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OF MARINE POLLUTION
- GESAMP -

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Report of the Twenty-second Session

Vienna, 9–13 March 1992

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IMO/FAO/Unesco/WMO/WHO/IAEA/UNEP Joint Group of Experts
on the Scientific Aspects of Marine Pollution (GESAMP)

REPORT OF THE TWENTY-SECOND SESSION

Vienna, 9–13 March 1992

IAEA 1992

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NOTES

1 GESAMP is an advisory body consisting of specialized experts nominated by the Sponsoring Agencies (IMO, FAO, Unesco, WMO, WHO, IAEA, UN, UNEP). Its principal task is to provide scientific advice on marine pollution problems to the Sponsoring Agencies and to the Intergovernmental Oceanographic Commission (IOC).

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Definition of marine pollution by GESAMP:

"POLLUTION MEANS THE INTRODUCTION BY MAN, DIRECTLY OR INDIRECTLY, OF SUBSTANCES OR ENERGY INTO THE MARINE ENVIRONMENT (INCLUDING ESTUARIES) RESULTING IN SUCH DELETERIOUS EFFECTS AS HARM TO LIVING RESOURCES, HAZARDS TO HUMAN HEALTH, HINDRANCE TO MARINE ACTIVITIES INCLUDING FISHING, IMPAIRMENT OF QUALITY FOR USE OF SEAWATER AND REDUCTION OF AMENITIES."

* * *

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Reports & Studies No.	Title	Date	Language
25.	Report of the Fifteenth Session	1985	E,F,R,S
26.	Atmospheric Transport of Contaminants into the Mediterranean Region	1985	E
27.	Report of the Sixteenth Session	1986	E,F,R,S
28.	Review of Potentially Harmful Substances. Arsenic, Mercury and Selenium (Published also as UNEP Regional Seas Reports and Studies No. 92)	1986	E
29.	Review of Potentially Harmful Substances. Organosilicon Compounds (Silanes and Siloxanes) (Printed in limited number by IMO and published also as UNEP Regional Seas Reports and Studies No. 78)	1986	E
30.	Environmental Capacity. An approach to Marine Pollution Prevention (Published also as UNEP Regional Seas Reports and Studies No. 80)	1986	E
31.	Report of the Seventeenth Session	1988	E,F,R,S
32.	Land-sea Boundary Flux of Contaminants: Contributions from Rivers	1987	E
33.	Report of the Eighteenth Session	1988	E,F,R,S
34.	Review of Potentially Harmful Substances. Nutrients	1989	E
35.	The Evaluation of the Hazards of Harmful Substances Carried by Ships: Revision of GESAMP Reports and Studies No.17	1989	E
36.	Pollutant Modification of Atmospheric and Oceanic Processes and Climate: Some Aspects of the Problem (Printed in limited number by WMO and also published as UNEP Regional Seas Reports and Studies No.117)	1989	E
37.	Report of the Nineteenth Session	1989	E,F,R,S
38.	Atmospheric Input of Trace Species to the World Ocean	1989	E
39.	The State of the Marine Environment	1990	E
40.	Long-Term Ecological Consequences of Low-Level Contamination of the Marine Environment	1989	E
41.	Report of the Twentieth Session	1990	E,F,R,S
42.	Review of Potentially Harmful Substances. Choosing Priority Organochlorines for Marine Hazard Assessment	1990	E
43.	Coastal Modelling	1990	E
44.	Report of the Twenty-first Session	1991	E,F,R,S
45.	Global Strategies for Marine Environmental Protection	1991	E
46.	Review of Potentially Harmful Substances	1991	E
47.	Reducing Environmental Impacts of Coastal Aquaculture	1991	E
48.	Global Change and the Air/Sea Exchange of Chemicals	1991	E
49.	Report of the Twenty-second Session	1992	E,F,R,S

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GESAMP REPORTS AND STUDIES PUBLICATIONS

These Reports may be obtained from any of the Sponsoring Agencies in the Language(s) indicated
English, French, Russian, Spanish

Reports & Studies No.	Title	Date	Language
1.	Report of the Seventh Session	1975	E,F,R,S
2.	Review of Harmful Substances	1976	E
3.	Scientific Criteria for the Selection of Sites for Dumping of Wastes into the Sea	1975	E,F,R,S
4.	Report of the Eighth Session	1976	E,F,R
5.	Principles for Developing Coastal Water Quality Criteria (Published also as UNEP Regional Seas Reports and Studies No. 42)	1976	E
6.	Impact of Oil on the Marine Environment	1977	E
7.	Scientific Aspects of Pollution Arising from the Exploration and Exploitation of the Sea-bed	1977	E
8.	Report of the Ninth Session	1977	E,F,R,S
9.	Report of the Tenth Session	1978	E,F,R,S
10	Report of the Eleventh Session	1980	E,F,S
11.	Marine Pollution Implications of Coastal Area Development	1980	E
12.	Monitoring Biological Variables related to Marine Pollution	1980	E,R
13.	Interchange of Pollutants between the Atmosphere and the Oceans (First report)	1980	E
14.	Report of the Twelfth Session	1981	E,F,R
15.	The Review of the Health of the Oceans (Published also as UNEP Regional Seas Reports and Studies No. 16)	1982	E
16.	Scientific Criteria for the Selection of Waste Disposal Sites at Sea	1982	E
17.	The Evaluation of Hazards of Harmful Substances Carried by Ships	1982	E
18.	Report of the Thirteenth Session	1983	E,F,R,S
19.	An Oceanographic Model for the Dispersion of Wastes Disposed of in the Deep Sea	1983	E
20.	Marine Pollution Implications of Ocean Energy Development	1984	E
21.	Report of the Fourteenth Session	1984	E,F,R,S
22.	Review of Potentially Harmful Substances	1985	E
23.	Interchange of Pollutants Between the Atmosphere and Oceans (Second report)	1985	E
24.	Thermal Discharges in the Marine Environment	1984	E

IV. ORGANIZATIONAL ELEMENTS OF STRATEGY

IV.1 Institutional arrangements

36. The effective implemantation of any strategy, or elements thereof, for marine environmental protection and management, at regional, national or international levels, depends upon cooperation and coordination among many agencies and jurisdictions.

37. Implementation of the strategy requires clear national policies based on international obligations, a sound legal basis, and opportunities for wide input and participation from all sectors of society. It must involve processes for planning and consultation between parties both at the onset and throughout the conduct of coastal management.

38. Agreement between parties on the objectives and design of parts of the strategy is essential for achieving its goals. This is especially true for scientifically-based parts of the strategy such as monitoring.

39. A lead agency and committed cooperating agencies in each country, responsible and accountable for all policies, programmes and actions leading from strategy, are also clearly required.

IV. 2 Public awareness and participation

40. The ability of the public to distinguish between the relative importance of marine environmental issues needs strengthening. It is equally important that decision-makers are fully aware of public aspirations.

41. Many wrongly assume that public participation means decision-making by the public. On the contrary, the roles of the public and desicion-makers are distinct.

42. Public participation in the process of decision-making should be encourage and facilitated. Those who receive public input have an obligation to publicly indicate whether, how, and to what extent, public views have been taken into account when the final decisions are made.

IV. 3 Data and information management

43. Effective marine and coastal environmental management requires the acquisition, storage, retrieval, exchange, quality assessment and application of appropriate data and information.

44. Information management facilitates the storage and access of data and reduces duplication and loss. It provides opportunities for the use of standard procedures of measurement and the efficient collection, compilation and storage of data, preferably in electronic forms. It must incorporate quality assurance, the adoption of compatible data formats and ensure data retrieval in a form suitable for synthesis, evaluation, reporting and planning.

45. Integrated environmental databases, especially Geographic Information systems (GIS), are essential for long-term coastal zone management. They readily assist in the translation of data of various types into accessible information useful for decision-makers.

IV.4 Legal obligations and enforcement

46. The obligations to protect the marine and coastal environment assumed by states through existing national legislation, as well as through regional and global agreements, must be implemented and enforced in a more effective way.

GESAMP XXII
(9-13 March 1992)

1 INTRODUCTION

1.1 The Joint Group of Experts on the Scientific Aspects of Marine Pollution (GESAMP) held its twenty-second session at the Headquarters of the International Atomic Energy Agency (IAEA), Vienna from 9 to 13 March 1992, under the chairmanship of Mr. D. Calamari. Mr. J. Gray was Vice-Chairman of the session.

Opening of the session

1.2 Mr. Jia-Luo Zhu, Director of the IAEA Division of Nuclear Fuel Cycle and Waste Management, on behalf of the Director General of the IAEA, welcomed the Group to this session. Mr. Zhu emphasized the importance of GESAMP as a multidisciplinary advisory body which brought a wide range of expertise to bear on problems put forward by the sponsoring agencies in relation to particular aspects of marine pollution. The IAEA has benefitted from the work of GESAMP over the years in particular with regard to issues related to the sea disposal of radioactive wastes. Mr. Zhu noted further the concern of the international community related to potential global environmental effects of human activities on this planet. He appreciated that GESAMP has taken action in providing an input to the forthcoming United Nations Conference on Environment and Development (UNCED) to be held in Brazil in 1992. Finally, Mr. Zhu wished the Group every success in this session.

1.3 The Chairman thanked Mr. Zhu on behalf of the participants for his good wishes for the success of this session.

1.4 The Chairman informed the Group that Mr. Michael Waldichuk (Canada) who had attended altogether fourteen sessions of the Group and was a Chairman of three GESAMP sessions, as well as of many GESAMP Working Groups, had died unexpectedly during the intersessional period. Mr. Waldichuk was recognized as one of the founding fathers of GESAMP and the Group considered his work and his impact on the development of GESAMP to be highly significant. The Group noted his passing away with deep regret.

Adoption of the agenda

1.5 The agenda for the session as adopted by the Group is reproduced in Annex I. The list of documents considered at the session is given in Annex II. The list of participants, shown in Annex III, includes a representative from Greenpeace International who was invited to discuss certain issues under items 2 and 3 of the agenda.

2 STATE OF THE MARINE ENVIRONMENT

2.1 Review of GESAMP Reports and Studies No. 39

2.1.1 The Group was informed of a request from IMO to respond to a critique submitted by Greenpeace to the Fourteenth Consultative Meeting of Contracting Parties to the London Dumping Convention (25-29 November 1991) (GESAMP XXII/2).

2.1.2 The Group noted that the Intersecretariat had agreed to invite two representatives from Greenpeace to attend the session when the comments of Greenpeace were discussed under this agenda item. Mr. Peter Taylor from Greenpeace was present.

2.1.3 The Chairman asked the Ex-Chairman (H. Windom), who had been involved in the preparation of the report on the State of the Marine Environment to describe the procedures used for the preparation of the report.

2.1.4 Work on the report had commenced in 1985. It is based on the reports of a number of GESAMP Working Groups as well as those of 12 review groups set up by UNEP, FAO and IOC on a regional basis, and also on the input from the GESAMP membership and that from invited experts from outside GESAMP. Members of GESAMP felt that the conclusions of the report are still valid. It was acknowledged that the report may eventually require updating and for this purpose a mechanism would have to be developed.

2.1.5 The Chairman informed Mr. Taylor that a response to the Consultative Meeting of Contracting Parties to the London Dumping Convention had been prepared as follows:

"GESAMP'S RESPONSE TO CONTRACTING PARTIES TO THE LONDON DUMPING CONVENTION REGARDING THE GREENPEACE CRITICISM OF GESAMP REPORTS AND STUDIES NO. 39 ON 'THE STATE OF THE MARINE ENVIRONMENT'

GESAMP has considered the comments made by Greenpeace on GESAMP Reports and Studies No. 39 "The State of the Marine Environment", as requested by the IMO Technical Secretary on behalf of the Contracting Parties to the London Dumping Convention (LDC). These comments clearly indicate that Greenpeace has reservations about the basis for the conclusions drawn by GESAMP in this report. GESAMP nevertheless reassures the Contracting Parties to the LDC that, contrary to the views expressed by Greenpeace, the wide consultative process adopted in the preparation of this report lends authority to its conclusions. Accordingly, GESAMP believes that the document constitutes the most authoritative evaluation of conditions in the marine environment in recent years.

GESAMP would like to clarify the following points:

Ranking of Marine Environmental Problems

GESAMP's ranking, on a global basis, of marine environmental problems has been questioned by Greenpeace. The ranking was based on a wealth of scientific evidence contained in the 12 UNEP/IOC/FAO Regional Reviews, several recent GESAMP Reports and Studies, and the expertise of those involved in the review who were drawn from diverse disciplines. Greenpeace has not ranked problems and not offered perspective on the seriousness of the issues it raises.

Distinction between coastal and oceanic environments

Greenpeace's position that a distinction between coastal and oceanic waters was unscientific, is incorrect. GESAMP used a definition of coastal waters wherein the offshore coastal zone boundary is at the shelf break. Coastal waters have physical, chemical and biological properties that are distinctly different from those of oceanic waters. Recognizing such differences does not suggest that exchanges across coastal-oceanic boundaries are unimportant.

Cleanliness of the open ocean

GESAMP's statement that "open oceans are relatively clean compared to coastal waters" does not imply that the open oceans are

III.5 Comparison of options

28. Marine environmental management implicitly requires that choices be made between various actions. Any decision to adopt a particular management strategy, technology or procedure should be preceded by a comparison of the advantages and disadvantages of realistically available alternatives. This does not mean that every conceivable alternative should be subject to detailed assessment.

While emphasis needs to be placed on the environmental advantages of the options considered, comparisons must also take account of economic and social-political factors. This will require a systematic evaluation of scientific and technical alternatives and the integration of the findings of this evaluation with non-technical evaluations. This involves careful balancing of the overall costs and benefits taking account of inherent uncertainties. Preferred options will be those which provide for sustainable uses of the environment and human health.

29. Actions designed to protect or manage the marine environment should also be evaluated for their potential to affect other sectors of the environment. Such evaluations should also take into account measures that prevent trans-frontier pollution or the unequal sharing of costs and benefits among neighbouring States.

30. It must be accepted that the relative state of knowledge on alternative approaches or technologies will vary. For this reason, direct comparisons between environmental and economic and socio-economic factors may sometimes prove difficult or impossible. These imbalances and associated uncertainties, as well as the steps required to reduce them, should be addressed within the comparative assessment process.

III.6 Monitoring

31. Considerable advances have been made in developing chemical and biological effects monitoring techniques. However, the potential for technically efficient and focussed monitoring has not yet been fully exploited.

32. Many current monitoring programmes have neither provided the required information on the state of the marine environment nor adequately determined the effects of anthropogenic activity that they were ostensibly designed to do. A further criticism is that monitoring programmes often continue without the periodic scientific and administrative reviews essential for ensuring their effectiveness.

33. Greater emphasis needs to be given to the specification of goals and objectives, the formulation of testable hypotheses, consideration and linkages between environmental compartments, quality control procedures and the statistical design of monitoring programmes.

34. When a well-designed monitoring programme results in unanswered questions about environmental impacts or early warnings of likely effects are detected, supportive research needs to be provided.

35. Monitoring programmes must also be tied to an a priori commitment for action when pre-determined consequences appear likely to be exceeded. Monitoring programmes must also be subject to regular assessment as to their effectiveness and revised or terminated if this is warranted.

III.3 Impact prediction and assessment

20. Impact prediction is an essential component of the broader Environmental Impact Assessment (E.I.A.) process.

21. The concerns regarding the effects of anthropogenic activities on the environment and human health comprise: physical alteration and disturbance of the natural environment; modification of natural biological systems; and the dispersion, fate and effects of chemicals into the environment. Impact prediction is the process whereby the potential effects or risks of anthropogenic activities on the marine environment are defined and quantified. Factors that need to be considered in an effect or risk prediction are: the scale (load) of the disturbance (physical, biological or chemical); identification of the critical components and processes of the system; and determination (modelling) of the fate and effects on the components which are potentially affected (hazard assessment). All of these factors embody a degree of uncertainty which usually can be quantified, and conservatively allowed for, in the assessment. Such predictions can be used to compare different development options on a common basis.

22. When an assessment reveals a potential problem, the relative scale of impact must be compared with those of alternative options. One of these options will be that of the abandonment of the proposed development. The assessment also provides a basis for a clearly-defined and well-focussed monitoring programme for ensuring that the consequences do not exceed those predicted.

23. Periodic reassessment of potential impact and of prevailing conditions in the affected environment is essential.

III.4 Classification of substances

24. Substances vary widely in the concentrations at which they can exert toxic effects on organisms. Their potential for transfer through food chains to predators, including humans, depends in part on their capacity for bioaccumulation. The extent to which a substance is distributed in the environment depends in part on its persistence. The three properties of toxicity, bioaccumulation and persistence in combination represent the hazardous properties of a substance and can be used as the basis for classification systems.

25. Such systems can be enlarged to include the risk of the substance appearing in certain environmental compartments at significant concentrations; relevant factors are the production, use, disposal and environmental distribution of the substance.

26. Existing classification systems vary in the extent to which these various properties and factors are utilized. Sub-division into classes is achieved by using arbitrary boundary criteria. Difficulties in allocation occur with chemicals whose attributes lie close to a class boundary. The accuracy of the relevant data available for each substance may be limited.

27. Classification systems provide only very crude guides to the potential harmfulness of substances. The classification of individual properties may be useful in the context of labelling, packaging and transport of substances, but inadequate as a basis for their environmental control and regulation. For this latter purpose, the totality of the relevant information on the individual properties and potential loads of each substance has to be subjected to critical scientific evaluation before an allocation to any grouping within a regulatory framework can be made.

uncontaminated. GESAMP sees nothing in the Greenpeace comments which would contradict this view.

Impacts of settlements in the coastal zones

GESAMP stands by its conclusion that increased population densities and urban development of the coastal zone are primary causes of anthropogenic impacts on the marine environment. The problems caused by sewage, especially in the absence of sound management practices, illustrate this situation.

Acceptability of contamination

GESAMP accepts that it is important to distinguish between the assessment and the acceptability of environmental changes caused by substances and wastes. GESAMP indeed made judgements on scientific grounds but does not presume that these will always be acceptable on political, social and economic grounds (i.e. to society as a whole).

Notwithstanding the above remarks, GESAMP welcomes constructive comments on any of its reports, from Greenpeace or any other organization, as a means of improving both the scientific basis of these documents and their value to the international community."

2.1.6 The representative from Greenpeace made several suggestions on how a future review of the state of the marine environment should be carried out.

2.1.7 The Group noted the proposals and thanked Mr. Taylor for his constructive suggestions.

2.2 Emerging issues of concern

2.2.1 The Chairman asked members of the Group to introduce issues which had come to their notice in the last twelve months and which they considered worth the attention of the Group. Major topics raised by members of the Group were as follows:

.1 The state of the Black Sea. Recently published data and information made available to the Group suggested that the Black Sea was in a much worse state than previously estimated. GESAMP expressed its deep concern about the deterioration of the environmental quality of the Black Sea that has occurred during the past few decades.

.2 PCBs in cod liver in the Barents Sea. New data show levels of PCBs which are as high as those found in the North Sea. This raised questions concerning the sources involved, and as to whether the problem was a general one for areas in high latitudes.

.3 Surface microlayer. Concerns have been expressed about the surface microlayer as a significant source of contaminant accumulation. In discussion, GESAMP raised questions as to the conditions under which the layer occurs and is modified, and on its significance for biological process and air/sea exchanges.

.4 Algal toxins. Reference was made to sea bird mortality due to an algal toxin present in fish on the US West Coast. Related items discussed were the causes of changes in toxicity of algal species and the physical factors controlling the distribution of toxic algal blooms.

.5 Low levels of organochlorines in marine mammals and birds. The continued uncertainty of the link between low levels of organochlorines was noted and mortality and pathology in marine mammals and birds were discussed.

2.2.2 GESAMP agreed to keep these items under consideration for possible inclusion in a future revision of the "State of the Marine Environment" report.

2.2.3 A member of the Group agreed to prepare intersessionally a short review on the significance of the surface microlayer for consideration by GESAMP XXIII.

3 COMPREHENSIVE FRAMEWORK FOR THE ASSESSMENT AND REGULATION OF WASTE DISPOSAL IN THE MARINE ENVIRONMENT

3.1 Review of GESAMP Reports and Studies No. 45

3.1.1 The IMO Technical Secretary introduced document GESAMP XXII/3 containing comments from Greenpeace on Reports and Studies No. 45 (1991) entitled "Global Strategies for Marine Environmental Protection". He explained that IMO had been requested by the Consultative Meeting of the Contracting Parties to the London Dumping Convention to relay the comments to GESAMP and to invite the Group to respond.

3.1.2 The Chairman welcomed the attendance of Mr. P. Taylor, a representative of Greenpeace, as an observer for this sub-agenda item.

3.1.3 The Chairman then informed Mr. Taylor that GESAMP had discussed the comments from Greenpeace in detail and had formulated its response as follows:

"GESAMP'S RESPONSE TO THE CONSULTATIVE MEETING OF CONTRACTING PARTIES TO THE LONDON DUMPING CONVENTION REGARDING THE GREENPEACE CRITICISM OF GESAMP REPORTS AND STUDIES NO. 45 'GLOBAL STRATEGIES FOR MARINE ENVIRONMENTAL PROTECTION'

The critique by Greenpeace contests many of the arguments and points of view that GESAMP has used to justify its proposal for a new and improved framework for marine environmental protection and management. Greenpeace questions GESAMP's motives in promoting a more structured approach to pollution control that would take full advantage of scientific knowledge and capabilities. GESAMP feels that this reflects a misunderstanding of the underlying purpose of the document.

GESAMP's consideration of strategic approaches to marine pollution control is predicated on the global state of the marine environment as described in the preceding GESAMP Reports and Studies No. 39 and other supporting scientific documents. In essence, there is clear evidence that certain sectors of the marine environment are seriously and adversely impacted by human activities and that remedial action is urgently required. GESAMP does not believe that this situation is due to a failure of science; rather, it is attributable to a failure to apply the best available knowledge and capabilities, both scientific and non-scientific, to environmental management.

Accordingly, the approach taken by GESAMP was to examine the many and various elements of environmental management. The next step was to search for linkages that would allow these elements to be combined into a common and comprehensive framework that would be globally applicable and consistent with the concept of sustainable development.

under the titles of " the principle of anticipatory environmental protection" and the "precautionary approach". The assimilative capacity concept does not conflict with these expressions of precaution; indeed advice on the application of the assimilative capacity concept previously developed by GESAMP clearly emphasizes the need for the adoption of a precautionary approach using scientific conservatism to allow for uncertainty.

15. Several recent interpretations of the precautionary principle would seem to imply that protection of the marine environment can be attained solely by progress towards a zero discharge policy. This is a flawed approach; rejection of scientifically based impact assessments will prevent proper allocation of priorities and rational evaluation of alternative options.

III. SCIENTIFIC ELEMENTS OF STRATEGY

III.1 Environmental management and planning

16. Development inevitably implies environmental change. The challenge for marine and coastal zone management is to balance short-term development needs against the long term sustainability of ecosystems, habitats and resources such that the range of choices and opportunities available to future generations is not diminished by the consequences of present development choices.

17. Comprehensive area-specific marine management and planning is essential for maintaining the long-term ecological integrity and productivity and economic benefit of coastal regions. Such management must incorporate comprehensive planning of waste management, including reduction of wastes, beneficial use or recycling of wastes, and treatment and disposal options that result in minimun harm to the environment and human health. It should also include local and regional management plans supported by quality criteria, assessments, monitoring and research.

III.2 The need for cleaner technologies

18. Considerable degradation of the coastal marine environment has resulted from the use of manufacturing processes now seen to be wasteful and environmentally-hostile. While the problem has been exacerbated by poor waste management, even the best treatment and disposal practices cannot be guaranteed to protect the environment against a constantly increasing quantity of substances and wastes that cannot be productively recycled.

19. Progress in the fields of industrial design and chemical engineering now afford the opportunity to use manufacturing technologies that substantially reduce waste production and facilitate the containment of harmful substances. These technologies are applicable both to the development of new processes and to the up-grading of existing ones. Their application must be seen as an integral part of national and international programmes for the protection of the marine and all other sectors of the environment. To this end, greater attention must be given to the establishment of advisory services for the transfer of clean technologies into national programmes for industrial development. Such services should be linked to regulatory systems that provide for periodic waste audits and environmental impact assessments for all major industrial developments. A number of information centres on clean technologies have already been established.

minimizes the impact of anthropogenic activities on the environment as a whole. It is both scientifically unsound and ethically to take measures to protect one sector of the environment without considering the implications of that action to other sectors or the costs and benefits attendant on that action. Thus, protection of the marine environment must include mechanisms for the comparison of benefits and detriments associated with options in other sectors.

II.3 The global perspective

8. The oceans constitute one global integrated system. There is consequently a need to consider the effects of anthropogenic activities on near-field and far-field scales. This dictates that any marine protection and management strategy should be regional in design but global in concept.

9. The scale of impacts resulting from present human activities, such as greenhouse gas production that may adversely affect global systems and processes, emphasizes the need for this global perspective.

II.4 Scientific basis of environmental protection

10. The effectiveness of management actions to protect the ocean cannot be assessed without scientific analysis and knowledge. Accordingly, comprehensive protection strategies should incorporate scientific principles; however, it is recognized that decision-making frequently involves considerations other than scientific arguments. Close interaction among scientists and decision-makers is essential.

11. The uncertainties inherent in predicting the consequences or effects of anthropogenic activity may lead to inadequate control measures, ranging from none to overly restrictive ones. However, despite such uncertainties, sufficient data and understanding frequently exist to allow conservative scientific predictions of the potential for environmental damage. Judicious application of available information will generally support the development and implementation of appropriate control measures. Where appropriate data do not exist, additional research is considered essential.

II.5 Important scientific concepts

12. The concept of assimilative capacity was advanced in the Declaration of the 1972 Stockholm Conference on the Human Environment. It reflects the fact that the environment can accommodate change providing this is not accompanied by deleterious effects. This concept must, however, be augmented with complementary measures to minimize adverse effects on the environment, including reduction of inputs at source, to the extent commensurate with social, economic and political circumstances. It must also be used within a mechanism for sound comparison among alternative options for the disposal of substances; this requires a multi-disciplinary approach.

13. Adoption of the assimilative capacity concept implicitly requires acceptance of a distinction between contamination and pollution with only the latter implying adverse effects on the environment or human health.

14. The concept of precaution is intrinsic to scientific prediction and allows the inherent uncertainties associated with scientific analysis and assessment to be accommodated. This concept has recently been adopted a a specific instrument of environmental protection policy

The framework developed by GESAMP is intentionally broad in scope. It contains elements that are inherently scientific and other elements that lie predominantly in economic, social and political spheres to which science merely acts in an advisory capacity. Assessments of risk and harm, and the acceptability of environmental change, are made at the political level. Such decisions will be strongly influenced by economic, social and political perspectives. However, scientific input is also legitimate and necessary. GESAMP believes that the absence of a comprehensive framework, identifying the essential elements of environmental management and protection, contributes to the continuing degradation of the oceans.

In summary, GESAMP Reports and Studies No. 45 seeks to stimulate debate on the opportunities for resolving environmental and development conflicts at national, regional and global levels. GESAMP welcomes responses and contributions that will lead to the development of the ideas contained in this report."

3.1.4 The above statement would be the basis of the response to the Consultative Meeting of the Contracting Parties to the London Dumping Convention and would be transmitted by IMO.

3.1.5 Mr. Taylor thanked the Group for having given him the opportunity to introduce Greenpeace comments. Mr. Taylor made a number of additional comments on Reports and Studies No. 45 to which the Group responded. The Group invited Greenpeace to produce its own version of global strategies for marine environmental protection and to publish this, as it feels appropriate.

3.2 Can there be a common framework for managing radioactive and non-radioactive substances to protect the marine environment?

3.2.1 The Group considered a study prepared by the GESAMP Working Group at a meeting held at IMO Headquarters, London, from 2 to 6 September 1991 under the Chairmanship of Mr. R. Boelens. The study (GESAMP XXII/3/1) was prepared in response to a question raised by the Inter-Governmental Panel of Experts on Radioactive Waste Disposal at Sea (IGPRAD) established under the London Dumping Convention, as follows:

"Examine the parallels between the regulatory approaches to, and environmental assessments of, the dumping at sea of both radioactive and non-radioactive wastes to identify opportunities for developing a common, comprehensive and holistic framework for the regulation of dumping at sea of all wastes".

3.2.2 The study prepared by the Working Group summarizes GESAMP Reports and Studies No. 45, reviews the principles and mechanisms designed to protect human health and the environment from excessive exposures to radioactive materials, and demonstrates the compatibility of the approaches currently used.

3.2.3 The Group discussed the study in detail and proposed a number of amendments which were included in the study (GESAMP XXII/3/1/Rev.1). After further discussion of the revised document during which some editorial changes were proposed, the Group adopted the study for publication as GESAMP Reports and Studies No. 45, Addendum 1. A summary is given in Annex IV.

4 REVIEW OF POTENTIALLY HARMFUL SUBSTANCES

4.1 Mutagenic and teratogenic substances

4.1.1 From a human health point of view, mutagenic and teratogenic substances may contribute to cancer induction and conversely carcinogenic substances are usually genotoxic. A brief review of the literature indicates that potentially mutagenic and teratogenic substances in the marine environment of major concern to human health are metals (e.g. Pb, Hg, Cd), organochlorine compounds (e.g. DDT, hexachlorocyclohexanes, PCBs), PAHs and components of oil.

4.1.2 An assessment of the carcinogenic risk to humans of most of these chemicals via exposure from seafood has been carried out in GESAMP Reports and Studies No. 46 "Review of potentially harmful substances: carcinogens". An additional GESAMP report "Review of potentially harmful substances: oil, and other hydrocarbons including used lubricating oils, oil spill dispersants and chemicals used in offshore exploration and exploitation" (in press) contains a detailed health risk assessment of oil and related products.

4.1.3 Based on these assessments, GESAMP concluded that a detailed review of potentially mutagenic and teratogenic substances is not warranted at this time.

4.1.4 There is limited information on mutagens and mutagenic effects in the marine environment. The probability is that these substances and effects may be relatively widespread. Nevertheless, the evidence available at present suggests that any harmful consequences on marine organisms are restricted in scale and significance. More research and study will be required to establish exactly how limited or serious the problems are, or might become. Until such information is available GESAMP urges caution, as with carcinogens, in relation to the release of known or suspected mutagens into the marine environment.

4.2 Organochlorine compounds

4.2.1 The FAO Technical Secretary informed the Group that no meeting was held by the sub-group on organochlorine compounds because no requests had been received from the Agencies to deal with specific hazard profiles.

4.2.2 The Chairman of the sub-group, Mr. R. Lloyd introduced document GESAMP XXII/4.3. He reported that general enquiries and a brief review of the literature indicated that there was indeed little information on the discharge of organochlorine substances, other than the persistent pesticides and PCBs to coastal waters. Studies were largely confined to analyses of concentrations of substances in the water (dissolved and/or total); there were no comprehensive data on loads, degradation and distribution between water, sediment and biota.

4.2.3 However, these studies showed that measurable amounts of the following substances can be found in certain estuaries and coastal waters:

Chloroform; 1,1,2-Trichloroethane; 1,1,2-Trichloroethylene; 1,1,2,2-Tetrachloroethylene; Chlorobenzene; Dichloroethane; Dichloroethylene; Trichlorophenol.

4.2.4 The chairman of the sub-group proposed that GESAMP could review relevant information on these compounds within a QSAR (Quantitative Structure-Activity Relationship) framework. This would be a natural extension of the initial study published as GESAMP Reports and Studies No. 42., and a prediction of the likely distribution of these substances in the water, sediment and marine biota may encourage scientists to make the corresponding field measurements and assessments.

ANNEX I

PROTECTING AND MANAGING THE OCEANS

Underlying Principles and Elements for the Protection and Management of the Marine and Coastal Environments

I. INTRODUCTION

1. The principles of environmental protection, as defined by the 1972 United Nations Conference on the Human Environment (Stockholm 1972), and since amplified by the World Commission on the Environment and Development, have led to the identification of principles and concepts which are now broadly accepted as underlying effective management of the environment and its resources.

2. Sustainable development implies that the present resources used by the population should neither be degraded nor exhausted to the point where they can no longer support future generations. This further implies that renewable resources which are currently used should be managed on an optimal yield basis.

3. To achieve sustainable development therefore development activities must be analysed from an integrated viewpoint including economic, social, cultural and environmental factors, and activities must be based on the sound use of the global resources. In the light of this it is important to consider the contributions which marine environmental assessment, monitoring, management and planning may make to sustainable development.

4. This document outlines principles and concepts that provide a rational basis for the sustained use of the marine and coastal environment including marine pollution control measures reflecting the generally accepted principles for marine environmental preservation and protection (e.g. UNCLOS Part XII). They should be considered for the formulation of appropriate strategies for marine protection and management, whether regional or global in scope, and serve as a background for the development of such strategies.

5. This document was prepared by the IMO/FAO/UNESCO/ WMO/WHO/IAEA/UN/ UNEP, Joint Group of Experts on the Scientific Aspects of Marine Pollution (GESAMP) on the basis of intersessional work and agreed at the twentieth session of GESAMP in May 1990.

II. STATEMENTS OF PRINCIPLE

II.1 Implications of sustainable development for marine environmental protection and management.

6. The concept of sustainable development implies that the present use of the marine environment and its resources shall not prejudice the use and enjoyment of that environment and its resources by future generations. Past practices that have neglected this principle are the fundamental cause of many current environmental problems.

II.2 The need for an "holistic" approach

7. In order to prevent the transfer of environmental problems from one sector of the environment to another, all sectors need to be managed and protected on a holistic basis that

in the global production and use of pesticides and fertilizer and their correlation with world population growth, it is likely that nutrients, pesticides and synthetic organic compounds will pose a greater threat to the marine environment in the future. It is also likely that the mobilization of sediment by man's activity will increase in relation to population growth, large-scale deforestation and poor land-development practices. Also, in certain areas damage has been caused by the reduction in freshwater flow to estuaries due to increased water demands by agriculture and expanding population. The threat posed by sediments to the marine environment, however, is obviously not as severe as that posed by nutrients or synthetic organic compounds.

77. From this, it can be concluded that the contaminants from land-based sources posing the greatest threat to the marine environment are probably sewage, synthetic organic compounds and nutrients.

K. NEEDS FOR INTERDISCIPLINARY MARINE RESEARCH TO LINK DEVELOPMENTAL AND ENVIRONMENTAL ISSUES

78. Marine environmental research of an interdisciplinary nature, linking developmental and environmental issues, must pursue at least three basic directions: above all, development of environmental impact assessment methodologies with predictive capabilities; additional large-scale interdisciplinary research on selected geographic areas; and study of the effects of and adaptation to low-level chemical contamination along industrialized and inhabited coastlines. Environmental impact assessment research should concentrate on the development of integrated biological and chemical techniques to detect and monitor potentially harmful change due to human interventions. Particularly important is research on large coastal water bodies, studying whole ecosystems in detail, especially to determine the cumulative extent of human impact in industrialized embayments.

79. Research that leads to more efficient and less wasteful production technologies can make a particularly important contribution, both to sustainable development and to the reduction of marine pollution. For example, knowledge of the effects and behaviour of substances in the marine environment should stimulate the innovation of treatment methods for sewage and other effluents so that such wastes can be more readily assimilated or recycled by natural marine systems.

L. COMPOSITION OF GESAMP

80. The studies undertaken by GESAMP at the request of its sponsoring agencies are, for the most part, relevant to all regions of the world and to all coastal States. However, it is recognized that in some cases reports and studies could be enhanced by the greater involvement of scientists from those regions to which the work is most applicable. Also, greater contact between GESAMP and its Working groups (which involve many scientists not members of GESAMP), and the scientific community in developing countries, would help to identify marine environmental problems which have not so far received sufficient attention.

81. With this in mind, GESAMP and the technical secretaries of the sponsoring agencies have discussed ways to increase the participation of scientists from developing regions in GESAMP and its Working Groups. In this regard, one possibility would be to hold some working group sessions at regional centres so as to facilitate the input and participation of selected experts familiar with local programmes and problems.

4.2.5 It was noted that a report is being prepared by the Mediterannean Action Plan on semivolatile organochlorinated hydrocarbons. That study proved the suitability of predictive models in the hazard assessment process for organochlorine compounds, and went some way towards satisfying the requests of GESAMP for verification of the applicability of predictive models. Also, progress was being made elsewhere in using QSARs to set water quality standards for homologous groups of compounds.

4.2.6 Taking into account also that to date no requests for specific hazard profiles have been received from the Agencies, the Group decided that there was no further need for work by the sub-group on organochlorine compounds.

4.3 Oil, and other hydrocarbons including used lubricating oils, oil spill dispersants and chemicals used in offshore exploration and exploitation.

Impact of oil and related chemicals and wastes on the marine environment.

4.3.1 The Technical Secretary of the International Maritime Organization introduced for consideration the draft final report prepared by the GESAMP sub-group on Oil, with the view to approval for publication in the Reports and Studies Series. The Chairman, Mr. P.G. Wells, gave a summary of the reviews considered, the major parts of the report that had received new attention, and the main points in the executive summary. He acknowledged the hard work of his Group during the last meeting from November 8 to 12 where the report was corrected, based on the technical reviews solicited during Summer 1991.

4.3.2 Comments and suggestions made by the GESAMP members based largely on the executive summary included the following:

.1 it should be explained why tropical coastal ecosystems are particularly vulnerable and sensitive to oiling;

.2 sections on the recovery of oiled seagrasses should be modified;

.3 the problem of crankcase oil in coastal waters in developing countries should receive more emphasis;

.4 the executive summary should be edited for clarity and emphasis of the main messages;

.5 some numbers describing inputs should be revised to reflect the correct precision, and the ranges should be given;

.6 the Gulf War spill should be mentioned with input figures;

.7 health assessment for lead should be revised using more recent information (i.e. GESAMP Reports and Studies No. 46);

.8 the usefulness, as currently understood, of bioremediation agents should be highlighted;

.9 general terms such as "small" or "many" should be quantified wherever possible, in the executive summary;

.10 the change in transportation routes since the last report should be described if data are available;

.11 the need for more information regarding land-based sources of oils should be highlighted;

4.3.3 The Chairman of the sub-group undertook to include the proposed amendments in the final report.

4.3.4 The Group agreed that the report be adopted for publication in the Report and Study Series as No. 50. The contents of the report are reflected in Annex V.

5 IMPACTS OF ANTHROPOGENICALLY MOBILIZED SEDIMENTS IN THE COASTAL ENVIRONMENT

5.1 In the absence of the Technical Secretary from UNESCO, the Chairman of the Working Group Mr. J. Gray, presented the report. In outlining the history of the Working Group, the Chairman conveyed the view that the Working Group had not been adequately funded to complete its task. Both the Chairman of the Working Group and the Group itself felt that the coverage of the report was uneven and did not reflect a truly expert review of the subject.

5.2 In discussion, GESAMP confirmed its opinion that the impacts of anthropogenically derived sediments on marine ecosystems was a serious and important problem and that a report was needed. However, and as indicated in the report to date, this subject should be considered on a more holistic non-sectoral basis. This issue was particularly important if the ultimate aim is to provide a sound scientific basis for coastal zone management.

5.3 As the Working Group reported, increased inputs of sediments to coastal areas may result in deleterious effects such as harm to living resources, hindrance to marine activities and reduction of amenities. The report also indicated that deleterious effects may result from decreased sediment inputs to coastal areas.

5.4 In view of the Working Group's findings, and the further sessional discussion of this topic by GESAMP Experts, it was recommended that this Working Group should continue its efforts but that its terms of reference (see report of the nineteenth session, item 8(c)) should be modified to reflect the need for a more holistic river-basin scale evaluation of the problem with the aim of providing a more appropriate scientific framework for managing the impacts of changing sediment inputs to coastal zones. The new terms of reference represent a refinement of the nine items previously listed, based on experience gained in preparing the draft report (GESAMP XXII/5). These are as follows:

.1 Review and quantify where possible the effects of land-based human activities on sediment transport rates and volumes in relation to watershed characteristics;

.2 Review on a regional basis the known and potential impacts of changes in sediment flux to coastal and near-shore waters on coastal environments, resources, amenities and human use; and

.3 Develop conceptual models that would provide a better understanding of the time scales which connect watershed activities and coastal impacts in different watershed types and regions.

6. EVALUATION OF THE HAZARDS OF HARMFUL SUBSTANCES CARRIED BY SHIPS

6.1 The IMO Technical Secretary gave a short outline of the achievements of the Working Group on the "Evaluation of the Hazards of Harmful Substances Carried by Ships", and the use of the results of the work by IMO bodies.

Substance	Status of Science and management	Known/Suspected Targets/Effects
Nutrients	Science limited Conservative management possible	Eutrophication Harmful algal blooms
Synthetic Organics	Science limited Conservative management possible	Human health Animal health
Sediment	Science limited Conservative management possible	Destruction of amenities (habitats/organisms) Decreased productivity
Litter	Science adequate Management deficient	Animal life Destruction of amenities
Metals	Science adequate Management deficient	Human health Animal health
Radionuclides	Science adequate Management adequate	Human health Animal health
Oil/Hydrocarbons	Science generally adequate* Management deficient	Animal health Destruction of amenities Decreased productivity
PAHs	Science limited Management deficient	Human health Animal health Foodstuff taint

* except for land-based sources of oil and associated neashore effects.

74. It can be concluded that radionuclides and heavy metals pose the least threat to the future viability of the marine environment. The remaining classes of contaminants can be divided generally into two groups: those for which an adequate scientific framework exists for environmental management and those for which such a framework does not exist.

75. The sources, fate and environmental effects of sewage, litter and petroleum (especially from oil spills) are fairly well understood. What is needed is improved management. For oil spills, the management strategies in place appear to be working. While information on litter is inadequate to evaluate the effectiveness of management strategies on a global scale, it is unlikely that this form of contamination poses a great threat to the viability of the marine environment. The management of sewage discharge, however, does not appear to be improving. The construction of waste treatment facilities in developing regions of world has not kept pace with population growth, and this situation is likely to worsen in the future.

76. For anthropogenically mobilized sediment, synthetic organic compounds, PAHs, oil and hydrocarbons, and nutrients from land-based sources, there still remain significant gaps in scientific understanding of sources, transport, fate and environmental effects. Based on trends

67. Since the beginning of the century, the transfer of aquatic species around the globe, either through deliberate introduction by man or by accident, has increased. Such transfers and introductions may alter or impoverish the biodiversity of the receiving ecosystem through inter-breeding, predation, competition for food and space, and habitat destruction. Genetic degradation of indigenous stocks is possible.

68. Farmed fish have been selected for traits which make them suitable for farming (e.g. rapid growth and placid behaviour) but less well adapted to the natural ecosystem. Thus, escaped fish could initially outcompete native stocks, but then decline, or the progeny resulting from inter-breeding could be poorly adapted to the ecosystem. There is insufficient information available to judge whether this interaction is a serious ecological impact. It is known that farmed fish do escape and that the numbers of escapees can be large. Some countries have initiated studies to address this issue and in recognition of the potential problem, Norway prohibits the siting of salmon farms within 30 kms of important salmon rivers.

69. It is unlikely that, in the marine environment, at global or regional levels, species other than higher vertebrates (reptiles, birds, mammals) will become extinct due to man's activities and thus change biodiversity. However, at subregional or local levels, such effects are likely. This could be counteracted by the establishment of carefully-selected nature sanctuaries and marine parks.

70. In view of the fact that some of the habitats in tropical coastal seas (e.g. coral reefs) belong to the most species-rich in the world, and considering that many of these habitats are threatened to become extinct, there is an urgent need to increase our knowledge about them. These communities constitute a rich resource both for taxonomic research and for chemical-pharmacological research, and have a great potential for future use in pharmacology and biotechnology.

71. Genetic diversity of fish stocks can suffer as a result of irresponsible fishing, e.g. where due to too small mesh sizes, only small early spawners can escape and reproduce.

72. In recent years, great advances have been made using molecular biological techniques for the study of natural systems and the manipulation of farmed organisms. Yet in general the application of such techniques to marine organisms has lagged behind developments in the terrestrial system. It is necessary to focus on the application of molecular techniques to marine systems, particularly in marine environmental aspects. Transfer of technology relevant to molecular techniques from developed to developing countries must be a priority area.

J. PRIORITY CONTAMINANTS FROM LAND-BASED SOURCES

73. The Table below lists the contaminants from land-based sources which constitute the greatest real or perceived threat to the marine environment. Assignments under the heading of Status of Science and Management relate to routine operations in the civil sector; they do not relate to catastrophic accidents.

Substance	**Status of Science and management**	**Known/Suspected Targets/Effects**
Sewage	Science adequate Inadequate management	Human health Pathogens Eutrophication

6.2 The Chairman, Mr. P.G. Wells, gave a brief summary of the work accomplished at the 26th session of the Working Group (London, 8-12 April 1991), covering intersessional work, correspondence with the chemical industry, evaluation of the various categories of substances, review of hazard profiles of several specific groups of chemicals, consideration of copper and copper compounds, consideration of floating chemicals, marine toxicity testing schemes, data computerization and specific issues on lube-oil additives, the carriage of petroleum solvents and coal tar fractions.

6.3 A number of comments were received from the GESAMP members, including:

.1 the request that current application of the definition of column A ratings be carefully compared to previous studies and that the bioaccumulation ratings be re-examined;

.2 observations of considerable differences of values reflecting toxicity to fish versus crustaceans are common; high toxicities measured in tests may also be due to artifacts in the exposure conditions;

.3 consideration should be given in the future to a subdivision of Category 4, Column B, where LC50's are below 1 mg/l.

6.4 The Group also expressed concern about the large number of petrochemicals discharged and carried under conditions of MARPOL 73/78, Annex I rather than under Annex II of the Convention.

6.5 The Chairman undertook to transmit the above suggestions and comments to the Working Group for consideration at the next meeting.

6.6 The contents of the report of the Working Group are listed in Annex VI.

7. ENVIRONMENTAL IMPACTS OF COASTAL AQUACULTURE

7.1 The FAO Technical Secretary recalled that at the twenty-first session of GESAMP, the Chairman of the Working Group, Mr. Chua Thia-Eng had been requested to prepare a scoping document on the feasibility of undertaking work on the following subject areas:

.1 the preparation of a comprehensive review on viral, bacterial and parasitic human diseases associated with coastal aquaculture operations covering potential health risks, prophylactic measures and hygienic surveillance schemes;

.2 the establishment of monitoring procedures for aquaculture-specific pollutants leading to the assessment of the environmental capacity of aquaculture operations;

.3 the formulation of guidelines for the safe use of chemicals in coastal aquaculture based on drug-specific information, including mode of use, drug withdrawal times and environmental fate; and

.4 the formulation of a preliminary aquaculture-specific contingency plan for red tide outbreaks.

7.2 The Chairman of the Working Group, introduced a document (GESAMP XXII/7), which he had prepared to identify critical areas in present and future coastal aquaculture activities that require interventions to reduce impacts on the environment and on human health. He reported that there had been very little response from experts and agencies contacted for contributions to the paper, and that he was not very optimistic on what could

be achieved in the future by correspondence, taking into account that due to financial constraints, it was unlikely that the Working Group could meet during the forthcoming intersessional period. Furthermore, a number of international bodies are currently working on a number of related subjects, e.g. FAO/WHO on the Codex Alimentarius, ICES (International Council for the Exploration of the Sea), ICLARM (International Center for Living Aquatic Resources Management), NACA (Network of Aquaculture Centers in Asia). A number of relevant meetings have been convened recently on the above and related issues.

7.3 The Group pointed out that it is important and a matter of urgency to regulate the use of chemicals and drugs in coastal aquaculture in developing countries where most coastal aquaculture practices occur. However, it was recognized that even in developed nations, compiling information on the use of such substances turned out to be difficult, and progress in this direction has been slow.

7.4 Mr. Chua proposed to either disband the Working Group or to keep it in abeyance for one year to await the outcome of the work of the other groups. A subject which however could be tackled without waiting for the results from the other groups, would be the compilation of practical guidelines for environmentally sound management of aquaculture in developing countries. Such guidelines would be very useful and timely.

7.5 In view of the considerable importance of aquaculture in the coastal regions of developing countries, and the concomitant potential for environmental damage being caused by such activity, the Group recommended that the Working Group should remain in existence for a further year with the following limited terms of reference:

.1 the Working Group should consider the preparation of general guidelines for aquaculture development within the overall framework of Integrated Coastal Zone Management; these should include in particular the need to avoid human and environmental health risks arising from the use of chemicals; and

.2 to this end, the Chairman of the Working Group should maintain contact with other regional groups and organizations such as ICES, NACA, IOC, FAO, WHO and review the relevant literature which is being produced in order to assess its relevance to the problems and needs of developing countries and to report progress to the next Session of GESAMP.

7.6 The conclusions of the scoping document are recorded in Annex VII.

8 BIOLOGICAL INDICATORS OF MARINE ECOSYSTEM 'HEALTH'

8.1 Increasingly national, regional and international bodies require assessment of the state of the marine environment within their jurisdiction. Yet there are few accepted indicators that are available to make such assessments at the level of ecosystems.

8.2 Given GESAMP's role in the periodic assessment of the state of the marine environment, and the scientific assessment on man's impact on the marine environment, it is important that GESAMP define environmental criteria that can be used to indicate 'health' of marine ecosystems. Ecosystems incorporate physical, chemical and biological properties which operate as an integrated whole. It is recognized that physical and chemical indicators alone may not detect changes in ecosystems caused by natural or anthropogenic

input pathway, and human activities, the major source. This is particularly true of marginal, inland and shelf seas. Present day fluxes are highest from developed regions, but future projections are that the anthropogenic component of atmospheric fluxes may increase in the future relatively more rapidly in developing regions.

61. These findings parallel those for the riverine flux of nutrients for which the present day anthropogenic component equals or exceeds the natural component. Here also the ratio of the anthropogenic to the natural component is highest for developed regions of the world but future projections indicate that the anthropogenic component will increase relatively more rapidly in developing regions.

H. TOLERANCE OF MARINE ECOSYSTEMS TO CHANGES IN OCEAN CIRCULATION PATTERNS, CLIMATIC VARIATIONS AND LONG-TERM CLIMATE CHANGE

62. This is a highly complex question which GESAMP has not previously been asked to address. The possibility of major changes in oceanic circulation caused by natural long-term climatic cycles or anthropogenic modifications of atmospheric composition clearly exists. While marine ecosystems will change in response to major shifts in oceanic circulation patterns, especially at regional levels, change and adaptability is an inherent property of such ecosystems, as evidenced by geological history. However, the detailed nature of such change would be most appropriatedly addressed by the International Panel on Climate Change (IPPC).

63. There is a need for more modelling studies with coupled ocean-atmosphere models of a sufficiently fine resolution to give realistic simulations of the atmosphere and ocean circulations, and using gradual increases in CO_2, to allow proper assessment of transient effects.

64. Assessment is needed of the impact on ocean mixing and marine processes of a more stable thermocline caused by more rapid warming of the surface than deeper layers.

65. Although Global Circulation Models (GCM) predict likely global changes in climate and its effects, the link to local regional models has not been made. It is at regional levels, particularly in the coastal zone, that the effects of climate change will be first felt. There is a need to develop regional coastal models of climate change which can be linked to the GCM. After such models are developed, proper planning and management of the effects of climate change on the coastal zones will be possible.

I. RESEARCH NEEDS IN MARINE BIOTECHNOLOGY AND MARINE BIODIVERSITY

66. The need for conservation of biodiversity of aquatic organisms is apparent at several levels. In wild stocks, the loss of species, and more specifically local races, through bad fishing practices, environmental change or species introduction (including escapes of cultured species into open waters), is a real and persistent danger. Although fisheries and aquaculture have lagged behind other sectors in the exploitation of genetics and biotechnology for management and development, advantages of genetic manipulation to aquaculture are becoming more and more apparent.

a) Data and information management

52. Effective marine and coastal environmental management requires the acquisition, storage, retrieval, exchange, quality assessment and application of appropriate data and information.

53. Information management facilitates the storage and access of data and reduces duplication and loss. It provides opportunities for the use of standard procedures of measurement and the efficient collection, compilation and storage of data, preferably in electronic form. It must incorporate quality assurance, the adoption of compatible data formats and ensure data retrieval in a form suitable for synthesis, evaluation, reporting and planning.

54. Integrated environmental databases, especially Geographic Information Systems (GIS), are essential for long-term coastal zone management. They assist in the translation of data of various types into accessible information useful for decision-makers.

b) Monitoring

55. Considerable advances have been made in developing monitoring techniques of chemical and biological effects. However, the potential for technically efficient and focussed monitoring has not yet been fully exploited. In relation to global climate change, it is important that new techniques be developed for large-scale sampling of the global ocean to assess the role of the oceans in climate change processes. This will involve development of automatic monitoring systems including a wide range of new biological and chemical sensors.

56. Many current monitoring programmes have neither provided the required information on the state of the marine environment nor adequately determined the effects of anthropogenic activity that they were ostensibly designed to do. A further criticism is that monitoring programmes often continue without the periodic scientific and administrative reviews essential for ensuring their effectiveness.

57. Greater emphasis needs to be placed on the specification of goals and objectives, the formulation of testable hypotheses, consideration of the linkages between environmental compartments, quality control procedures, continuing critical assessment of sampling methods and analytical procedures, and the statistical design of monitoring programmes. Periodic intercalibration exercises should also be carried out.

58. When a well-designed monitoring programme of environmental impacts still leaves questions unanswered, or in the presence of early-warning signs of likely effects, supportive research needs to be done.

59. Monitoring programmes must also be tied to an a priori commitment for action when pre-determined consequences appear likely to be exceeded. Monitoring programmes must also be subject to regular assessment as to their effectiveness and revised or terminated if this is warranted.

G. NUTRIENT INPUTS TO THE MARINE ENVIRONMENT

60. A major recent scientific finding which changes dramatically our approach to developing the scientific understanding of nutrient (nitrogen and phosphorus) fluxes to the marine environment, is that atmospheric transport, for many regions of the world, may be the dominant

factors. Therefore, the focus of this group will be biological responses that are detectable in relation to environmental change, emphasizing their potential and limitations.

8.3 Accordingly, it is proposed that a working group be established which should:

.1 identify characteristics of components of marine ecosystems that can generally be used to indicate the normal functioning of those ecosystems;

.2 consider the origin and value, for these purposes, of terms such as stress, population, community and ecosystem with specific reference to space and time scales and energy flow in the marine environment;

.3 review the methods used to detect stress on marine populations, communities and ecosystems and assess their value and limitations;

.4 review the methods used to detect stress on individual marine organisms in a field situation and assess their value and limitations; and

.5 identify, on the basis of the above, suites of indicators of the state of marine ecosystems that can be used to assess the impact of anthropogenically induced chance of the marine environment.

9 REPORT ON GESAMP CONTRIBUTION TO UNCED

In response to a request made by the UNCED Secretariat at the twenty-first session for GESAMP to assist the preparatory process for the UN Conference on Environment and Development, an ad hoc group, comprising the Chairman, three members of GESAMP and two Technical Secretaries, met at Halifax, Canada, from 11-13 May 1991, to draft a "Response to Specific Questions Posed by the UNCED Working Group on Oceans". That draft was finalized by the Chairman on the basis of written comments submitted by the GESAMP membership. This contribution was subsequently submitted to Governments as UNCED Research Paper No.11, "Some Reflections on Scientific Research on Marine Issues" (English only). It is annexed to the present report (Annex VIII), in view of its considerable importance for the future direction of the work of GESAMP and for the marine scientific community at large.

10 FUTURE WORK PROGRAMME

10.1 Interpretation of the terms 'bioaccumulation', 'toxicity' and 'persistence'

10.1.1 Some members of the Group proposed that authoritative advice from GESAMP could assist in clarifying the meaning and applications of terms used for the hazard classification of substances contained in lists of international regulatory instruments. Terms such as toxicity, bioaccumulation and persistence have in some cases been interpreted very loosely and the relationship between the respective properties in hazard assessments have in many cases not been taken into account. It was therefore necessary to review the scientific basis of these properties.

10.1.2 Several members however emphasized that there was sufficient scientific literature available which provided the necessary information. Others pointed out that current methods for quantifying persistence were not satisfactory.

10.1.3 The Chairman of the Working Group on the "Evaluation of the Hazards of Harmful Substances Carried by Ships", Mr. P.G. Wells, noted that his Working Group will make an attempt to quantify the term 'toxicity' for the purposes of his Group.

10.1.4 The Group deferred action on the above proposal until the study prepared by the above Working Group was available.

10.2 Impact of maritime activities in shelf areas

10.2.1 The IMO Technical Secretary informed the Group that a scope document had been prepared by IMO for consideration by GESAMP with a view to establishing a new Working Group. During the preparation of the document it had been recognized that the wide range of maritime issues concerned were strongly linked with managerial issues of coastal zone planning.

10.2.2 The paper accordingly requested a comprehensive review of coastal activities with a view to assisting those responsible for coastal and marine environment protection. It had also been recognized that such work was beyond the current terms of reference of GESAMP. Consequently, it had been decided not to present the scope document to GESAMP XXII.

10.2.3 Several members noted that the work outlined in the original IMO proposal made at GESAMP XXI was also related to the work of the Working Group on "Impacts of Anthropogenically Mobilized Sediments in the Coastal Environment" (see section 5) and that the outcome of that Group should be awaited before action on the above be considered.

10.2.4 The IMO Technical Secretary informed the Group that his Organization would make an attempt to develop a new set of terms of reference for the work needed from the perspective of IMO; however this might be difficult without including managerial aspects of coastal protection and development.

10.3 The future of GESAMP

10.3.1 Given the particular importance of GESAMP's "State of the Marine Environment" report, and the on-going need for periodic assessments of the state of the marine environment and trends thereon (as recognized in UNCED doc. A/CONF.151/PC/100/Add. 21, para. 118(d)), the Group agreed to discuss at the next session, the timing, duration, processes involved, information and data needs for the next such report. Members were asked to submit their views in writing to the Chairman in advance of the next session.

10.3.2 The Group noted that in discussions on a variety of different subjects, e.g. aquaculture, sedimentation, and marine 'health' indicators, questions were raised repeatedly as to their intimate relationship with environmental protection and management generally and with integrated coastal zone management specifically. The Group also remarked on a clear trend in requests from agencies for advice from GESAMP on management-related scientific issues. Finally, the Group affirmed the continuing importance, regardless of context, of the independence of the expertise required to serve a joint advisory mechanism.

10.3.3 The Group recognized that the future role of GESAMP will have to be redefined in the light of the outcome of the United Nations Conference on Environment and Development, within an inter-agency consultation involving all sponsoring organizations of GESAMP as well as other organizations which might wish to participate in a future new GESAMP mechanism.

E. RESEARCH NEEDS TO IMPROVE CAPABILITIES FOR INTEGRATED MANAGEMENT OF MARINE AND COASTAL AREAS, PARTICULARLY FOR DEVELOPING COUNTRIES

45. To be effective, marine and coastal environmental management must include consideration of all uses and sectors of the coast, including consideration of adjacent land and watershed areas and their use. Such integrated management will require research across many disciplines and will need to be directed at terrigenous, limnological, atmospheric and riverine sources.

46. However, in many cases an adequate hazard assessment can be made on the basis of limited scientific information, for example when the risk of damage is very high or very low. More detailed information is required only when there is some doubt about whether damage will or will not occur.

47. Studies contributing to integrated management should also give importance to the linkage between habitat contamination and/or destruction and loss of productivity in particular, which is often reflected in a decline in economically-important fisheries. This is especially relevant to the developing country situation, where a great percentage of the population relies on the seas productivity for food.

48. Development of management measures for any specific ecosystem or ecological zone very much depends on the assimilative capacity of the environment to cope with external inputs from human activities. Theorecally, knowledge of carrying capacity enables resource planners to determine the level and scale of permissible activities without causing unacceptable ecological changes and socio-economic consequences. While predictive environmental-capacity models have been attempted, considerable improvements are still needed, especially for their application in conditions prevailing in tropical countries.

49. Economic activities that rely on primary products often create conditions that result in non-sustainability of resources. This is because the resource base is assumed to be common property or open access in nature (e.g. fishery resources) so that the ecological value is grossly understated. Valuation of resources for its ecological and aesthetic, as well as economic, importance could minimize the indiscriminate utilization of these resources.

50. The assessment process, to be effective and meaningful, must have a scientific basis. Thus, adequate scientific knowledge of the sources, transport, fate and effects of contaminants is needed to support the process. The disciplinary fields in which supporting knowledge is required for assessment purposes are: physical oceanography, marine bio-geochemistry, marine biology, toxicology and ecotoxicology. Equally important is the requirement for adequate communication among these, and other disciplines, to ensure that no unbalanced deficiencies in individual disciplines occur. The application of research to the acquisition of information on the conditions, fluxes and fate of contaminants in rivers, estuaries and coastal marine environments, particularly in semi-enclosed marginal seas and embayments, is the most important.

F. STRATEGIES FOR DATA GATHERING AND INFORMATION SYSTEMS

51. The ultimate goal of data gathering and associated information systems should be to ensure the adequate basis for assessment of environmental conditions and predictive capabilities.

36. Debate is continuing in the marine scientific community about the importance chemicals other than classical nutrients have in influencing phytoplankton production and population dynamics. See also section G.

C. GEOGRAPHIC AREAS WICH NEED GREATER SCIENTIFIC CAPACITY

37. Studies of the quality of the marine environment are fairly advanced in a number of regions such as the North Atlantic region, including the North Sea, the Baltic and the Mediterranean, as well as in the North Pacific region. Arctic and Antarctic waters are also well covered by marine research programmes.

38. Other regions have a good potential of well-trained marine scientists, but need financial support to develop and maintain research programmes pertinent to the protection and management of the marine environment. This category comprises inter alia South and South-East Asian waters, the Western Central Atlantic and the South-east Pacific.

39. Other regions, such as the Eastern Central Atlantic and the South-West Indian Ocean, as well as parts of the South Pacific need not only research funding but also development and strengthening of associated infrastructure. This also entails extensive training programmes in marine science and environmental assessment and management.

40. Regional scientific support vis a vis marine environmental research programmes should be tailored to regional environmental problems. For example, in regions where nutrients are the major problem it is not particularly effective to improve the ability to monitor heavy metals.

D. SCIENTIFIC STRATEGIES THAT COULD BE INCLUDED IN UNCED'S AGENDA 21

41. GESAMP has recognized that management deficiencies, and not the limitations of science, are primarily responsible for the continued degradation of marine and coastal environments. However, part of the problem is the way in which science is interpreted and applied for management purposes.

42. With this in mind, the sponsoring agencies of GESAMP initiated in 1989, a series of discussions and working groups in which GESAMP members addressed the fundamental requirements of marine environmental protection and management and the contributions of science in this regard.

43. In its statement on Protecting and Managing the Oceans (GESAMP Reports and Studies No. 41, 1990, Annex IV), GESAMP has clearly identified the technical, scientific and regulatory components that are essential to accommodate the need for social and economic development within a management framework that will ensure the necessary degree of protection of the marine environment while also allowing rational use of marine resources.

44. As a subsequent step, GESAMP has completed a detailed report on Global Strategies for Marine Environment Protection (Reports and Studies No.45, 1991), which concludes that the absence of a common and global strategy is a serious impediment to progress in mitigating the harmful effects of human activities on the marine environment. GESAMP's recommendations are intended to overcome this fundamental problem and are presented in a manner that should facilitate the development of a global strategy as part of the UNCED process.

10.3.4 The Technical Secretaries informed the Group that efforts will be made to convene a high-level intersecretariat consultation in 1992 following UNCED, to discuss inter alia the future role and functions of GESAMP.

10.4 Intersessional work

Taking into account the decisions of the Group, intersessional work will be carried out in the framework shown below. The organizations supporting the intersessional work, as well as the members of the Group participating in it, are listed as agreed by the intersecretariat meeting of agencies sponsoring GESAMP as follows:

.1 Evaluation of the hazards of harmful substances carried by ships (Working Group 1)

Lead agency: IMO
Co-sponsor: UNEP
Chairman: P. Wells

Two meetings of the Working Group will be held in late 1992/early 1993.

.2 Impacts of anthropogenically mobilized sediments in the coastal environment (Working Group 30)

Lead agency: Unesco
Co-sponsors: UN, UNEP, FAO, IMO
Chairman: H. Windom

A meeting of the Working Group will be held in 1992.

.3 Environmental impacts of coastal aquaculture (Working Group 31)

Lead agency: FAO
Co-sponsors: UNEP, Unesco, WHO
Chairman: Chua Thia-Eng

Preparation by the Chairman of the Working Group of a feasibility study on practical guidelines on environmentally sound aquaculture.

.4 Indicators of marine ecosystem 'health' (Working Group 33)

Lead agency: UNEP
Co-sponsors: UN, FAO, Unesco, IMO, IAEA
Chairman: J. Gray

A meeting of a task force of 6 experts will be held in Summer 1992.

11 OTHER MATTERS

Selection of experts for GESAMP

Several members of GESAMP noted that the experts participating in the Group represented to a larger part the northern hemisphere rather than the south. The sponsoring agencies were requested to provide in future for a more balanced geographical representation.

12 DATE AND PLACE OF NEXT SESSION

The Group noted that the twenty-third session of GESAMP will be hosted by the United Nations and held at UN Headquarters, New York, 19-23 April 1993.

13 ELECTION OF CHAIRMAN AND VICE-CHAIRMAN

The Group unanimously elected Mr. J. Gray as Chairman and Mr. O. Osibanjo as Vice-Chairman for the next intersessional period and for the twenty-third session of GESAMP.

14 CONSIDERATION AND APPROVAL OF THE REPORT OF THE TWENTY-SECOND SESSION

14.1 The draft report of the twenty-second session of the Group was considered by the Group on the last day of the session and was approved with amendments as reproduced in this document. It contains, in Annexes IV to VIII, summaries or conclusions of reports prepared by the Working Groups and their sub-groups. This material is included for information only and was not considered by the Group with a view to approval.

14.2 The twenty-second session of GESAMP was closed by the Chairman of the Group at 12.10 pm on 13 March 1992.

useful, not only in predicting the toxic effects of mixtures on aquatic organisms, but also in explaining and understanding some mechanisms which regulate the interactions among the effects of different chemicals.

28. The accumulation in aquatic organisms can be adequately described by QSARs. There is a ample literature demonstrating that log K_{ow} is the main parameter for predicting predicting bioaccumulation.

29. On the basis of existing scientific knowledge, the threats to populations of marine organisms, posed by carcinogenic substances, appear to be low.

30. At normal levels of consumption and contamination of seafood, there appears to be little reason for concern about the effects of certain ingested carcinogens on human health. However, there may be increased risks to consumers of high amounts of seafood in cases where the ingested seafood is abnormally contaminated with carcinogens, particularly PAHs.

31. The hazards posed by synthetic organosilicon compounds to marine organisms and humans are not so great previously believed.

32. Considerable advances have been made in developing a hazard assessment approach that takes two factors into account: the first, intrinsic with the chemicals under examination (biological activity, physico-chemical properties); the second, depending on extrinsic conditions (loads, biological system characteristics, environmental characteristics). Particular progress has been made in ranking chemicals according to the hazards they present to the environment and human health.

c) Marine Ecology/Biology

33. With the recent development of new tecniques, it has been possible to quantify the role of micro-organisms in marine food-webs. It is now known that the microbial web consumes considerable amounts of carbon that is not necessarily incorporated higher in the food chain. Recently, naturally-occurring marine viruses have been found in large numbers in almost any sample of sea water taken. The role of viruses in the ecosystem is poorly understood. Such findings could change our understanding of marine food chains and may have consequences for our understanding of the cycling of nutrients and other elements.

34. Data collected within the last two years has quantified for an area of the North Atlantic the link between phytoplankton productivity and draw-down of CO^2 from the atmosphere to the ocean. Whilst relatively few areas have been studied using similar techniques, there is great interest in quantifying further such relationships. Debate is continuing on the importance of the process in relation to global climate change in that it is not yet known what the fate of the carbon drawn down to the ocean is, i.e. whether it is recycled within a short period of time or enters the long time-scale deep-ocean circulation.

35. It has been argued that not only is the frequency and extent of unusual algal blooms in the ocean increasing, but that the causes of changes in the relative abundance of diatoms (silicious algae) and dinoflagellates (calcareous algae) are directly related to reductions in the silicate input to the ocean from land. It has been further speculated that the production of some phycotoxins may be related to changes in the relative inputs of nitrogen and phosphorus compounds that constitute nutrients.

B. NEW FINDINGS, INTERPRETATIONS AND OTHER ADVANCES

a) Bio-geochemistry

20. It is now recognized that transport of contaminants to the marine environment through the atmosphere is a pathway of greater significance than previously believed, and may be the dominant pathway for some substances, e.g. certain synthetic organic compounds.

21. There are now greatly improved capabilities for distinguishing between natural and man-made substances in marine sediments which allow better interpretations of data from sediment monitoring programmes.

22. It is presently recognized that there is a natural synthesis of compounds identical or similar to several substances which have hitherto been considered as xenobiotics. This natural synthesis, e.g. of various halogenated compounds, may be in certain instances or in enclosed seas quantitatively important and must therefore be taken into consideration in hazard assessments of man-made substances.

23. For many years, information on the distribution and fate of chemical substances was acquired largely through broad retrospective studies involving monitoring programmes encompassing large numbers of chemical analyses. This retrospective approach leaves wide margins of error in the environmental management of chemical substances, and thus provides only a weak basis for developing a predictive system of problem identification. One approach in overcoming the difficulties associated with retrospective analysis is to forecast the behaviour and fate of chemicals through the use of environmental distribution and fate models and physico-chemical properties of chemical substances. This approach can be used to construct a cost-effective monitoring programme directed toward relevant environmental compartments.

b) Toxicology and Ecotoxicology

24. The evaluation of chemicals and chemical mixtures in artificial experimental ecosystems, from simple microcosms to relatively complex mesocosms, is being recognized as a valuable technique for both existing problem analysis and the study of the behaviour and effects of new substances.

25. A number of biological effects measurement techniques have been newly developed, or have been recently improved. They can be applied at all stages of management (viz. identification, testing, assessment, source and ambient monitoring) of toxic chemicals or complex wastes that enter and can pollute marine systems, and can provide sensitive early-warning systems for management purposes. Examples of biochemical procedures are: mixed function oxygenase (MFO) systems; metallothionein detoxification; lysomal membrane stability; blood chemical assays; cytogenic tests, including DNA adduct analyses; and steroid hormone assays. Their practical value can be enhanced when integrated into a chemical monitoring programme.

26. It is now possible to predict with a high degree of certainty the toxicity of substances to aquatic organisms, with substantial agreement between expected and experimentally-observed toxicity levels, within relatively homogeneous classes of organic chemicals.

27. Qualitative Structure-Activity Relationships (QSARs) have been successfully applied to the study of the effects of mixtures of chemicals on aquatic organisms. They have been very

ANNEX I

AGENDA

1 Adoption of the provisional agenda

2 State of the marine environment

3 Comprehensive framework for the assessment and regulation of waste disposal in the marine environment

4 Review of potentially harmful substances
- 4.1 Mutagenic substances
- 4.2 Teratogenic substance
- 4.3 Organochlorine compounds
- 4.4 Oil, and other hydrocarbons including used lubricating oils, oil spill dispersants and chemicals used in offshore exploration and exploitation

5 Impacts of anthropogenically mobilized sediments in the coastal environment

6 Evaluation of the hazards of harmful substances carried by ships

7 Environmental impacts of coastal aquaculture

8 Indicators of marine ecosystem health

9 Report on GESAMP contributions to UNCED

10 Future work programme

11 Other matters

12 Date and place of next session

13 Election and Vice-Chairman

14 Consideration and approval of the report of the twenty-second session

ANNEX II

LIST OF DOCUMENTS

Agenda Item	Document	Submitted by	Title
1	GESAMP XXII/1	Administrative Secretary	Provisional agenda
2	GESAMP XXII/2	IMO	State of the marine environment: Critical review by Greenpeace International of GESAMP Rep. Stud. No. 39 on the state of the marine environment (1990)
	GESAMP XXII/2/Add. 1	IMO	State of the marine environment: Appendix to GESAMP XXII/2 containing a paragraph-by-paragraph commentary by Greenpeace International on GESAMP Rep. Stud. No. 39
	GESAMP XXII/WP1		GESAMP's response to the Greenpeace review of GESAMP's state of the marine environment report
	GESAMP XXII/WP1/Rev. 1		Ditto
3	GESAMP XXII/3	IMO	Comprehensive framework for the assessment and regulation of waste disposal in the marine environment: Critical review by Greenpeace International of GESAMP Rep. Stud. No. 45 on global strategies for marine environmental protection (1991)
	GESAMP XXII/3/1	IMO	Comprehensive framework for the assessment and regulation of waste disposal in the marine environment: Can there be a common framework for managing radioactive and non-radioactive substances to protect the marine environment?

12. Since the great majority of existing scientific data on trophic relationships, as well as nutrient and energy cycling in marine coastal ecosystems, have been obtained from studies in temperate seas, there is a need to deepen our knowledge about the fundamental differences between these better known ecosystems and analogous systems in tropical seas. The general influence of existing factors, such as higher and less variable temperature and incipient radiation or higher salinity as well as intrinsic factors such as higher species diversity and lack of seasonality in reproduction and growth, on productivity, overall tolerance, etc., in tropical ecosystems as opposed to temperature ones, should be further elucidated. In the same way, comparison between temperate and arctic systems should be undertaken.

13. For improved understanding of the ecological significance of nutrient enrichment in the marine environment, there is a particular need for studies to elucidate the effects of enrichment on the relationship between primary and secondary production, in both coastal and offshore environments. For example, the effect of increasing phytoplankton production on the relative abundances of commercial fish and shellfish may be an important factor when considering the management of land-sea nutrient fluxes due to fertilizer use and sewage disposal.

14. The role of oceans in climate change processes is poorly understood, as emphasized in the IPCC report. It is especially important that the role of planktonic systems in the draw-down of CO^2 from the atmosphere to the ocean be quantified over large areas and the fate of the carbon assessed, particularly in relation to the amounts entering the long time-scale deep-water circulation system.

15. There is mounting evidence that commercial fishing seriously disturbs the community structure and the functioning of both planktonic and benthic systems. The removal of top predators and important herbivores on unprecedented spatial scales is felt likely to alter the basic structure and functioning of assemblages. Yet, data is largely lacking, as there are few areas where fishing is restricted which can act as control sites. Commercial trawling may also seriously affect benthic habitats. Research is needed to determine the nature and extent of such disturbances, their ecological significance, the recovery times involved and the means of mitigating damage by changing methods or patterns of harvesting.

16. Further research is warranted on the distribution and fate of pathogens, especially viruses introduced to the marine environment in municipal sewage, including studies on the viability and, where appropriate, the dormancy of pathogens in seawater, sediments and tissues of commercial species. The emphasis should be on improved methods of direct enumeration of pathogens, rather than reliance on surrogate indicator organisms (e.g. E. coli).

17. Studies should be carried out to investigate the dependency of species and communities on the sea-surface micro-layer, taking into account the possible role of the micro-layer as a habitat, energy source or critical link in the life-cycle of species of commercial or ecological importance.

18. Priority should continue to be given to the definition of environmental criteria that can be used to indicate the health of marine ecosystems. Chemical, physical and biological parameters are needed that can be used to reflect the conditions which sustain populations and communities and which can then be applied to the design of monitoring programmes and the interpretation of monitoring data.

19. It is of critical importance to obtain additional understanding of the nature and recovery time of chemically perturbed marine ecosystems, particularly to assist in choosing appropriate pollution prevention and control measures and for the cleanup of polluted sites.

substances released to the environment, and for improving risk assessments, taking into account the time-scales of the events concerned.

b) Toxicology and Ecotoxicology

7. Research needed to improve prediction of the toxicological properties of complex organic substances, with particular emphasis on carcinogenic and mutagenic properties.

8. An assessment should be undertaken of the reliability of threshold or non-threshold, dose-response relationships for conservatively assessing the risks to human health of exposures to a range of suspected carcinogens.

9. The potential for extending the use of Quantitative Structure-activity Relationships (QSARs) to predict the effects of chemicals at the community or ecosystem levels should be explored, examining mode of action and biological processes. It would also be valuable to develop prediction systems for assessing the persistence of chemicals through the various pathways of degradation (i.e. photo-degradation, bio-degradation and hydrolysis).

10. Assessments of the relationship between contaminant exposure and biological response should include a wider variety of contaminants and conditions. There is a particular need for:

i) basic comparative toxicity studies of the responses of different groups of marine organisms to relevant contaminants with different types of toxic action;

ii) experimental studies of the sensitivity pollution of organisms from different habitats in coastal tropical seas (coral reefs, sea-grass beds, mangrove swamps). Of particular interest is to select a broad array of test organisms for use in toxicity tests and mesocosm studies, representing both "specialists" (exploiting a narrow ecological niche) and "generalists" (inhabiting a broader spectrum of habitats);

iii) continued experimentation to determine how marine organisms compensate or adapt during long-term low-level exposures, to further investigate the key biochemical and physiological mechanisms involved in order to assess their value in monitoring chemical changes in the environment;

iv) further quantitative linking of fate models and monitoring data, leading to predictive appraisals of the hazards associated with long-term low-level exposures to contaminants, both singly and in a combination (i.e. mixtures);

v) periodic critical evaluation of long-term marine environmental data sets, especially on estuarine and inshore ecosystems, to test the overall hypothesis of long-term chemically-induced change at different levels of biological organization, and the importance to be attributed to such change.

c) Marine ecology/biology

11. Greater understanding is required of the complex interrelationships between individual nutrients, primary production (both rates and diversity), and the physiological behaviour of marine algae (e.g. production of toxins).

Agenda Item	Document	Submitted by	Title
	GESAMP XXII/3/1/ Corr. 1	IMO	Ditto
	GESAMP XXII/3/1/ Rev. 1	IMO	Ditto
	GESAMP XXII/WP2		GESAMP's response to the Greenpeace critique of GESAMP Rep. Stud. No. 45 entitled "Global strategies for marine environmental protection"
4	GESAMP XXII/4	IMO	Review of potentially harmful substances: oil, and other hydrocarbons including used lubricating oils, oil spill dispersants and chemicals used in offshore exploration and exploitation: Impact of oil and related chemicals and wastes on the marine environment.
	GESAMP XXII/4.3	FAO	Review of potentially harmful substances: organochlorine compounds.
5	GESAMP XXII/5	UNESCO	The impacts of anthropogenically derived sediments in the coastal environment
6	GESAMP XXII/6	IMO	Evaluation of the hazards of harmful substances carried by ships; Report of the twenty-sixth session of the Working Group
7	GESAMP XXII/7	FAO	Environmental impacts of coastal aquaculture
8	GESAMP XXII/8	Chairman	Indicators of marine ecosystem health
9	GESAMP XXII/9	Chairman	Report on GESAMP's contribution to UNCED: Response to specific questions raised by the UNCED Working Group on Oceans

Agenda Item	Document	Submitted by	Title
	GESAMP XXII/9/ Add. 1	IMO	Report on GESAMP's contribution to UNCED: List of major pollution issues and priority substances in the coastal marine environment
Information documents			
	GESAMP XXII/INF. 1	IAEA	List of participants
	GESAMP XXII/INF. 2	IAEA	List of documents
	GESAMP XXII/INF. 3	UN	Some reflections on scientific research on marine issues: UNCED Research Paper No.11
	GESAMP XXII/INF. 4	WHO	GESAMP Rep. Stud. No. 46. Review of potentially harmful substances: carcinogens
	GESAMP XXII/INF. 5	WMO	GESAMP Rep. Stud. No. 48. Global changes and the air/sea exchange of chemicals, draft
	GESAMP XXII/INF. 6	UN	Extracts from the Annual Report on the Law of the Sea to the forty-fourth session of the UN General Assembly (A/44/461)
	GESAMP XXII/INF. 7	UN	Preparatory Committee for the UNCED, fourth session. Item 2(C) of the Plenary Session, item 2 of provisional agenda of Working Group II

JOINT GROUP OF EXPERTS ON THE SCIENTIFIC ASPECTS OF MARINE POLLUTION (GESAMP)

SOME REFLECTIONS ON SCIENTIFIC RESEARCH ON MARINE ISSUES

INTRODUCTION

1. As part of the preparatory process for the United Nations Conference on Environment and Development (UNCED), the secretariat of UNCED invited GESAMP to provide answers to a number of questions concerning the role and contribution of science to the protection and management of the marine environment. In presenting these questions and answers, no particular sequence or priority has been assumed. Whenever possible, GESAMP has formulated responses on the basis of existing advice contained in GESAMP Reports and Studies.

2. GESAMP is particularly pleased to be given this opportunity to contribute to the UNCED process. Throughout its history, GESAMP has been acutely aware of the linkages between environmental protection and social and economic development and has consistently tailored its advice to the needs of environmental managers whose responsibility must be to ensure the rational use of marine environments without damage to marine resources. Scientific knowledge is essential to achieving this goal. Implicit in this report is the impellent need to apply this knowledge to protect the natural state of the marine environment, to ensure a sustainable exploitation of resources and to protect the health of man.

A. GAPS AND NEEDS OF SCIENTIFIC RESEARCH

The various research items outlined in this section are the basis of a scientifically founded control strategy as indicated under sections D, E, and F.

a) Bio-geochemical studies

3. The fluxes of contaminants in dissolved and particulate form entering the marine environment from riverine and atmospheric sources are not adequately know or quantified for management purposes.

4. The ability to discriminate between naturally and anthropogenically mobilized contaminants in the freshwater and marine environments needs to be improved, especially with regard to their availability to aquatic organisms.

5. Greater understanding of how land-use and watershed characteristics (e.g. climate, geology, topography) influence the flux of nutrients and sediments to coastal marine environments is needed for purposes of integrated management. Key questions in this context are: (i) what is the interval between the onset of a land-use practice and the resultant load (i.e. flux); and (ii) how long does a flux persist after the practice ceases? See also paragraph 12.

6. While considerable progress has been made within the past ten years in predicting the distribution of organic chemicals between different environmental compartments (e.g. soil, water, air, biota), there is a need to study the rates at which organic substances move from one medium to another. Such knowledge is critical for modelling and predicting the fates of

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ANNEX VIII

SOME REFLECTIONS ON SCIENTIFIC RESEARCH ON MARINE ISSUES

Prepared by the Group of Experts on the Scientific Aspects of Marine Pollution

UNITED NATIONS CONFERENCE ON ENVIRONMENT AND DEVELOPMENT

Research Paper No.11
July 1991

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It is recognized that the preparation of comprehensive guidelines to reduce the environmental impacts of coastal aquaculture is seriously constrained by the:

(a) lack of information on the use of chemicals in developing nations including types and levels of application;
(b) lack of information on the ecotoxicology of chemicals used in aquaculture;
(c) socioeconomic and legislative complexity in coastal aquaculture development in developing nations; and
(d) severe scarcity of published information on ecological changes caused by coastal aquaculture development.

However, this situation is gradually improving as more information becomes available (e.g. NACA/ADB 1991; ICLARM's Aquaculture and Environment Conference in Bellagio, 1990; and recent conferences organized by Asian Fisheries Society, World Aquaculture Society etc.). Despite the above constraints, there is sufficient information from existing literature and experts that can be drawn on to prepare the needed guidelines.

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ANNEX VII

ENVIRONMENTAL IMPACTS OF COASTAL AQUACULTURE

Report of the Chairman of the Working Group on Environmental Impacts of Coastal Aquaculture (Working Group No. 31)

Following the approval of the Working Group Report "Reducing Environmental Impacts of Coastal Aquaculture", the Chairman of the Working Group presented to the 21st Session of GESAMP the following recommendations for future work:

1. the preparation of a comprehensive review of viral, bacterial and parasitic human diseases associated with coastal aquaculture operations covering potential health risks, prophylactic measures and hygienic surveillance schemes;

2. The establishment of monitoring procedures for aquaculture-specific pollutants leading to the assessment of the environmental capacity of aquaculture operations;

3. The formulation of guidelines for the safe use of chemicals in coastal aquaculture based on drug-specific information, including mode of use, drug withdrawal times and environmental fate; and

4. the formulation of a preliminary aquaculture-specific contingency plan for red tide outbreaks.

These four topics for future work are of considerable importance from human health, ecological and economic standpoints. The issues are significant international concerns and deserve the attention and efforts of GESAMP to provide appropriate advice and guidance. Since the main objective of Working Group 31 is to reduce the environmental impacts of coastal aquaculture, it is imperative that it continues to address the above issues from a global perspective, with special focus on developing nations.

However, the scope of the issues for coverage within a timeframe of about a year is too large, and hence is not realistic given the manpower and financial constraints for meetings. In view of the current efforts of WHO, ICES, FAO, NACA and IOC in addressing some aspects of the above issues, GESAMP should work closely with these organizations. This coordination could distill relevant information from past and present studies.

The multidisciplinary approach of Working Group 31 provides a unique opportunity for interaction among different disciplines (social, economic, ecological and public health scientists), which is required to come up with well-balanced guidelines for aquaculture planning and management. This is a long-term solution to ensure environmentally acceptable aquaculture practices. Experience from the tropical region is essential; thus, inviting scientists from the tropical developing nations will be useful.

The main target outputs of Working Group 31 should be scientifically based guidelines that will help reduce the environmental impacts of coastal aquaculture including human health risks. These guidelines are meant for government and private sectors involved in the development, planning and management of aquaculture; and also for individual aquaculturists.

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TERMS OF REFERENCE

To examine and evaluate available data and to provide such other advice as may be requested, particularly by IMO, for evaluating the environmental hazards of harmful substances carried by ships, in accordance with the rationale approved by GESAMP for this purpose.

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ANNEX VI

EVALUATION OF THE HAZARDS OF HARMFUL SUBSTANCES CARRIED BY SHIPS

Summary of the Report of the 26th meeting of the Working Group on the Evaluation of the Hazards of Harmful Substances Carried by Ships.
(Working Group No. 1)

1 The Working Group held its 26th meeting under the chairmanship of Mr. Peter Wells at IMO Headquarters, London, from 8 to 12 April 1991. The report of the Working Group (EHS 26/18) can be made available by IMO.

2 The Working Group considered the hazards of about 180 substances transported by ships.

3 The Working Group considered the following:

3.1 Comments from GESAMP sessions XX and XXI on issues discussed by the Working Group at its 25th meeting;

3.2 Matters arising from IMO bodies relevant to the activities of the Working Group;

3.3 The results of intersessional work carried out by individual members of the Working Group, in particular with regard to the tainting properties of chemicals and the need to develop screening tests for chemicals that were suspected to taint seafood;

3.4 The results of correspondence between the chemical industry and the IMO Technical Secretary of GESAMP on hazard evaluations carried out by the Working Group;

3.5 The evaluation of new substances proposed for inclusion in the IMO Bulk Chemical Codes;

3.6 The evaluation of solid bulk cargoes listed in the IMO Bulk Code;

3.7 The review of substances which are suspect of bioaccumulating in marine organisms;

3.8 The evaluation of specific classes of compounds: alkylbenzenes, nitroalkylbenzenes, chloropropylenes;

3.9 The impact of copper and copper compounds used in marine antifouling paints;

3.10 The hazard assessment of floating chemicals after an accidental spill at sea; and

3.11 The computerization and retrieval of data generated by the Working Group.

ANNEX IV

CAN THERE BE A COMMON FRAMEWORK FOR MANAGING RADIOACTIVE AND NON-RADIOACTIVE SUBSTANCES TO PROTECT THE MARINE ENVIRONMENT?

Summary of the Report of the Sub-Group on Global Strategies for Marine Environmental Protection
(Working Group No. 29)

This report was prepared by a small sub-group of Working Group 29 as a supplement to Reports and Studies No. 45 "Global Strategies for Marine Environmental Protection" (1991). The report responds to a question transmitted to GESAMP by the Inter-Governmental Panel of Experts on the Radioactive Waste Disposal at Sea (IGPRAD) of the London Dumping Convention. The essence of the question was whether or not there can be a common basis for evaluating the disposal at sea of both radioactive and non-radioactive wastes.

The report summarizes the properties of radioactive substances which distinguish them from non-radioactive substances and compares the current level of scientific understanding regarding their environmental effects. It also gives an overview of waste disposal options, emphasizing the differences between disposal and containment. The report then reviews the main elements of the strategy proposed by GESAMP in Reports and Studies No. 45, focusing on the scientific and management procedures which can be used to evaluate the acceptability of emissions. This is followed by a concise description of contemporary international principles and procedures (ICRP) for assessing and preventing the environmental and human health effects of radionuclides.

Having discussed the similarities and differences between the two systems, the report concludes that there are no substantive reasons why the comprehensive framework proposed by GESAMP could not be used to evaluate management and disposal options for both radioactive and non-radioactive wastes.

The report was adopted by GESAMP and will be published as Reports and Studies No. 45 Addendum.

ANNEX V

IMPACT OF OIL, INDIVIDUAL HYDROCARBONS, AND RELATED CHEMICALS ON THE MARINE ENVIRONMENT, INCLUDING USED LUBRICATING OILS, OIL SPILL CONTROL AGENTS AND CHEMICALS USED OFFSHORE

Summary of the Report of the Sub-Group on the Review of Potentially Harmful Substances: Sub-Group on Oil, and Other Hydrocarbons, Including Used Lubricating Oils, Dispersants and Other Control Agents, and Wastes from Offshore Petroleum Operations (Working Group No. 13)

The Sub-Group met under the chairmanship of Mr. P. Wells from 8 to 12 November 1991. The contents of the draft report is shown below, together with the Terms of Reference and the Members of the Working Group.

IMPACT OF OIL AND RELATED CHEMICALS AND WASTES ON THE MARINE ENVIRONMENT

TABLE OF CONTENTS

Part I - Executive Summary

SCOPE AND INTENT OF THE REVIEW

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

1 Oil and individual hydrocarbons

2 Used lubricating oils

3 Oil spill control agents, particularly dispersants

4 Wastes from offshore oil exploration and exploitation

Part II - Resource Document

1. INTRODUCTION

2. OIL AND INDIVIDUAL HYDROCARBONS

2.1 Introduction

2.1.1 Reason for the concern
2.1.2 Applicable agreements and conventions

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5.6 Effects on human health

5.7 Effects on fisheries

5.7.1 Tainting by drilling muds, cuttings and production water

5.8 Conclusions

5.9 Recommendations

APPENDIX

Table 4.1: Licensed, registered or approved Oil Spill Response Products

Part III - Bibliography

1 Chapter One - Introduction

2 Chapter Two - Oil and individual hydrocarbons

3 Chapter Three - Used lubricating oil

4 Chapter Four - Use of dispersants and other control agents in oil spill response

5 Chapter Five - Wastes from offshore petroleum operations

Terms of Reference

The following general terms of reference adopted for Working Group No. 13 apply for the work of the sub-group:

1 To prepare short referenced reviews on selected substances which include an assessment of the following factors:

(a) the total of particular substances which reach the maritime environment (on a local, regional and global scale) with particular attention being given to the relative importance of land-based sources;

(b) the fate (transfer, distribution and transformation) of these substances in the marine environment;

(c) the effects of these substances on the marine environment and adjacent coastal areas, both direct and indirect, on living resources, human health and amenities.

2 To produce a scientific evaluation of the harmful effects of substances released into the marine environment on living resources, human health, aesthetics and other legitimate uses of the marine environment and adjacent coastal areas.

2.2 Composition of hydrocarbon mixtures from different sources

2.2.1 Sources of hydrocarbons
2.2.2 Compositional characteristics of different sources
2.2.2.1 Chemical composition and physical properties of crude oils
2.2.2.2 Composition of combustion generated hydrocarbon mixtures
2.2.2.3 Composition of recent biosynthetic hydrocarbon mixtures

2.3 Inputs of oil and its hydrocarbons

2.3.1 Changes in inputs over the past two decades
2.3.2 Estimated inputs from shipping and relation to other inputs
2.3.3 Extent of oil pollution in selected regional seas and coastal waters
2.3.3.1 Europe
2.3.3.2 North-West Atlantic
2.3.3.3 Caribbean
2.3.3.4 Africa
2.3.3.5 Middle East
2.3.3.6 Indian Ocean
2.3.3.7 South Asia
2.3.3.8 South-East Pacific
2.3.3.9 North Pacific
2.3.3.10 Polar Seas
2.3.4 Global oil pollution - its extent

2.4 Physical, chemical and biological methods

2.4.1 Methods of chemical analysis
2.4.1.1 Sampling
2.4.1.2 Analytical methods
2.4.1.3 Weathering
2.4.1.4 Analytical challenges
2.4.2 Tainting

2.5 Fate of spilled oils

2.5.1 Physical and chemical fate
2.5.2 Oil spill trajectory modelling

2.6 Marine ecosystem and oil - effects and recovery

2.6.1 Introduction
2.6.2 Impacts of oil in the sea

2.7 Effects on human health

2.8 Effects on man's use of the sea

2.8.1 Tainting of fish by oil
2.8.2 Other considerations

2.9 Summary, conclusions and recommendations

2.9.1 Summary and conclusions
2.9.2 Recommendations

3 USED LUBRICATING OILS

3.1 Introduction

3.2 Sources and inputs

- 3.2.1 Production and consumption of lubricating oils
- 3.2.2 Production, input and fate of used lubricating oils
- 3.2.3 Production and fate of industrial oils

3.3 Chemical composition and physical properties

3.4 Physical, chemical and biological methods

- 3.4.1 Mutagenicity and other short term tests
- 3.4.2 DNA adducts

3.5 Fate of used lubricating oils in marine ecosystems

3.6 Biological effects

- 3.6.1 Toxic effects
- 3.6.2 Sublethal effects
  - 3.6.2.1 PAH's
  - 3.6.2.2 Lead
  - 3.6.2.3 Additives
  - 3.6.2.4 Dioxins and furans
  - 3.6.2.5 Industrial oil additives
- 3.6.3 Conclusions

3.7 Effects on human health

- 3.7.1 PAH's
- 3.7.2 Lead
- 3.7.3 Corrosion inhibitors

3.8 Effects on man's use of the sea

3.9 Summary, conclusions and recommendations

- 3.9.1 Summary and conclusions
- 3.9.2 Recommendations

4 USE OF DISPERSANTS AND OTHER CONTROL AGENTS IN OIL SPILL RESPONSE

4.1 Introduction

- 4.1.1 Types and uses of spill control agents
- 4.1.2 Role of dispersants in spill control
  - 4.1.2.1 Major issues
  - 4.1.2.2 Do dispersants do any good?
  - 4.1.2.3 Do dispersants do any harm?
- 4.1.3 Role of other spill control agents
- 4.1.4 Testing and regulation of control agents - international perspective

4.2 Composition, chemical and physical properties

- 4.2.1 Dispersants
- 4.2.2 Demoussifiers
- 4.2.3 Recovery enhancers
- 4.2.4 Shoreline washing agents
- 4.2.5 Herders
- 4.2.6 Sinking agents
- 4.2.7 Biodegradation enhancers
- 4.2.8 Hot water washing
- 4.2.9 Burning

4.3 Toxicology

- 4.3.1 Dispersants
- 4.3.2 Dispersed oils
- 4.3.3 Other agents

4.4 Mesocosm and field studies on dispersants

- 4.4.1 Physical and chemical experiments
- 4.4.2 Biological experiments

4.5 Effects on human health of dispersant use

4.6 Effects on man's use of the sea

- 4.6.1 Fishing gear
- 4.6.2 Fish tainting
- 4.6.3 Aquaculture
- 4.6.4 Beaches and other public amenities
- 4.6.5 Wildlife sanctuaries and marine parks
- 4.6.6 Water intakes - public and industrial
- 4.6.7 Other economic considerations

4.7 Conclusions

4.8 Recommendations

5 WASTES FROM OFFSHORE PETROLEUM OPERATIONS

5.1 Introduction

5.2 Discharge sources

5.3 Regulatory controls

5.4 Chemical composition of exploration and production wastes

- 5.4.1 Drilling fluids
- 5.4.2 Production water
- 5.4.3 Sanitary wastes
- 5.4.4 Surfactants
- 5.4.5 Biocides
- 5.4.6 Chemicals for enhanced oil recovery

5.5 Environmental effects

- 5.5.1 Drilling discharges
- 5.5.2 Production water