based Corning Inc. has agreed to supply substantial fibre, which will be based on LEAF™ brand of fibre.

Project OXYGEN Network will be built and installed under a supply contract between Project OXYGEN Ltd. and selected suppliers. Cable installation will begin in late 1999. Landing stations will be built by landing parties in each country and location. Project OXYGEN will provide financing for the construction of these landing stations where requested.

Project OXYGEN Network by country 101 Phase-I landing points

Country (Locations)	
Antigua (St. Johns)	Mexico (Acapulco, Tijuana)
Argentina (Buenos Aires)	Morocco (Casablanca)
Australia (Perth)	Netherlands (Imjuiden, Katwijk)
Bahamas (Nassau)	Norway (Kristiansand)
Bahrain (Al Manamah)	Oman (Salalah)
Barbados (Bridgetown)	Pakistan (Karachi)
Belgium (Oostende)	Panama (Amador, Colón)
Bermuda (St. Davids)	Peru (Lurin)
Brazil (Fortaleza, Rio de Janeiro)	Philippines (Batangas)
Canada (Halifax, Vancouver Island)	Poland (Gdansk)
Canary Islands (Las Palmas)	Portugal (Sesimbra)
Cape Verde (São Tiago)	Puerto Rico (San Juan)
Chile (Arica, Valparaiso)	Qatar (Doha)
China (Shanghai)	Russian Federation (St. Petersburg)
Colombia (Barranquilla)	Saudi Arabia (Damman, Jeddah)
Denmark (Copenhagen)	Singapore
Djibouti (Djibouti)	Republic of Korea (Pusan)
Dominican Republic (Cacique)	Spain (Barcelona, Cadiz)
Eire (Wexford)	Sri Lanka (Colombo)
Ecuador (Punta Carnero)	St. Vincent and the Grenadines (Kingstown)
Egypt (Alexandria, Cairo, Port Said, Suez)	Suriname (Paramaribo)
Eritrea (Massawa)	Sweden (Stockholm)
Finland (Helsinki)	Syrian Arab Republic (Al Ladhqiqyah)
France (Brest, Le Havre, Marseille)	Taiwan (Kaohsiung)
Germany (Grosshiede, Kiel, Sylt)	Thailand (Satun, Songkhla)
Greece (Athens)	Trinidad and Tobago (Port of Spain)
Guam (Agana)	Tunisia (Bizerte)
Guatemala (San José)	Turkey (Antalya)
Hawaii (Makaha)	United Arab Emirates (Al Fujayrah)
Hong Kong	United Kingdom (Gilbratar, Liverpool, Redcar, Sennen Cove)
India (Mangalore, Mumbai)	United States (Bandon (2), Charleston, San Luis Obispo, Tuckerton, Washington, D.C., West Palm Beach)
Indonesia (Jakarta)	Uruguay (Maldonado)
Italy (Palermo, Savona)	Venezuela (Punto Fijo)
Japan (Chikura, Kagoshima)	Viet Nam (Ho Chi Minh City)
Kuwait (Al Kuwait)	Yemen (Aden)
Lebanon (Beirut)	
Malaysia (Kota Baharu)	
Malta (Valetta)	

Between 20 and 30 ships will be constructed to build and service the system.

Project OXYGEN believes its network is going to be far superior to point-to-point cables existing today: significant reliability, significant resilience, very low cost, and ubiquitous technology around the world.

The global trade and global traffic patterns have changed completely. There is no way for carriers around the world to predict what their traffic patterns are going to be in the future. Project OXYGEN believes that even trying to predict future global traffic patterns is futile because the very nature of Internet is unpredictability.

Today more than 90 per cent of all Internet traffic around the world transits through the US. Internet traffic originating from Bangalore, India going to New Delhi also transits through the United States. Therefore, the traffic to the US has gone up so much that at this point of time carriers cannot obtain trans-Atlantic or trans-Pacific circuits at any price. In five years from now, the US is no longer going to be the centre of the Internet world. As Internet becomes an ubiquitous, reliable medium, it is going to be a distributed medium. The hub-and-spoke model that exists today is going to be converted into a distributed model—carriers that are today buying tonnes of capacity to the US are going to find out that they have excess US capacity and not enough capacity to other destinations. Project OXYGEN offers them a very flexible and future-proof fibre-optic cable system where carrier investments are protected to the fullest degree.

On a social level, Project OXYGEN is going to change the way people work. Trans-oceanic telecommuting to work is going to become big business three to five years from now—electronic immigration. These trends exist already. People in Ireland could be doing data-entry work for a US company. Or people in Russia could be doing scientific software programming for a British company. And these kinds of trends are going to make business even more global. As prices of global communications drop to a point where Project OXYGEN sees them five years from now, carriers could offer a fixed monthly price where people can call anywhere in the world free of charge beyond that point. Global 800 numbers will become more commonplace and video conferencing becoming mainstream in the business sector, according to Project OXYGEN. (Source: *SEA TECHNOLOGY*, July 1998)

I. PUBLICATIONS

Guidelines for the control and management of ships' ballast water to minimize the transfer of harmful aquatic organisms and pathogens

The Marine Environment Protection Committee of IMO (MEPC), at its thirty-first session (1-5 July 1991), adopted voluntary guidance in the form of the international guidelines for preventing the introduction of unwanted aquatic organisms and pathogens from ships' ballast water and sediment discharges (resolution MEPC.50(31)). This activity had been initiated by a number of States in the light of problems they encountered concerning marine organisms introduced into their waters with ballast water and associated sediments. In 1993 the IMO Assembly adopted these Guidelines by resolution A.774(18), in response to requests from the United Nations Conference on Environment and Development (UNCED). This resolution further addressed the MEPC and the Maritime Safety Committee (MSC), requesting them to keep the ballast water issue and the application of the Guidelines under review with a view to developing the Guidelines as a basis for a new Annex to MARPOL 73/78.

Accordingly, since 1993 the MEPC has been working towards the development of legally binding provisions on ballast water management, together with guidelines for their effective implementation. The MSC has, as requested by resolution A.774(18), developed guidance on safety aspects of ballast water exchange at sea, which has been distributed as MEPC/Circ.329 and MSC/Circ.806, both of 30 June 1997. The MSC further undertook to consider relevant issues concerning ballast water management, as well as design objectives for new ships.

The IMO Assembly in 1997, by resolution A.868(20), adopted the Guidelines for the control and management of ships' ballast water to minimize the transfer of harmful aquatic organisms and pathogens, as set out herewith. The resolution further requests Governments to take urgent action in applying these new Guidelines, including their dissemination to the shipping industry, and to use them as a basis for any measures they adopt with a view to minimizing the risks mentioned above. Governments are requested to report to the MEPC on any experience gained in implementing these Guidelines, taking into account the Committee's ongoing work in developing legally binding provisions on ballast water management.

IMO Publication, Sales number: IMO-661E, ISBN 92-801-1454-9. Available from the International Maritime Organization, 4 Albert Embankment, London SE1 7SR.

IMO Guidelines for sampling and identification of oil spills

The IMO Guidelines for Sampling and Identification of Oil Spills are intended to provide guidance to governments,

including those of developing countries, on the techniques, equipment and strategies for sampling oil to identify unknown sources of spilled oil. Although references are given for the laboratory methods required for analysis, the emphasis in this text is on the details of the field work required to collect the samples.

The integrity of the samples at every point from collection through shipment and analysis is important. The foundation of any chemical analysis is sampling. Sampling correctly provides a representative portion of oil that is not contaminated by other products. Storage and shipment ensure that the sample will not deteriorate before it can be analysed. For oil spills in particular, the analytical process involves comparing the chemical characteristics, or "fingerprints", of the spilled oil and various suspected sources. Therefore, success in matching spills to sources depends on knowing locations where samples should be taken. The education of field samplers with the information in this publication will facilitate the identification of the sources of spilled oil.

This publication has been written to provide a comprehensive and detailed explanation of all aspects of the sampling process. These Guidelines, which deliberately include many different options that are currently in use, may be used in several ways. They can be provided directly to field personnel or used as a basis to prepare guidelines specifically for individual countries.

The draft of this document was developed by a working group formed of technical experts who attended the 1995 Oil Spill Research and Development Forum, which was held at IMO headquarters in London in May 1995. LCDR Kristy Plourde of the US Coast Guard Marine Safety Laboratory chaired the working group and prepared the draft, with active participation by experts from Australia, Bulgaria, the UK, Germany and Denmark.

IMO Publication, Sales number: IMO-578E, ISBN 92-801-1451-4. Available from the International Maritime Organization, 4 Albert Embankment, London SE1 7SR.

SOLAS, International Convention for the Safety of Life at Sea, 1974. 1996 Amendments, effective July 1998

The publication contains amendments to the International Convention for the Safety of Life at Sea (SOLAS), 1974, adopted by the Maritime Safety Committee (MSC) of IMO during 1996.

Resolution MSC.47(66) was adopted by the MSC at its sixty-sixth session (May/June 1996) and contains amendments to chapter II-1 to include, in particular, a new part A-1 on structure of ships and damage stability requirements for cargo ships of 80 m in length and upwards but not exceeding

100 m; to chapter III, which was totally revised; to chapter VI, to deal with loading, unloading and stowage of bulk carriers; and to chapter XI. By way of the revised chapter III, the International Life-Saving Appliance (LSA) Code, adopted by MSC by resolution MSC.48(66), has been made mandatory under SOLAS.

Resolution MSC.57(67) was adopted by MSC at its sixty-seventh session (December 1996) and contains amendments to chapter II-1 regarding structure of ships and machinery and electrical installations; to chapter II-2 relating to fire protection of ships; and to chapter VII dealing with the carriage of dangerous goods. The amendments to chapter II-2 have, in particular, made the International Code for Application of Fire Test Procedures (FTP Code), adopted by MSC by resolution MSC.61 (67), mandatory under SOLAS.

Subject to the "tacit acceptance" procedure, both sets of amendments are expected to enter into force on 1 July 1998.

Footnotes in this publication have been added for ease of reference. They do not form part of the SOLAS Convention.

IMO Publication, Sales number: IMO-167E, ISBN 92-801-1447-6. Available from the International Maritime Organization, 4 Albert Embankment, London SE1 7SR.

Blue Motion-The World Directory of Video & CD-ROM on Fisheries and Aquatic Environment

by Gary Bernacsek. Published by Global Aquatic Corporation Pty Ltd Australia, October 1997.

This book is a compilation of technical and educational videos and CD-ROM, dealing with every aspect of fisheries and aquatic environment including: how to mount nets and repair motors, fish biology, fishing, processing and marketing, conservation and environmental impact assessment. It also contains a listing of feature films on fisheries and contact addresses of sources of videos and CD-ROM. A comprehensive subject index lets you find what you need fast.

Available from: Global Aquatic Corporation Pty Ltd, 45 Birchgrove Road, Balmain NSW 2041, Sydney, Australia. Tel./Fax: (61-2)95557151. (Source: *INFOFISH International* 2/98)

Directory of Fish Importers, Exporters and Producers: Europe

Published by FAO GLOBEFISH, October 1997

Covering 22 countries in Europe, the Directory contains the list of importers, exporters and processors by country in alphabetical order, and by 10 major species. The Directory is divided into five sections. The first section provides the full details of the companies, listed by country in alphabetical order. The second section covers the list of importers, the third is on exporters and the fourth covers the list of processors. The last section provides the list of companies by species. It is a user-friendly guide with 255 pages.

Available from: FAO GLOBEFISH, FAO of the United Nations, Fishery Industries Division, 00100 Rome, Italy. Tel.: 57056313/5059, Fax: 57055188. (Source: *INFOFISH International* 2/98)

The Market for Fish in Southern Africa

by Benedikte Jacobsen. Published by FAO GLOBEFISH, Rome, Italy, December 1997.

The publication reviews the market for fish and fish products in Southern Africa, covering seven countries in the region. Local production, demand, market structure, intra-regional trade and trends in imports are explored in the document.

Available from: INFOFISH, P.O. Box 10899, 50728 Kuala Lumpur, Malaysia. Tel.: (603)2914466. Fax: (603)2916804. (Source: *INFOFISH International* 2/98)

A Guide to Tilapia Farming

by Rafael D. Guerrero III. published by Aquatic Biosystems, Philippines, 1997.

This well illustrated guidebook includes the latest farm-tested techniques for the culture of tilapias worldwide. The document is expected to help the beginner in starting tilapia venture right and also to serve as a handy reference for those planning to engage or those already in the business.

Available from: The Publisher, Aquatic Biosystems Bay, Laguna 4033, Philippines. Price: P 200 (Philippines) or US\$ 15 (other countries). Tel.: (63-49)2493406. (Source: *INFOFISH International* 2/98)

EEZ Technology

A Review of Advanced Technologies for the Management of EEZs Worldwide. Published by ICG Publishing Ltd, London, 2nd edition 1998.

The aim of the publication, EEZ Technology is to disseminate information and to educate specifiers regarding controlled exploitation of the EEZ's, as the concepts of sustainable development and environmental protection are achieving greater importance. Contents in the report are classified into various sections including global issues, R&D, policing and administration, surveillance and electronic detection, fisheries and environmental issues.

Information: ICG Publishing Ltd, Russell House, 28 Little Russell Street, London WC1A 2HN, United Kingdom. Tel.: (44-0171)4040123. Fax: (44-0171)4041670. (Source: *INFOFISH International*, 4/98)

Perspectives in Asian Fisheries

Edited by Sena S. De Silva. Published by Asian Fisheries Society, 1996.

This book is published in commemoration of the tenth anniversary of the Asian Fisheries Society with some wide-ranging topics of the Asian fisheries industry. Topics of importance range from socio-economic issues to aquaculture and biology of fish, to processing and trends in Asian fisheries. Since aquaculture has become a more dominant issue in fishery development in the region, the publication is skewed towards aquaculture topics. However it gives the reader a broad cross-sectional view of the fishery sector in Asia and of issues related to the sector's long-term sustainability.

Available from: Asian Fisheries Society, MCPO Box 2631, Makati City 0718, Philippines. (Source: *INFOFISH International* 1/98)

Directory of Aquaculture Producers of Latin America and the Caribbean 1997/98

Published by INFOPECSA. The publication is a testimony to the growing importance of aquaculture in Latin America and the Caribbean. It contains a detailed list of 606 aquaculture producers by country in Section 1, alphabetical list of the producers in section 2 and in section 3, a list of producers by species. World aquaculture statistics in brief are also available in graphical presentation and figures.

Available from: INFOPECSA, Casilla de Correo 7086-Correo Central, Montevideo, Uruguay. Tel.: (598-2)9028701. Fax: (598-2)9030501. (Source: *INFOFISH International* 1/98)

Post-harvest fisheries development

A guide to handling, preservation, processing and quality. Compiled by I. J. Clucas and A. R. Ward. Published by Natural Resources Institute, United Kingdom.

This publication is an updated version of a two-volume report on fish handling, preservation and processing in the tropics, published in the early 1980s by the Tropical Products Institute (a forerunner of NRI). It is designed to bring to a lay audience the basic concepts behind post-harvest fisheries science and technology, both in modern and traditional fisheries in many parts of the world. While fisheries all over the world face full exploitation or even over-exploitation, there is a need to ensure that the fish caught reaches consumers with minimal losses and at the quality demanded by fish consumers. This requires policy makers and fishery workers, as well as all decision makers, to have an understanding of the post-harvest fisheries.

Available from: Natural Resources Institute, Central Avenue, Chatham Maritime, Kent ME4-4TB, United Kingdom. Price £25.00. (Source: *INFOFISH International*, 6/97)

Seafood Safety, Processing and Biotechnology

Edited by Fereidoon Shahidi, Yvonne Jones and David D. Kitts. Published by Technomic Publishing Company Inc., Lancaster, PA, USA, 1997.

The publication carries twenty-five articles related to seafood safety, processing and biotechnology. Safety issues, nutritional issues and formation of potentially toxic products, fish parasite detection, utilization of HACCP in the prevention and control of food-borne trematodes in aquaculture fish etc., are discussed in several articles.

The publication also covers topics related to assay of fish components and contaminants, such as assessment of marine toxins, analysis and confirmation of domoic acid in shellfish, HPLC analysis of antibiotics in salmonids, identification of shellfish using electrophoresis as well as topics related to development of models for microbial growth and survival, prediction of microbial fish spoilage and general issues related to predictive microbiology.

The development of mince products, use of fish oil in foods and concentration of omega-3 fatty acids from marine oils and some areas of special interest to the processing industry are given. The publication also provides coverage on the utilization of fish waste for animal feeds and fertilizers.

Available from: Technomic Publishing Co. Inc., P.O. Box 3535, 851 New Holland Avenue, Lancaster, PA 17604-9961, USA. Fax: (717)2954538. (Source: *INFOFISH International* 6/97)

Dynamics of marine sands

A manual for practical applications by Richard Soulsby.

The movement of sediment in rivers, estuaries and the sea is a subject of great practical importance for engineering applications, and is also a fascinating and challenging area of academic research.

However, the practical engineer looking for an urgent solution to a sediment-related project often finds that the results of the relevant academic research are published in unfamiliar language in journals and conference proceedings that are not easily available. Dynamics of marine sands bridges the gap between academic research and practical applications by summarizing the research results in a unified form, backed up by worked examples and case studies.

This comprehensive new book presents methods for calculating the various hydrodynamic and sediment-dynamic

quantities necessary for marine sediment transport applications, and recommends the most appropriate methods to use for engineering projects. It is also a valuable text for eaching purposes for graduate engineers, oceanographers and earth scientists.

Dynamics of marine sands specifically deals with coastal and offshore sea areas, as well as rivers and estuaries, for sand and gravel sediments. The book presents a convenient and usable introduction to sediment processes in a form that is accessible to a wide readership.

January 1998. Hardbound. 250 pp., 234x156 mm, 072772584 X, Price: £50.00. Available from The Book Sales Department, Thomas Telford Ltd, 1 Heron Quay, London E14 4JD.

Scour at marine structures

by Richard Whitehouse.

The topic of scouring has received a large amount of attention at both the academic and research level, elucidating the processes and developing predictive formulae, and at the practical level, where the potential and likely extent of scour around a specific structure has been studied as part of engineering works. This has led to the generation of a large and diverse literature on scour, with different conventions and approaches being used.

Scour at marine structures brings together the research results and the practical findings to provide researchers and practitioners with a state-of-the-art review of scour by waves and currents. It also provides methodologies to assess the potential for scour and the extent of scour at a given coastal or offshore site.

May 1998. Hardbound. 216 pp. 234x156 mm, 072772655 2, Price: £45.00. Available from The Book Sales Department, Thomas Telford Ltd, 1 Heron Quay, London E14 4JD.

Concrete in coastal structures

Edited by R.T.L. Allen.

Many types of structure are subject to maritime conditions, and construction and maintenance of coastal structures is a major part of the construction workload of any country bordering the sea. This book is a comprehensive source of information for all who are concerned with the commissioning, design, construction or maintenance of concrete structures in or near the sea. As well as describing the nature of the marine environment and the effects of man-made structures on the behaviour of the sea, this book deals with hydraulic design, the material properties of concrete and the design and specification of structures for coastal environments. The deterioration of concrete in coastal structures is usually a result of lack of durability rather than overloading, so much of the book has been directed towards the production of durable structures. British standards and other standards and codes from around the world are discussed, along with the planning of construction works under coastal conditions, and the maintenance of coastal structures.

All of the chapters were written specially for this book by practising engineers with specialized knowledge and wide experience of coastal engineering. As most of the authors have been responsible for work in many parts of the world, this book is relevant regardless of where coastal structures are situated.

May 1998. Hardbound. 312 pp, 276x219 mm, 07277 2610 2, Price: £55.00.

Available from: The Book Sales Department, Thomas Telford Ltd, 1 Heron Quay, London E14 4JD.