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**IMO / FAO/UNESCO/WMO/WHO/IAEA/UN/UNEP
JOINT GROUP OF EXPERTS ON THE SCIENTIFIC ASPECTS
OF MARINE POLLUTION
- GESAMP -**

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REPORT OF THE NINETEENTH SESSION

Athens, 8-12 May 1989



UNITED NATIONS ENVIRONMENT PROGRAMME

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

REPORT OF THE NINETEENTH SESSION

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UNEP, 1989

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 SEA WATER AND REDUCTION OF AMENITIES."

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OPENING OF THE SESSION

- 0.1 The Joint Group of Experts on the Scientific Aspects of Marine Pollution (GESAMP) held its nineteenth session at UNEP's Co-ordinating Unit of the Mediterranean Action Plan in Athens, from 8 to 12 May 1989, under the Chairmanship of Mr. H. L. Windom. Mr. D. Calamari was Vice-Chairman of the session.
- 0.2 Mr. S. Keckes, the UNEP Technical Secretary for GESAMP, welcomed the participants on behalf of the Executive Director of UNEP and stressed the importance UNEP attaches to the work of GESAMP.
- 0.3 Mr. L. Jeftic, the Senior Marine Scientist of UNEP's Co-ordinating Unit for the Mediterranean Action Plan also welcomed the participants and expressed satisfaction for having the privilege to host the session of GESAMP. He briefly outlined the Action Plan and highlighted its main components: (a) the Barcelona Convention (in force from 1978) and its four protocols; (b) the research and monitoring programme (MED POL) in which more than 100 research centres participate and which provides the scientific and technical data base and information for other components of the Action Plan; (c) the integrated planning component of the Action Plan consisting of a prospective study of the Mediterranean Basin's development until the year 2025 (the Blue Plan) and a set of "priority action programmes"; and (d) the mechanisms and structures supporting the Action Plan (UNEP as the secretariat co-ordinating the Action Plan and the Convention; regular meetings of the Contracting Parties and their subsidiary bodies as the highest authority for the Action Plan; and the Trust Fund set up by the Parties to support financially the Action Plan).
- 0.4 The Chairman of GESAMP thanked Messrs S. Keckes and L. Jeftic on behalf of the participants for their welcome and good wishes for a successful session, for the hosting of the session and for the provision of secretariat facilities.

1. ADOPTION OF THE AGENDA

- 1.1 The agenda for the session, as adopted by the Group, is given in Annex I. The list of documents submitted to the session is given in Annex II. The list of participants is given in Annex III.

2. REVIEW OF POTENTIALLY HARMFUL SUBSTANCES (Working Group 13)

- 2.1 The Unesco Technical Secretary introduced this item referring to the report of the eighteenth session of GESAMP which had decided that the work of the Working Group 13 should proceed along three subject areas in sub-groups on:

- carcinogenic, mutagenic and teratogenic substances;
- chlorinated hydrocarbons; and
- oil, including used lubricating oils, oil spill dispersants and chemicals used in offshore exploration and exploitation.

- 2.2 In each of these subject areas intersessional activities have been pursued following the decisions made at the eighteenth session of GESAMP, and progress reports were presented with a view to requesting the Group to review and provide advice for the further work.

- 2.3 It was noted that at the eighteenth session of GESAMP it had been agreed that Working Group 13 should, for practical reasons, operate through a number of sub-groups. This had left it rather unclear as to how the work should be co-ordinated. Accordingly the Technical Secretaries for Unesco, WMO, IMO and UNEP stated that it should be recognized that overall co-ordination of the activities of the sub-groups rested with the Chairman of Working Group 13 (Mr. J. Portmann) and the Technical Secretary of the lead agency (Unesco). Moreover, it was stressed that although the Working Group was working through three sub-groups, the overall unity of the work should be preserved through the application and adherence to the Terms of Reference of the Working Group. It was also stressed that the conclusions were required by the sponsoring agencies for them to fulfill their obligations of providing advice to Member States.
- 2.4 The Chairman of the Working Group then proceeded to present the intersessional work of the Working Group. He reiterated that the Terms of References of the Working Group inter alia especially requested recommendations on the level of harmfulness of the substances considered with respect to human health and biological effects in the marine environment.
- (a) Carcinogenic, mutagenic and teratogenic substances
- 2.5 The Unesco Technical Secretary recalled that at the eighteenth session of GESAMP it had been decided to pursue this activity in four stages, namely:
- identification of substances suspected and known to be carcinogenic themselves;
 - collation of information on levels of these substances in marine matrices;
 - risk assessment for human health based on food consumption patterns; and
 - reviews of available information relating to the marine environment, in particular, fish and shellfish.
- 2.6 He noted that the identification of substances and the provision of information on their levels in marine matrices had been completed intersessionally by IMO and that this information had been passed on to WHO to cater for the third identified activity. A preliminary report entitled "cancer risk assessment of trace metals, polycyclic aromatic and polychlorinated hydrocarbons in seafood", prepared by WHO, was tabled informally for the consideration and advice of the Group.
- 2.7 The paper was presented by the WHO Technical Secretary who explained its step-wise preparation. Following the provision of concentration data in edible marine biota and establishment of a list of human carcinogens, the associated health risk was estimated quantitatively by means of a model. The Group noted that there are several such models in use and it was agreed that WHO will apply several of them and comparatively evaluate their results. The summary report of the sub-group is presented in Annex IV.
- 2.8 In the ensuing discussion the toxicological and epidemiological basis for the risk assessment model used so far by WHO was raised including the acceptance of the non-threshold theory and the use of occupational exposure data for seafood assessments. It was argued, however, that the methods used were all on the conservative side and that the actual risk could be much less than estimated. The revised paper should reflect these considerations.
- 2.9 The Chairman of the Working Group then introduced a review of North American and Pacific Basin experience and knowledge of carcinogens and marine species which deals with the marine aspect of carcinogenicity. It was agreed that the papers, namely the draft reviews on evidence and experiences concerning carcinogenic effects in marine fish and shellfish from European waters (1988) and from North American and Pacific Basins (1989) and the preliminary paper on risk (1989), be revised and combined into one study by a

small group of experts. This final draft should then be submitted to the twentieth session of GESAMP for consideration and eventual approval. Considerable editing would also be essential to make the concepts of risk assessment and the findings understandable to the non-specialized scientists.

- 2.10 The earlier GESAMP request for simultaneous review of mutagens and teratogens in seafood was deferred until relevant data necessary for such an assessment became available. Efforts would continue intersessionally to collate relevant information through invited experts.

(b) Chlorinated hydrocarbons

- 2.11 Mr. D. Calamari, convenor of a small study group on chlorinated hydrocarbons, introduced a document on the feasibility of producing a review of organochlorine compounds as a single group of harmful substances. The concern about organochlorine compounds in the marine environment is in many cases ill-placed, since this group of compounds comprises a very large range of substances, with very different physical, chemical and biological properties. In order to identify compounds that really merit concern, the hazard assessment approach is proposed, based on physico-chemical properties of the substances, toxicity and on structure-activity relationships. A consultant made available by the International Register for Potentially Toxic Chemicals Programme Activity Centre (IRPTC) of UNEP currently is charged with the task of preparing a comprehensive list of organochlorine substances, group them and subject them to preliminary hazard assessment. Once this work is completed, the study group will propose to GESAMP a list of substances that need special attention due to their potential hazard, and will make recommendations on how to proceed with the production of review documents for those hazardous substances for which such reviews do not already exist. The summary report of the sub-group is presented in Annex V.

- 2.12 During the discussion of the document, attention was drawn to the problem posed by chlorinated effluents from paper mills, as well as to the combined toxic effects of mixtures of substances. It was, however, realised that although these aspects were important, dealing with complex mixtures, such as effluents, would unnecessarily complicate the work. The Group therefore welcomed the practical approach proposed by the study group and endorsed the work programme proposed.

- 2.13 The IMO Technical Secretary drew the attention to the GESAMP files kept at IMO on hazardous substances carried by ships, which contain information on about 160 halogenated substances.

- 2.14 The UNEP Technical Secretary underlined the need his organization had for quick practical advice on which substances pose real risks when discharged into the marine environment, in order to satisfy requests for advice from governments in connection with the different Regional Seas Conventions.

(c) Oil, including used lubricating oils, oil spill dispersants and chemicals used in offshore exploration and exploitation

- 2.15 The proposed review was introduced by the IMO Technical Secretary, giving the background to the request that GESAMP prepare a summary document on the major new facts and principles pertaining to marine pollution by petroleum oils, used lubricating oils, chemicals used in offshore exploration and exploitation and spill control agents.

- 2.16 The Chairman of this sub-group, Mr. P. Wells, presented a summary of the approach recommended for review and he described the contents of the proposed report. The outline of a future report on the above issues is shown in Annex VI.

- 2.17 The Group commented at length on the proposed report's contents, with special emphasis on additional topics that should be considered, for example the need to present hazard assessments of the materials, and the need to relate the conclusions of the review to the questions posed by agreements and conventions on marine pollution control and prevention. It was also pointed out that care should be taken to ensure that related on-going work will be taken into account with other programmes, e.g. within the joint IOC/UNEP/IMO Groups of Experts GEMSI and GEEP.
- 2.18 A decision was made to proceed with the review over a two year period, including all the topics contained in the proposed outline. It was noted that chemicals introduced into the sea from accidents on offshore rigs, together with problems related to the removal and disposal of offshore installations and structures as well as other issues related to offshore activities, would be the subject of separate work to be carried out in future by the Group. A proposal in this respect would be submitted by IMO at the next session of the Group.

3. EVALUATION OF THE HAZARDS OF HARMFUL SUBSTANCES CARRIED BY SHIPS (Working Group 1)

- 3.1 The IMO Technical Secretary informed the Group that Working Group 1 had met twice during the intersessional period at IMO Headquarters in London, from 29 August to 2 September 1988, and from 13 to 17 February 1989. He presented a short summary of the work carried out, drawing particular attention to those issues which in his view needed action or decision by the Group. In this connection the Group noted that the Working Group had finalized its comprehensive report "The Evaluation of the Hazards of Harmful Substances Carried by Ships: Revision of GESAMP Reports and Studies No. 17" which is currently prepared for publication as GESAMP Reports and Studies No. 35. The Working Group had also evaluated a large number of new substances proposed for carriage by ships and it reviewed many existing hazard profiles of substances for which additional data had been submitted by the chemical industry and maritime administrations or had been achieved through laboratory tests carried out by individual members of the Working Group. Summaries of the reports of the twenty-third and twenty-fourth sessions of the Working Group on the Evaluation of the Hazards of Harmful Substances Carried by Ships are shown in Annex VII.
- 3.2 The Chairman of the Working Group, Mr. W. Ernst, introduced the reports of the twenty-third and twenty-fourth sessions of the Working Group. He noted that in addition to individual substances a number of classes of compounds were reviewed: zinc compounds, barium compounds and partly arsenic and selenium compounds. With regard to zinc compounds the Working Group confirmed that, after the study and review of the scientific literature on the toxicity and bioaccumulation of zinc compounds in aquatic organisms, as summarized in an annex to the report of the twenty-fourth session, the rating in Column A of the hazard profiles should stay as "+" (bioaccumulated to significant extent and known to produce a hazard to aquatic life or human health).
- 3.3 Another item which had been discussed in considerable length and detail by the Working Group was the hazard evaluation procedure used by the Working Group, in particular for substances with properties such as low solubility, high volatility and low density. There had been different views expressed by chemical manufacturers' associations on the one side and the members of the Working Group on the other. The industry had organized a workshop and set up a specific task team to discuss and develop testing methods and mathematical models which would reflect the actual situations and conditions under which these products are discharged into the sea or spilled at sea, and thus predict the behaviour and fate of these substances once they have entered the marine environment. In this respect the Working Group reiterated its view that the field verification of the data derived from laboratory tests carried out by members of the Working Group or used by the Working Group were, although of scientific interest, beyond its terms of reference.

However, the Working Group had expressed its readiness to assist or to comment on the work carried out in this field by the industry if so requested by the relevant IMO bodies and GESAMP.

3.4 With regard to the review of zinc compounds carried out by the Working Group several members of the Group expressed their doubts that its decision to allocate a "+" rating (bioaccumulated to significant extent and known to produce a hazard to aquatic life or human health) was justified on the basis of the information contained in the annex to the report of the twenty-fourth session of the Working Group.

3.5 The Group recalled that the full definition of rating "+" in column A of the hazard profiles refers to "a substance which is known to be accumulated to a significant extent by certain marine organisms, which is not readily excreted or degraded into a less harmful metabolite by the organisms and which as a consequence is known, or strongly suspected, to be harmful to the animal, or to man if he eats the organism". The Group also noted that the Working Group, in general, uses a rather conservative approach in particular in those cases where some doubts existed concerning the quality of data submitted to the Working Group.

3.6 The Group advised the Working Group to review its position and in particular to express in more detail the reasoning of its decision concerning the bioaccumulative and toxic properties of zinc compounds.

3.7 The Group agreed to adopt the hazard profiles proposed by the Working Group subject only to the question related to zinc. The Group also took note of the various discussions and other issues and it approved the proposed work programme. In noting the discussions as recorded in the report of the Working Group's twenty-fourth session (see paragraph 3.3 above) the Group agreed that the Working Group was correct in taking the line that it should not concern itself with the field verification of laboratory tests to check the validity of laboratory test data. However, it was pointed out that in stating this position the Working Group had missed the point that although industry was correct in its view that environmental conditions might under favourable conditions reduce the toxic impact of a chemical, e.g. volatility can reduce possible periods of exposure, it was equally feasible that conditions might not be favourable. For this reason the Working Group must continue to assume worst conditions with regard to toxicity as fundamental property of a chemical substance. It was also noted that the nature of the chemicals as shipped (e.g. as a pesticide, a pure solid or formulated suspension) might make a difference to the impact of a substance on entering the sea and again the worst position must be catered for. The results of laboratory tests as used by the Working Group took into account such possibilities.

4. INTERCHANGE OF POLLUTANTS BETWEEN THE ATMOSPHERE AND THE OCEANS (Working Group 14)

4.1 The WMO Technical Secretary informed the Group that, as agreed upon at the eighteenth session of GESAMP, a Working Group 14 workshop on the Atmospheric Input of Trace Species to the World Ocean was held from 10 to 14 October 1988 at the University of Rhode Island, USA to evaluate quantitatively the atmospheric input of trace metals, synthetic organic compounds and nutrients to the world ocean and to some specific regions. The workshop was attended by 20 experts and the work was done both at plenary meetings and at five panels: on atmospheric transport, boundary layer exchange, trace metals, synthetic organics and nutrients. The preparatory work done before the workshop allowed relevant and up-to-date data to be collected on air concentrations and deposition rates of the species of interest as well as information on atmospheric transport processes and air/sea exchange processes that were used for model calculations and extrapolation of available data for some specific seas, oceanic regions and the global ocean. The draft report submitted to the present session of GESAMP was prepared during a short additional meeting

- held in December 1988 and attended by the workshop co-chairmen and the workshop panel chairmen. It was noted that the work on the report was being continued to include some additional calculations and comparisons of atmospheric and riverine inputs, but the Working Group was of the opinion that this draft report could be presented to the Group for consideration and possible adoption, with the report being finally completed later in 1989.
- 4.2 The Chairman of Working Group 14 introduced the report. The report addresses several issues relative to the atmospheric input of the trace species of interest to the ocean:
- atmospheric fluxes to the global oceans by ocean basins;
 - atmospheric fluxes to selected coastal areas and seas;
 - comparison of atmospheric fluxes with riverine fluxes for the global ocean and selected coastal areas; and
 - the relative importance of the various air/sea exchange mechanisms (i.e. direct gas exchange, particle dry deposition, and rain) for the species of interest.
- 4.3 The report indicated clearly that atmospheric input dominates riverine input for most trace species considered. For most synthetic organic species atmospheric input accounted for 90% or more of the combined atmospheric plus riverine input to the global ocean. This is also the case for many dissolved trace metals, e.g. Pb, Cd and Zn; while atmospheric and riverine input are similar for Cu, Ni and Fe. Atmospheric input of nitrogen species dominates that from rivers as well. The major fraction of the input of these species occurs in the northern hemisphere. For most substances the input by precipitation was more important than that from dry deposition processes.
- 4.4 It was indicated that several parts of the report are still being finalized, including a comparison of atmospheric and riverine input for metals; detailed flux calculations for NO, NO₂ and such reduced nitrogen compounds as NH₃ and organic nitrogen; comparison of atmospheric and riverine fluxes for nitrogen species; discussion of nitrogen species and synthetic organics in coastal waters. This should be completed by Autumn of 1989.
- 4.5 During the discussion it was suggested that there be some additional comments on the net versus gross input of these atmospheric species. In particular, the mercury cycle was mentioned.
- 4.6 It was pointed out that there is a growing awareness of the importance of atmospheric input to the coastal zone, particularly for nitrogen species, and this needs to be emphasized and clarified.
- 4.7 It was suggested that results of EMEP modelling of nitrogen and sulphur species in marine areas adjacent to Europe be referenced and discussed briefly.
- 4.8 It was indicated that a comparison of tectonic inputs of trace metals to the ocean with the atmospheric and marine input would be useful.
- 4.9 It was indicated that there is evidence of accumulation of chlorinated hydrocarbons in the surface microlayer and that in the cold waters of polar regions there is evidence that the microbiological degradation of these substances is much slower than in temperate and tropical regions.
- 4.10 There was concern expressed that there be a balance between the various chapters on trace metals, nitrogen and synthetic organics.

- 4.11 It was pointed out that an executive summary is necessary, and this will be part of the final report.
- 4.12 It was also pointed out that it would be useful if a uniform format and SI units could be used for presenting the ranges and best estimates of these fluxes as well as an indication of the primary causes for the uncertainties indicated for the various fluxes.
- 4.13 After a number of comments were made by the Group and explanations were given by the Chairman of the Working Group, the Group approved the report, requested the Working Group to finalize the report as it planned and, taking into account the above comments, recommended that the report should be published in the GESAMP Reports and Studies series. A summary of the report is given in Annex VIII.

5. COASTAL MODELLING (Working Group 25)

- 5.1 The IAEA Technical Secretary informed the Group that members of Working Group 25 had met twice during the intersessional period: the fifth session of the full Working Group met in Vienna, Austria, from 7 to 11 November 1988, where the Working Group revised the structure of the draft report presented at the eighteenth session of GESAMP. A drafting group met again in Vienna, Austria, from 13 to 17 March 1989, to improve the homogeneity of the seven chapters initially written by various authors.
- 5.2 The Chairman of Working Group 25, Mr. J. Blanton, reviewed the current status of the report noting that while the present draft of the report appears to be intellectually sound, practical examples of models and their construction are lacking. Some examples exist in a separate annex that was unavailable to the Group. Other details on coastal oceanographic processes and their parameterizations were also in separate annexes. The summary report of the Working Group is presented in Annex IX.
- 5.3 There was a definite wish expressed by many members of the Group that the practical aspects of model construction be included in the report. Several case studies presently existing in annexes were described by the Working Group Chairman, and he stated that these or other case studies would be considered for inclusion in the main body of the report. Suggestions for additional case studies were solicited from the Group with the provision that each request specify in unambiguous terms the receiving coastal environment and the pathway of concern. The Working Group Chairman reiterated that there were no generic models available that could be used in all coastal situations and for all pollutants.
- 5.4 Other concerns were expressed about the content of the section on biological processes. It was suggested by several members of the Group that this material be reviewed before its final incorporation in the report.
- 5.5 The Chairman of the Working Group proposed to send the document in its present form to a selected list of "peer" reviewers for their comments and suggestions. This list was presented in the Working Group report submitted for this session of the Group. Suggestions for other reviewers were requested.
- 5.6 The Chairman of the Working Group stated that a separate meeting of the Working Group would be required to examine specific case studies and to take into account the views and opinions expressed by the Group and the observers of the session. The deliberations at that meeting would also take into account any comments that are received from outside reviewers. The Working Group would focus its efforts to provide specific case studies to show examples of pollutant transport and fate from simple to more complex situations.

- 5.7 The Group concurred with the need for the additional work specified in paragraph 5.6.
- 5.8 There was a consensus in the Group that an additional intersessional meeting of the Working Group would be held to finalize the report which would be tabled for approval of the next session of GESAMP.
6. STATE OF THE MARINE ENVIRONMENT (Working Group 26)
- 6.1 Mr. F. Sella, who served Working Group 26 as Technical Secretary since its establishment at the fifteenth session of the Group in 1985, briefly recalled the events leading to the preparation of the draft report submitted for the consideration of the Group.
- 6.2 Since its establishment the Working Group had held four one-week sessions and the present draft report has been written by a drafting group composed of the Chairman of the Working Group and Ms. G. Howells. A first version of the draft has been considered at the eighteenth session of the Group. A further draft had been considered by the Working Group at its last meeting in November 1988, and a revised draft was widely circulated for comments at the end of 1988. The draft presented to this session of the Group reflected the remarks of some 30 experts, including members of the Group, members of the Working Group and a few other experts.
- 6.3 Attached to the final report will be 15 technical annexes written by individual experts selected by the Working Group. The annexes were not available to the Group and were not discussed by it. Thus while the Group takes responsibility for the contents of the final report, the annexes are the responsibility of their authors.
- 6.4 The Working Group was assisted by a parallel activity of UNEP which will result in the publication of fourteen regional reviews on the state of the marine environment.
- 6.5 In addition to drawing on the technical annexes, on other GESAMP reports and on information culled from open literature, this report is therefore based also on the information being assembled and assessed in the preparation of the regional reviews.
- 6.6 In presenting the draft report to the Group, Mr. A. McIntyre, the Chairman of the Working Group, first drew attention to the general structure of the report. He pointed out that in accordance with the GESAMP definition of marine pollution, the report began with a review of those human activities which generate adverse effects in the sea. These activities included not only operations offshore and on the coasts, but also a wide range of activities in the hinterland which affect the marine environment. The report continued with an account of the levels and distribution of contaminants in the sea, and then with a chapter on biological effects, focusing on public health, on the biological significance of observed concentration in the sea, on eutrophication, and on the problems of more subtle, long-term effects of low levels of contaminants. Later chapters dealt with climate change effects, with economics and with strategies for prevention and control of pollution. The report finished with a general overview and an executive summary was included. The summary report of the Working Group is presented in Annex X.
- 6.7 In the ensuing discussion, several participants underlined that the report represented a considerable progress over the earlier draft considered by the Group at its previous session. A number of suggestions were made on its presentation, including the need for a professional editor to revise the text thoroughly, the use, where possible, of maps indicating critical areas, the need for references and for an index and the value of dealing in "boxes" with certain items that would illustrate the text but, if left in it, would distract the reader from the main flow of the report.

6.8 Substantive points were raised by various members including:

- (a) whether it was justified to assign the highest priority to eutrophication when the problems of sewage disposal may be as important, or according to some speakers more important, and as widespread, with direct consequences on human health;
- (b) the value of mentioning the long-term effects of low levels of petroleum hydrocarbons;
- (c) the need to give a more positive flavour to the final section of chapter III (paragraphs 306-312);
- (d) the need to refer to genotoxic effects of low concentration of contaminants;
- (e) the need to underline, in discussing the changes that have intervened since the adoption of the first GESAMP report on the health of the oceans, the fact that the public awareness of the problems of the marine environment has deepened and the audience widened;
- (f) the need to ensure the accuracy of paragraphs 240 - 255;
- (g) the possibility of recommending that a baseline of the incidence of various fish diseases be established;
- (h) carbon dioxide is not the only greenhouse gas and therefore the report should indicate the relative contribution of other gases to the greenhouse effect and show that some, such as methane, rise faster and will play an increasing role in the causation of the effect;
- (i) the rising concern about new environmental contaminants;
- (j) in dealing with extreme events the need for preparedness should be emphasized;
- (k) criticisms were levelled against chapter VI but detailed discussion was deferred until the arrival of its author (Mr. J. Broadus);
- (l) a clear indication of the inadequacy of the data bases in many areas should be included in the executive summary; the executive summary should highlight the trends that were identified;
- (m) regional aspects ought to be emphasized drawing on the regional draft reports; and
- (n) the executive summary should contain no information that had not been reviewed in the body of the report.

6.9 The Group considered the re-draft of chapters V and VI which had been prepared during the present session of the Group by a small drafting group composed of Mr. A. McIntyre, Mr. J. Broadus, Ms. G. Howells and Mr. G. Needler. However, in the course of the ensuing discussion, a number of reservations were expressed about the contents of these chapters.

6.10 It was therefore decided to reject the revised draft of these chapters with the understanding that chapter V of the original draft considered by the Group would be omitted from the final report, whereas chapter VI of the same draft would be edited by the editorial group, taking account of comments received in writing during the present session of the Group.

6.11 It was agreed that the remainder of the report be accepted subject to editing by the drafting group in accordance with the comments made by the Group at this session.

7. LONG-TERM ECOLOGICAL CONSEQUENCES OF LOW-LEVEL CONTAMINATION OF THE MARINE ENVIRONMENT (Working Group 27)

7.1 The FAO Technical Secretary introduced the report of a small steering group which met in Rome, Italy, 6-8 June, and Cambridge, U.K., 8-9 August 1988.

7.2 Ms. G. D. Howells, Chairman of Working Group 27, reminded the Group of the history of the Working Group and recalled the decision of the eighteenth session of the Group to develop a framework and principles for a structural approach to be taken. It was recognized that existing long-term data series collected in the marine environment were found insufficient for the task of the Working Group since such data series were not collected with the specific objective to identify early warning signs of environmental changes due to low-level contamination. The report now presented to the Group used four case studies (nutrients, organochlorine compounds, tributyltin and hydrocarbons) which clearly confirm the hypothesis that low-level contamination have ecological consequences in the long-term. The steering group indicated those early warning signs that could be used in design of biological monitoring programmes to detect effects of low-level contamination. The report also included two preliminary analytical frameworks to be considered in the assessment of case study data. The summary report of the Working Group is presented in Annex XI.

7.3 During the discussions further proposals were made on how to broaden the basis of the report, including looking for genetic changes in micro-organisms, dealing in more depth with rehabilitation and recovery aspects, prediction and modelling of ecological changes in open ocean areas, adding additional case studies on metals, radionuclides, etc. The Group, however, supported the pragmatic approach taken by the steering group in answering the question posed. It was therefore decided that, although the present paper was intended to give guidance for further work of Working Group 27, the report should be developed, as necessary, as a final statement by a further meeting of the steering group. The Group therefore approved the report in substance and authorized its publication as Reports and Studies.

8. FUTURE WORK PROGRAMME

(a) Scientifically based strategies for marine environmental protection and management

8.1 The FAO Technical Secretary reminded the Group that the eighteenth session of the Group charged Mr. D. Calamari with the preparation of a paper on strategies for marine environmental protection and management. Mr. D. Calamari then presented the paper he had prepared with the assistance of Mr. M. Bewers, Mr. P. Wells and Ms. A. Salo. He explained that recent developments in the field of ecotoxicology indicate that there have been sufficient advances in the science to open a discussion on the opportunities for developing more effective environmental management/protection strategies. He therefore proposed the following action to be taken:

- undertake an analysis of recent developments in marine ecotoxicology and related fields in order to identify new elements and procedures of potential application to more effective and comprehensive marine environmental protection instruments;
- identify scientific principles and management approaches that would provide a basis for more comprehensive and effective frameworks to the protection of the marine environment, its resources and amenities;
- analyse current marine environmental management strategies to identify their drawbacks and limitations and identify instances in which recent scientific developments offer opportunities for the correction of these deficiencies; and

- identify frameworks that would provide greater opportunities for the application of developing scientific understanding to marine environmental management.

- 8.2 Taking into account the comments received from the Group on the presentation made by Mr. D. Calamari, the UNEP Technical Secretary introduced the joint proposal of several GESAMP sponsors (UNEP, FAO, WHO, Unesco) and of Mr. D. Calamari, to initiate the formulation of science-based strategies for marine environment protection and management, as a task to be assigned to GESAMP as a whole. According to the explanations provided by the sponsors of the proposal, most of the strategies for the protection and management of the marine environment were in the past developed primarily to satisfy the immediate, or at best, the short-term interests and needs of individual countries, group of countries, or specific economic sectors. Few of these strategies are based on reliable and defensible scientific rationale. With the growing awareness that the mitigation or solution of the major environmental problems, in particular those which may have to be faced in connection with the predicted global changes, including those related to climatic changes, will require a coherent global approach, the need became evident for long-term strategies reconciling the frequently conflicting interests of individual countries or economic sectors, and firmly based on scientifically justified facts.
- 8.3 In order to assist GESAMP in the formulation of strategies, it was proposed that a small steering group meets during 1989 under the chairmanship of Mr. D. Calamari and, using the paper referred to in paragraph 8.1 as well as any other information which may be submitted to it by the sponsoring organizations, prepares a position paper listing the possible elements of strategies with an indication of the approach which may be adopted by the Group towards each of these elements. The position paper would be distributed well in advance of the twentieth session of the Group as the basis for the agenda item on the same subject. The twentieth session of the Group would be expected to prepare, during its session, the first draft of a document outlining the possible common, global and science-based strategies for the protection and management of the marine environment, and decide on the future steps to be taken in order to finalize the document.
- 8.4 In the ensuing debate the WMO and IMO Technical Secretaries expressed their organizations' interest to be associated with the proposal. The WMO Technical Secretary proposed that the activities of the steering group should include identification or prediction of potential problems which might become important for the marine environment in the future.
- 8.5 The Group agreed with the proposed course of action, emphasizing that the strategies expected to be formulated should be based on the best scientific information available and should especially address emerging global environmental problems.
- 8.6 Linkages should be ensured between the activities expected from the steering group and those expected from the Working Group on Comprehensive Framework for the Assessment and Regulation of Waste Disposal in the Marine Environment (see paragraphs 8.7-8.11).
- (b) Comprehensive framework for the assessment and regulation of waste disposal in the marine environment
- 8.7 The IMO Technical Secretary introduced a paper requesting the Group to consider the development of "a common, comprehensive and holistic framework for the regulation and assessment of dumping at sea of all types of wastes i.e. radioactive as well as non-radioactive wastes". It was explained that the request arose from discussions within the Inter-Governmental Panel on Radioactive Waste Disposal at Sea (IPGRAD) and that the issue would clearly require consideration of all waste inputs to the marine environment, including those from land-based sources.

- 8.8 This request had been noted by the Group at its eighteenth session and the Group had suggested that the issues raised constituted a suitable topic for further consideration within GESAMP.
- 8.9 In order to further the debate on this matter, several members of the Group prepared an introduction to draft terms of reference for a possible working group on this subject. The introduction noted that scientific considerations have a role to play in the development and implementation of environmental protection mechanisms; that the ethic and objectives of the World Commission on the Environment and Development, and the precautionary principle, are broadly advocated within the UN system; that the GESAMP definition of pollution is still valid; and that it was timely and important to examine current approaches and instruments for marine environmental protection and to assess the degree to which these were compatible with the above objectives, principles and definitions.
- 8.10 Following detailed discussion, the draft terms of reference were revised and adopted as follows:
- (a) analyse existing regulatory mechanisms, and their underlying concepts and principles, that are currently employed at both national and international levels, to protect the marine environment against the adverse effects of anthropogenic activities;
 - (b) determine the advantages, limitations and compatibility of these various mechanisms in terms of their practicality and effectiveness in protecting the environment on a sectoral and contaminant-specific basis and in providing a scientifically-defensible and holistic approach to pollution prevention;
 - (c) in addressing the question, the Working Group should take account of experience with the assessment of environmental problems, and recent scientific advances in the field of hazard assessment, with a view to their application in a marine environmental management context; and
 - (d) to prepare a report synthesizing current pollution control/prevention mechanisms, identifying the components and inter-relationships of those frameworks best suited to harmonized implementation and allowing for achievement of sustainable use and protection of the marine environment.
- 8.11 The Group agreed that the report of the planned steering group on Scientifically-Based Strategies for Marine Environmental Protection and Management (paragraphs 8.1-8.6 above) should make a useful contribution to the work of the new Working Group. Several Technical Secretaries indicated their intention to support this activity.
- (c) Impacts of anthropogenically mobilized sediments in the coastal environment
- 8.12 The Unesco Technical Secretary recalled the discussions at the eighteenth session of the Group regarding the concern that increased rates of sedimentation derived from human activities could potentially give rise to pollution effects, and that the decision was made for a review paper to be prepared for discussion on the matter at the present session of the Group. Mr. J. Pernetta had, accordingly, been invited to prepare a review, which was tabled for consideration by the Group.
- 8.13 Mr. J. Pernetta presented his paper, stating that the issue had been raised during the preparation of the review of the state of the marine environment. The paper reviewed briefly: mobilization of sediments on a global scale; origins of anthropogenically derived sediments in coastal zones; impacts of sediment on coastal biota (direct and indirect); and impacts of sediments on human use of the coastal zone, including remedial

actions. He emphasized the overview nature of the paper, concerned with the effects of inland activities on sediment transfer to the coastal zone and the effects of this on coastal zone ecosystems. Several examples were reviewed in the paper, stressing the particular susceptibility of some tropical and subtropical ecosystems. Sediment starvation was also briefly mentioned, although not really a remit of the work. An abstract of the paper is provided in Annex XII.

- 8.14 Most members of the Group participated in the discussion raising several points, including: the need to consider a range of scales, from local to global; the importance of relating the problems to land-use practices, including remedial actions, with engineering and technological approaches used in coastal zone management; focus on impacts on resources and biological production and to take into account sedimentary budgets, including sinks, sediments as carriers of contaminants and possibly fate of particles in open sea; effects of sediment starvation; particular importance for tropical and subtropical areas; impacts on mangroves, coral reefs, fisheries; the necessity of bringing the problem to the attention of national and international bodies and put it in a socio-economic context; the possibility of evaluating impacts of expected global changes (e.g. sea level, temperature) on sediment budgets (erosion, sediment supply) and make predictions; use of various data sources, including satellite imagery; consider experiences from some semi-enclosed seas on biogeochemical and other processes, including microbiological ones, and changes of primary production.
- 8.15 All participants in the discussion recommended that the Group pursue the matter through the most appropriate mechanisms with the objective of producing an authoritative statement based on a review of available scientific information, data and understanding. Mr. J. Pernetta presented draft terms of reference for such an activity, which he prepared in consultation with Ms. H. Chansang and Mr. J. Lopez.
- 8.16 The Chairman concluded that these draft terms of reference should be revised, taking into account the discussion by the Group, and that the Group endorses the formation of an intersessional Working Group or Study Group who should prepare a progress report for consideration by the twentieth session of the Group.
- 8.17 The approved terms of reference for the Working Group/Study Group are:
- (a) to evaluate the geographic extent and distribution of problems resulting from anthropogenically mobilized sediments in the world's coastal zones;
 - (b) to review and assess available data on the volumes and fluxes of sediments in coastal zones, resulting from natural and human activities, including sediment starvation;
 - (c) to review the causes of anthropogenic sediment flux by geographic area and/or country, as appropriate;
 - (d) to evaluate the impacts of anthropogenically mobilized sediments in the coastal and nearshore environments;
 - (e) to identify inadequacies in the existing data and make recommendations for action in the implementation of future national and regional research and monitoring programmes;
 - (f) to assess the economic costs of anthropogenically caused sedimentation in coastal zones;
 - (g) to evaluate the efficacy of measures currently employed to control problems caused by sediments in coastal areas;

(h) to recommend policies and courses of action for handling the problems at both the national/international level; and

(i) to identify any aspects of the above items which might be applicable to sea-bed areas beyond the coastal nearshore zone.

(d) Intersessional work

8.18 Taking into account the decisions of the Group, the 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 inter-secretariat meeting of agencies sponsoring GESAMP.

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

Lead Agency: IMO
Co-operating Agency: UNEP
Chairman: W. Ernst
Member from GESAMP: P. Wells
Additional members: 7

Review of potentially harmful substances (Working Group 13)

Lead Agency: Unesco
Co-operating Agencies: UNEP, FAO, WHO, IMO
Chairman: J. Portmann

(i) Sub-group on carcinogenic, mutagenic and teratogenic substances

Lead Agency: Unesco
Co-operating Agency: WHO, IMO
Chairman: J. Portmann
Additional members: 2

(ii) Sub-group on chlorinated hydrocarbons

Lead Agency: FAO
Co-operating Agencies: UNEP, Unesco
Chairman: D. Calamari
Member from GESAMP: J. Portmann
Additional members: 1-2

(iii) Sub-group on oil, including used lubricating oils, oil spill dispersants and chemicals used in offshore exploration and exploitation

Lead Agency: IMO
Co-operating Agencies: UNEP, FAO and Unesco
Chairman: P. Wells
Additional members: 8

Coastal modelling (Working Group 25)

Lead Agency: IAEA
Co-operating agencies: UNEP, Unesco, IMO
Chairman: J. Blanton
Member from GESAMP: M. Bewers
Additional members: 3

Long-term ecological consequences of low-level contamination of the marine environment
(Working Group 27)

Lead Agency: FAO
Co-operating Agencies: UNEP, Unesco, IMO
Chairman: G. D. Howells
Members from GESAMP: P. Wells, D. Calamari, J. Gray

Scientifically based strategies for marine environmental protection and management
(Working Group 28)

Lead Agency: FAO
Co-operating Agencies: UN, UNEP, Unesco, WHO, WMO and IMO
Chairman: D. Calamari
Members from GESAMP: H. Windom, J. Gray, R. Duce, P. Wells, J. Portmann

Comprehensive framework for the assessment and regulation of waste disposal in the marine
environment (Working Group 29)

Lead Agency: IMO
Co-operating Agencies: UN, UNEP, FAO, Unesco, IAEA
Chairman: R. Boelens
Members from GESAMP: J. Portmann, M. Bowers
Additional members: 5

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

Lead Agency: Unesco
Co-operating Agencies: UN, UNEP, FAO, IMO
Chairman: J. Gray
Members from GESAMP: H. Chansang, D.C. Ibe, J. Lopez, J. Pernetta, P. Tortell
H. Windom
Additional members: ?

9. DATE AND PLACE OF NEXT SESSION

9.1 The Group noted that the twentieth session of GESAMP will be hosted by the World Meteorological Organization and held at the Headquarters of that organization in Geneva, commencing at 9 a.m. on 7 May 1990, and ending at about 5 p.m. on 11 May 1990.

9.2 The Group urged the Technical Secretaries to distribute the documents for the twentieth session of the Group not later than 9 March 1990. It was particularly emphasized that reports submitted for final approval of the Group could not be considered adequately if they were not in the hands of experts at least one month before the session.

10. OTHER MATTERS

(a) Oil spill in Alaska

10.1 One member of the Group drew attention to the recent Alaskan oil spill emphasizing the weaknesses in contingency planning, as well as in the control and the clean-up of marine pollution accidents. He proposed that a resolution be adopted by the Group requesting the establishment of a United Nations Commission to investigate the causes, results and actions taken in respect of this oil spill and to identify any lessons to be learned from the incident.

10.2 Several members of the Group felt that GESAMP was not the appropriate body to make such a resolution on this issue. Nevertheless, the Group noted with concern the immediate and long-term environmental implications of a number of recent marine oil spills in Alaska, Central America and the Antarctic which have raised questions as to the adequacy of accident prevention procedures and contingency planning for containment and clean-up of marine chemical spills. Considering the potential international implications of such accidents, the Group calls on the appropriate United Nations agencies to urgently study and evaluate these events with the aim of drawing appropriate conclusions and making recommendations to international agencies and to member nations for improving precautionary procedures and contingency planning in cases of marine spills.

(b) Utilization of GESAMP reports

10.3 Several members of the Group expressed their concern that the work of GESAMP and its outcome are not utilized to the full extent. In this respect the following proposals were made:

- publication of and distribution of reports through commercial publishers;
- improvement of the presentation of GESAMP Reports and Studies;
- wide advertising of reports and studies;
- preparation of summaries of reports and studies for publication in scientific journals;
- identification of target groups for which studies have been prepared and adoption of language and presentation accordingly;
- inclusion in each report of a short chapter on management related implications;
- wide distribution of leaflets to each study containing information on the contents, aims, objectives and scope of the study; and
- encouragement of the users of GESAMP Reports and Studies to comment or to provide other feedback through the sponsoring agencies to the Group.

10.4 The UN Technical Secretary proposed adding "GESAMP Publications" to the agenda of the forthcoming ad hoc Interagency Consultation on Ocean Affairs. Since these meetings are system-wide, including UN Regional Commissions, discussions there may add to:

- scope of distribution and targeting of users; and
- coverage in newsletters and related public information materials of the UN system.

10.5 The UN Technical Secretary also informed the Group that at the 44th session of the UN General Assembly prominent mention of GESAMP will be made and its role as the scientific advisory body to its sponsoring agencies will be emphasized.

10.6 The Group requested the Technical Secretaries to take the above proposals into account when considering the preparation and distribution of GESAMP Reports and Studies.

11. ELECTION OF CHAIRMAN AND VICE-CHAIRMAN FOR THE NEXT INTERSESSIONAL PERIOD AND FOR THE TWENTIETH SESSION

11.1 The Group unanimously re-elected Mr. H. Windom as Chairman and Mr. D. Calamari as Vice-Chairman for the next intersessional period and for the twentieth session of GESAMP.

12. CONSIDERATION AND APPROVAL OF THE REPORT OF THE NINETEENTH SESSION

12.1 The draft report of the nineteenth session of the Group was considered by the Group on the last day of the session and was approved with amendments reproduced in this document. It contains, in Annexes IV to XII, summaries of reports prepared by the Working Groups and their Sub-Groups. These summaries are included for information only and were not considered by the Group with a view to approval. The Terms of Reference of the Working Groups and lists of members are also provided in the Annexes.

12.2 The nineteenth session of GESAMP was closed by the Chairman of the Group at 12.15 p.m. on 12 May 1989.

Annex I

AGENDA

Opening of the session

1. Adoption of the agenda
2. Review of potentially harmful substances:
 - 2.1 carcinogenic, mutagenic and teratogenic substances
 - 2.2 chlorinated hydrocarbons
 - 2.3 oil, including used lubricating oils, oil spill dispersants and chemicals used in offshore exploration and exploitation
3. Evaluation of the hazards of harmful substances carried by ships
4. Interchange of pollutants between the atmosphere and the oceans
5. Coastal modelling
6. State of the marine environment
7. Long-term ecological consequences of low-level contamination of the marine environment
8. Future work programme
9. Date and place of next session
10. Other matters
11. Election of Chairman and Vice-Chairman for the next intersessional period and for the twentieth session
12. Consideration and approval of the report of the nineteenth session

Annex II

LIST OF DOCUMENTS

Working Documents

GESAMP XIX/1	Administrative Secretary	Provisional agenda
GESAMP XIX/2.2 <u>1/</u>	FAO Secretary	Report on the ad-hoc meeting on chlorinated hydrocarbons
GESAMP XIX/2.3	IMO Secretary	Review of potentially harmful substances: oil, including used lubricating oils, oil spill dispersants and chemicals used in offshore exploration and exploitation
GESAMP XIX/3	Working Group 1	Evaluation of the hazards of harmful substances carried by ships
GESAMP XIX/4	Working Group 14	Atmospheric input of trace species to the world ocean
GESAMP XIX/5	Working Group 25	Report of Working Group 25 on coastal modelling
GESAMP XIX/6 <u>2/</u>	Working Group 26	Report of Working Group 26 on the state of the marine environment
GESAMP XIX/6.1	Working Group 26	Revised outline for Chapter VI of GESAMP XIX/6
GESAMP XIX/6.2	Working Group 26	Sample of possible "boxes" to be inserted where appropriate in the report
GESAMP XIX/6.3	Working Group 26	Draft report on the state of the marine environment. V The economics and control of marine pollution
GESAMP XIX/7	FAO Secretary	Report of the steering group for Working Group 27 on long-term ecological consequences of low-level contamination of the marine environment

1/ Document originally distributed as GESAMP XIX/3.3

2/ Document originally distributed as GESAMP XIX/6.1

GESAMP XIX/8.1	FAO Secretary	Report of the study group on strategies for marine environment protection and management
GESAMP XIX/8.1/Add.1	UNEP/FAO/WHO/Unesco Secretaries and D. Calamari	Proposal for development of strategies for marine environmental protection and management
GESAMP XIX/8.2 ^{3/}	IMO Secretary	Comprehensive framework for the assessment and regulation of waste disposal at sea
GESAMP XIX/8.2/Add.1	IMO Secretary	Terms of reference for a proposed Working Group on the Assessment and Management of the Marine Environment
GESAMP XIX/8.2/Add.1/Rev.1	IMO Secretary	Future work programme
GESAMP XIX/8.3 ^{4/}	Unesco Secretary	The impacts of anthropogenically derived sediments in the coastal environment
GESAMP XIX/10	H. Shuval	Proposal for GESAMP resolution on the Alaskan oil spill

Information Documents

GESAMP XIX/Inf.1	Administrative Secretary	Provisional list of participants
GESAMP XIX/Inf.2	Administrative Secretary	Provisional list of documents
UNEP Regional Seas Reports and Studies No. 103	UNEP Secretary	G. Sestini, L. Jeftic and J. D. Milliman: Implications of expected climate changes in the Mediterranean region: an overview
MAP Technical Report No. 28	UNEP Secretary	The state of the marine environment in the Mediterranean region

Background Documents

GESAMP Reports and Studies No. 33		Report of the Eighteenth Session (Paris, 11-15 April 1988)
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^{3/} Document originally distributed as GESAMP XIX/8

^{4/} Document originally distributed as GESAMP XIX/10.1

Annex III

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Annex IV

SUMMARY OF THE REPORT OF THE SUB-GROUP ON CARCINOGENIC, MUTAGENIC AND
TERATOGENIC SUBSTANCES OF THE WORKING GROUP ON THE REVIEW OF
HARMFUL SUBSTANCES (WORKING GROUP 13)

1. It has been agreed at GESAMP XVIII that the work of this sub-group be carried out in four steps:
 - (i) IMO to provide lists of carcinogenic substances and their concentrations in the marine environment, in particular, in marine biota;
 - (ii) WHO to calculate effects on human health;
 - (iii) Unesco to solicit a report on the effects of carcinogenic substances on marine life; and
 - (iv) IMO/UNEP/FAO/Unesco to convene the meeting of a small group to prepare the final drafts.
2. Following GESAMP XVIII, IMO commissioned the first task to the Marine Biological Association of the United Kingdom which prepared a report on "Levels of carcinogens in the marine environment - parts 1 and 2". Information on 29 chemicals graded by the International Agency for Research on Cancer (IARC) as human carcinogens was provided. Subsequently, a linearized multi-stage extrapolation model was used to calculate the cancer risks associated with dietary intake of contaminated seafood. These calculations are contained in a paper by Dr. L. Magos, a former GESAMP expert member, with the title "Cancer risk assessment of trace metals, polycyclic aromatic and polychlorinated hydrocarbons in seafood". This paper was submitted to the International Programme on Chemical Safety for review and subsequently to GESAMP XIX for information and comments.
3. The third task, review of effects of carcinogenic substances on marine life was undertaken through a study by J. A. Couch, USEPA, entitled "Review of North American and Pacific basin experience and knowledge of carcinogens and marine species". This report summarizes historic and significant occurrences of neoplastic lesions in bivalve molluscs and in marine bony fish.
4. Due to lack of time before GESAMP XIX, the small group finalizing the draft report could not meet as planned. Consequently, the two above reports were only submitted to the Group for comments on their content and needs for their completion.

TERMS OF REFERENCE

The following general terms of reference adopted for Working Group 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 marine 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.

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Annex V

SUMMARY OF THE REPORT OF THE SUB-GROUP ON CHLORINATED HYDROCARBONS OF THE
WORKING GROUP ON THE REVIEW OF HARMFUL SUBSTANCES (Working Group 13)

A study group met in Rome, 27-29 July 1988, to consider the feasibility of producing a review of organochlorine compounds. It was concluded that it was not appropriate to review the potentially harmful effects of chlorinated hydrocarbons in a marine environmental context by considering them as a single generic group. Also, it should be recognized that adequate reviews already exist for many of these compounds. In order to avoid needless duplication of effort and to ensure that new reviews are prepared only for those compounds that really merit attention, a preliminary hazard assessment has to be undertaken according to the following steps:

1. prepare a comprehensive listing of chlorinated hydrocarbons;
2. subdivide the list into groups according to chemical criteria;
3. make a preliminary hazard assessment, within each group, collecting the necessary information only from the most readily accessible data sources;
4. on the basis of these group-wise, preliminary hazard assessments, prepare a carefully selected list of those compounds that appear most potentially dangerous in a marine environmental context; and
5. identify those compounds, on this selected list, for which reviews already exist and indicate those for which new, or partial, reviews are required.

These tasks are being undertaken by a consultant through UNEP (IRPTC).

Once this work is completed, the study group will propose to GESAMP a list of substances that need special attention due to their potential hazard, and will make recommendations on how to proceed with the production of review documents for those hazardous substances for which such reviews do not already exist.

TERMS OF REFERENCE

The general terms of reference adopted for Working Group 13 (see annex IV) apply for the work of the sub-group.

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Annex VI

SUMMARY OF THE REPORT OF THE SUB-GROUP ON OIL, INCLUDING USED LUBRICATING OILS,
OIL SPILL DISPERSANTS AND CHEMICALS USED IN OFFSHORE EXPLORATION
AND EXPLOITATION OF THE WORKING GROUP ON THE REVIEW
OF HARMFUL SUBSTANCES (Working Group 13)

Two meetings of a small group of experts had been convened at IMO Headquarters, London, in August 1988 and in February 1989, to prepare an annotated draft outline of a report on oil, including used lubricating oils, oil spill dispersants and chemicals used in offshore exploration and exploitation. The table of contents of the proposed report as prepared by the expert group is set out below.

Part I: Summary

Preface (scope and intent of the review)

Abstract

Oil and individual hydrocarbons
Used lubricating oils
Oil spill control agents, particularly dispersants
Chemicals used in offshore oil exploration and exploitation

Part II: Resource Document on Impact of Oil and Related
Chemicals on the Marine Environment

Chapter 1 Introduction

Chapter 2 Oils and individual hydrocarbons

- 2.1 Introduction
- 2.2 Sources and inputs of hydrocarbons
- 2.3 Chemical composition and physical properties of oils
- 2.4 Physical, chemical and biological methods
- 2.5 Fate of spilled oils
- 2.6 Marine ecosystem - effects and recovery
- 2.7 Effects on human health
- 2.8 Effects on man's use of the sea
- 2.9 Conclusions

Chapter 3 Used lubricating oils

- 3.1 Introduction
- 3.2 Sources and inputs
- 3.3 Chemical composition and physical properties
- 3.4 Physical, chemical and biological methods
- 3.5 Fate of used lubricating oils in marine ecosystems
- 3.6 Ecosystem effects
- 3.7 Effects on human health
- 3.8 Effects on man's use of the sea
- 3.9 Conclusions

Chapter 4 Oil spill control agents, with emphasis on dispersants

- 4.1 Introduction
- 4.2 Composition, chemical and physical properties of dispersants
- 4.3 Ecotoxicology of dispersants and dispersed oils
- 4.4 Mesocosm and field studies on dispersants and biological effects
- 4.5 Mammalian toxicology and human health effects
- 4.6 Conclusions

Chapter 5 Chemicals used in offshore oil exploration and production

- 5.1 Introduction
- 5.2 Types and composition
- 5.3 Physical, chemical and biological methods
- 5.4 Fate in marine ecosystems
- 5.5 Ecosystem effects and recovery
- 5.6 Effects on human health
- 5.7 Effects on man's use of the sea
- 5.8 Conclusions

Chapter 6 Summary and recommendations

- preamble
- oil and hydrocarbons - main findings, recommendations
- used lubricating oils - main findings, recommendations
- spill control agents - main findings, recommendations
- chemicals used in, and discharged, from offshore exploration and production installations - main findings, recommendations

PART III: Bibliography

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TERMS OF REFERENCE

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* Meeting 25-26 August 1988 only
** Meeting 17 February 1989 only

Annex VII

SUMMARY OF THE REPORTS OF THE WORKING GROUP ON THE EVALUATION OF THE HAZARDS OF HARMFUL SUBSTANCES CARRIED BY SHIPS (Working Group 1)

1. The Working Group met twice under the chairmanship of Mr. W. Ernst at IMO Headquarters, London, from 29 August to 2 September 1988 and from 13 to 17 February 1989.
2. The Working Group considered the hazard profiles of 130 substances, of which approximately half were new proposals for carriage by ships.
3. Correspondence with industry had indicated a continuing need to provide advice, particularly on aquatic marine toxicology and related problems. Advice was given on the specific problem of a protocol for determining the bioaccumulation of zinc in oysters.
4. The Working Group noted the progress in the preparation and review of data sheets for individual substances and the use of a computerized data base for the retrieval of individual ratings and other relevant information concerning substances for which profiles had been assigned.
5. The use being made of copper compounds as a replacement for trialkylated tin compounds in anti-fouling paints had been noted. The Working Group agreed to identify these and establish or review their hazard profiles at a future meeting.
6. The Working Group reviewed the hazard to marine organisms by the bioaccumulation of arsenic. High arsenic levels are noted in marine biota following consumption of algae which is the principal concentrator. The major part of the arsenic is present in compounds such as arsenobetain from which it is eliminated in a biphasic pattern. Such bio-concentration has not been shown to result in harm to the organism concerned. The possible effect of human consumption of seafood containing elevated levels of arsenic remains to be considered before a change could be made to the hazard profiles.
7. The Working Group noted that the bioaccumulation of zinc from both food and water into specific body compartments was well established. The mechanisms by which it is accommodated and detoxified are not yet clear but three independent studies had indicated a positive relationship between toxicity and bioaccumulation. On this basis the Working Group considered that the hazard profiles of zinc-containing substances should remain unchanged.
8. The Working Group appreciated the support of the University of Trondheim (Norway) for the computerization of the hazard profiles which will facilitate the retrieval of data.
9. The following items were identified for priority consideration at the next meeting of the Working Group to be convened at IMO Headquarters, London, from 26 to 30 March 1990:
 - (a) review of Column A of the hazard profiles for substances having a "Z" rating;
 - (b) review of the hazard profiles of arsenic, selenium and alhylbengenes;
 - (c) consideration of hazards posed by copper compounds; and
 - (d) evaluation of substances contained in the IMDG Code.

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 VIII

SUMMARY OF THE REPORT OF THE WORKING GROUP ON THE INTERCHANGE OF
POLLUTANTS BETWEEN THE ATMOSPHERE AND OCEANS (Working Group 14)

1. The preparation of the report was started at a Working Group 14 workshop held from 10 to 14 October 1988 at the University of Rhode Island, USA and the draft report presented to GESAMP XIX was prepared at a short additional meeting in December 1988 by the two workshop co-chairmen and the chairmen of five workshop panels. At the time of presentation of the report the work on it was being continued and was expected to be completed later in 1989. GESAMP XIX approved the draft report and recommended that it should be published when finalized.
2. The draft report consists of six chapters including the introduction where it was noted that because of recent research efforts it became possible for the first time to assess the atmospheric fluxes of many species to the oceans. The species of concern were those that could have an impact on biological processes and on chemical cycling.
3. Chapter two describes deposition processes and various approaches to the estimation of atmosphere-ocean mass fluxes including direct measurements and indirect estimates based on concentration terms and kinetic parameters for gases, particles and wet precipitation. It was agreed that the calculations of deposition would be made for $10^{\circ} \times 10^{\circ}$ grid squares for five ocean basins (North and South Atlantic, North and South Pacific and the Indian Ocean), for the global ocean and when possible for some regional seas.
4. Atmospheric transport of airborne species and precipitation climatology are dealt with in the third chapter. To obtain the meteorological information needed for calculations the two approaches were considered: the use of climatological fields and the use of Lagrangian/Eulerian transport models and general circulation models. For the present study the climatological approach was considered more appropriate. The gridded precipitation data were obtained by interpolation of values of precipitation frequency multiplied by the precipitation depth estimates. Only the annual total data were used in the calculations because of limitations connected with the availability of chemical data.
5. The atmospheric input of trace elements and mineral aerosols to the world ocean is considered in Chapter 4. Parameterizations of dry deposition velocities and scavenging ratios used for the trace metal and mineral flux calculations were made on the basis of available data, and different values of these parameters were used for different types of particles (pollutant or mineral aerosols) and for different ocean areas (remote or coastal). Deposition calculations for grid squares with missing concentration data were made by means of extrapolation. The global elemental fluxes for Pb and mineral aerosol as calculated from the concentration fields, dry deposition velocities, precipitation scavenging ratios and precipitation amounts are presented for five ocean basins as well as atmospheric fluxes of other primarily anthropogenic trace metals (Cd, Cu, Ni, Zn, As) and soluble fluxes of trace elements derived from mineral aerosol (Al, Fe, Si, P). The chapter also contains comparisons between predicted and observed data and summaries of available data and calculations of aerosol and rainwater concentrations of trace elements over the North, Baltic and Mediterranean Seas which allowed the estimation of their deposition fluxes and the comparison of these fluxes with the total emission estimates in Europe.

6. Chapter five deals with atmospheric input of oxidized and reduced nitrogen species that can be utilized in the ocean as nutrients (nitrate aerosol, nitrogen oxide gases, nitric acid, ammonium, ammonia and others). In view of the fact that there were a very limited number of experimental data for most nitrogen species (except nitrate aerosol) background mean values of concentrations were used for deposition flux estimates separately for open ocean and coastal areas and assumed half-decrease distances were applied for extrapolations. Assumptions for deposition velocities and scavenging ratios were made on the basis of available (but limited) observation data and chemical properties. The significance of the assumptions made is considered as well as sources of other uncertainties in flux estimates. The chapter summarizes results of concentration and deposition rate measurements, gives estimates of concentrations and wet/dry deposition fluxes for various ocean basins and the ocean as a whole and certain coastal areas. Comparison of the present calculations with measurement data and other estimates is also made.
7. Chapter six synthesizes the available data base of several synthetic organic compounds in the atmosphere and extrapolates measurements from the marine atmosphere to obtain basin scale and global scale estimates of these compounds to the ocean surface. The compounds selected are PCBs, HCHs, DDTs, chlordane, dieldrin, chlorobenzenes and some others. Practically all data collected over the last decade were used and linearly interpolated. Higher concentrations were used for coastal regions, except HCBs for which uniform distribution was assumed. Deposition flux calculations were made for material present both on particles and as gases. Gas/particle partitioning was assessed on the basis of field and laboratory observations and combined with atmospheric concentrations to obtain concentration fields for particle-bound species. Available data allowed reasonable assumptions to be made for scavenging ratios and deposition velocities. Gas-phase exchange processes were parameterized through Henry's Law constants. Maximum ranges and "best" estimates of deposition fluxes are presented for ocean basins and the world ocean and are compared with riverine inputs of organochlorine compounds.
8. The report indicated clearly that atmospheric input dominates riverine input for most trace species considered. For most synthetic organic species atmospheric input accounted for 90% or more of the combined atmospheric plus riverine input to the global ocean. This is also the case for many dissolved trace metals, e.g. Pb, Cd and Zn; while atmospheric and riverine input are similar for Cu, Ni and Fe. Atmospheric input of nitrogen species dominates that from rivers as well. The major fraction of the input of these species occurs in the northern hemisphere. For most substances the input by precipitation was more important than that from dry deposition processes.
9. The completed version of the report will include also a comparison of atmospheric and riverine inputs for metals and nitrogen species, detailed flux calculations for NO, NO₂, NH₃ and organic nitrogen, and coastal water problem discussion for nitrogen species and synthetic organics. The comments made at GESAMP XIX (see paragraphs 4.5 - 4.12) will also be taken into account.

TERMS OF REFERENCE

1. To provide a continuing review of air-sea material exchange with emphasis on modification by contaminants of the atmosphere, sea-surface microlayer and ocean processes related to climate, the energy balance of the ocean and mechanisms of mass and energy transfer between the atmosphere and the oceans;
2. To review recommendations and/or manuals on the use of suitable standardized measurement techniques for the determination of pollutants in the marine atmosphere and their deposition, taking into account the need to minimize sampling and analytical artefacts;
3. To describe atmospheric transport processes into specific regions and to review the scientific literature, and to assess and compare the pathways and fluxes of important contaminants and nutrients into the global ocean and specific regions through the atmosphere with those through other media for which adequate information exists.

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Annex IX

SUMMARY OF THE REPORT OF THE WORKING GROUP ON COASTAL MODELLING (Working Group 25)

Two meetings have been held since the eighteenth session of GESAMP (Paris). The full group held its sixth meeting in Vienna, Austria, 7-11 November 1988. To initialize the editing process, as planned in 1987, a drafting group met again in Vienna, Austria, 13-17 March 1989, and a draft version was prepared for presentation, review and comment by GESAMP members at the nineteenth session.

The current form of the report now comprises seven chapters entitled:

- Chapter 1 : Introduction
- Chapter 2 : Modelling framework
- Chapter 3 : Processes in coastal regimes
- Chapter 4 : Parameterization of processes
- Chapter 5 : Model construction
- Chapter 6 : Quality assurance procedures
- Chapter 7 : Summary and conclusions
- Appendix I : Examples of coastal regimes

The most important chapters of this report, in terms of providing an overall appreciation of the problem and its resolution, are chapters 2 and 7. Chapter 2 outlines the concept that permit oceanographic model selection and construction for dealing with environmental management questions. Chapter 7 deals with the group's response to the terms of reference. Both chapters explain the relationship between the oceanographic and effects models, models essential to the resolution of environmental management questions.

Three appendices have been prepared in draft form but have not been included in the version of the report as now presented. These appendices deal respectively with:

- Appendix II : Processes in coastal regimes
- Appendix III: Parameterization of processes
- Appendix IV : Case studies

Appendices II and III deal in significantly greater detail with the concept discussed in chapters 3 and 4 respectively. Appendix IV presents a number of specific case studies in which descriptions of models applicable to management questions in specific areas have been provided. Currently, these include the dumping of monazite sands, the discharge of cadmium into an estuary, the discharge and dumping of titanium dioxide wastes in the North Sea, eutrophication in Osaka Bay and a transport model for conservative contaminant movement in the North Sea.

This may not be a final selection. Some of these case studies may not be of sufficient practical interest to justify completion. The Working Group welcome comments and suggestions, first in respect to the case studies referred above, and second regarding additional topics or management problems that might be more deserving of attention in the context of model construction. It should be stressed, however, that requests to consider additional problems must be couched in specific terms, both in respect to the management question being posed and to the coastal receiving environment concerned.

It is proposed that a further meeting of the Working Group be convened during the next intersessional period to complete these annexes and deal with any comments and suggestions made by GESAMP members. Following this meeting the report would be circulated for scientific review before its final presentation in the next GESAMP session meeting.

TERMS OF REFERENCE

1. To evaluate the state of the art of coastal (including continental shelf) modelling relevant to waste inputs by sea dumping or land-based discharges in such areas;
2. To determine what model parameters are site and source specific and what parameters are generic to different coastal situations and contaminants; and
3. To make recommendations as to the types of models appropriate for specific coastal situations.

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Annex X

SUMMARY OF THE REPORT OF THE WORKING GROUP ON THE
STATE OF THE MARINE ENVIRONMENT (Working Group 26)

1. The GESAMP Working Group on the State of the Marine Environment met from 17 to 18 October 1988 at the Headquarters of IMO, London, and reviewed the main text of the draft report of GESAMP on the above subject. The Working Group provided detailed guidance to its Chairman who, assisted by Ms. G. D. Howells and the secretariat, subsequently revised the draft, which was distributed for comments to GESAMP members, technical secretaries and other experts. Their comments were reflected in a further version of the text submitted to GESAMP XIX.
2. The draft report consists of an introduction and five chapters which review:
 - (a) the main human activities affecting the sea;
 - (b) the levels and distribution of marine contaminants;
 - (c) their biological effects;
 - (d) effects of climate changes;
 - (e) the economic aspects of marine pollution; and
 - (f) prevention and control strategies.

A final overview recapitulates the main points raised in the earlier chapters and these points are presented again, in a more succinct way, in the executive summary.
3. The summary indicates that the main current areas of concern with regard to the oceans are along the coasts, where waters and habitats suffer both from activities taking place on the coastal strip itself and from a number of others carried out inland. Contamination by nutrients with the attendant risk of eutrophication, and microbial contamination of beaches and seafood from sewage disposal are both highly significant problems of immediate relevance to human health and to the well-being of the marine ecosystem.
4. The haphazard disposal of litter, especially plastic litter, results in serious damage to marine wildlife and to amenities. Among chemical contaminants, emphasis is given to chlorinated hydrocarbons. While their concentration has been decreasing in parts of the world where their use has been restricted, it is still rising in others, especially in the tropics and sub-tropics.
5. With plastic litter, oil is a major cause of beach fouling, whereas the summary notes that trace elements are now a matter of lesser concern than they were in the past. Levels of man-made radioactivity in the seas are low compared to levels of naturally recurring radionuclides, despite the inputs resulting from the Chernobyl accident.

6. While the global yield of fisheries continues to increase, over-fishing, pollution and the alteration of coastal habitats that serve as nursing grounds to a number of species has led to the decline of certain fisheries and to instability in others.
7. Finally, it is noted that some problems that cannot yet be fully assessed in relation to the seas, i.e. the effect of climate changes arising from global increases in greenhouse gases, and the effects of a reduction in stratospheric ozone, possibly affecting marine resources through an increase in exposure to ultra-violet radiation, will need GESAMP's continued attention in the future.

TERMS OF REFERENCE

1. To prepare a draft report consisting of a succinct critical review (up to 40 pages) of the state of the marine environment following as far as possible the pattern of UNSCEAR reports and making full use of the results and conclusions of other GESAMP working groups as well as of the data provided by relevant international and national programmes assessing the state of the oceans;
2. To examine and assess in the draft, global and regional trends, current and/or anticipated, arising from ongoing and planned human activities that, through changes of the ocean's chemical or physical state, may affect:
 - (a) the productivity of the oceans at all trophic levels;
 - (b) the quality of ocean resources for human use;
 - (c) the integrity of the role of the oceans in the energy balance of the earth;
3. To base its draft on detailed technical annexes that will become part of the report.

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Annex XI

SUMMARY OF THE REPORT OF THE WORKING GROUP ON LONG-TERM ECOLOGICAL
CONSEQUENCES OF LOW-LEVEL CONTAMINATION OF THE
MARINE ENVIRONMENT (Working Group 27)

1. The GESAMP Working Group on Long-term Consequences of Low-Level Contamination of the Marine Environment continued its work following the GESAMP session XVIII by a small steering group of GESAMP members under the chairmanship of Ms. G. D. Howells. A small meeting was held in Rome, Italy, 6-8 June 1988 and further consultations in Cambridge, U.K., 8-9 August 1988.
2. Over recent years, increasing damage to marine ecosystems, or their components, has been observed and is often attributed to human activities. The process of degradation has, in many cases, been very slow, and when damages are recognized it may be too late to intervene. The scientific community is often requested to identify or predict possible and/or probable long-term effects of low-level contamination in order to give an early warning of such change.
3. In contrast to the approach taken by the first meeting of the Working Group in 1987 which reviewed examples of long time-series data thought likely to reveal changes attributable to low-level contamination, the second approach took a pragmatic view.
4. While observations that ecological change has occurred are quite numerous, it is not always clear that this can be attributed to an identified agent, particularly at low level. On the other hand, there are some examples where a cause is indisputable or where there is evidence that the toxic agent is present in low and persistent concentrations. Some selected examples are given to illustrate the sequence of responses and to identify "early warning" signals as monitoring targets.
5. The examples selected represented diversity of contaminant type and of biological response so that the approach developed has some generality. They were:
 - (a) nutrients (nitrogen, phosphorus; primary productivity);
 - (b) chlorinated hydrocarbons (persistent xenobiotics, e.g. DDT; reproduction);
 - (c) tributyltin (toxic chemical; growth, reproduction); and
 - (d) hydrocarbons (persistent mixtures; wide range of less specific biological responses).
6. Review and analysis of the four examples selected to illustrate the relationships of persistent low-level exposure and long-term effects has shown that in these well investigated and documented cases such a relationship is evident. They also illustrate the kinds of information needed for assessment, and they indicate the sequence of effects that are to be expected, so that "early warning" signals can be identified and included in a monitoring programme. Further, where there is evidence of recovery, its time-scale is indicated.

7. Analytical and pragmatic frameworks were developed for an objective and critical evaluation of all the case studies selected that demonstrate, as clearly as is currently possible, the occurrence of long-term biological and ecological responses to low-level contaminant exposure. This approach allows the following assessment:
 - (a) to judge the current technical and theoretical ability to detect changes induced by low-level exposures, with confidence;
 - (b) to evaluate the characteristics, strengths and weaknesses of the unequivocal evidence showing such contaminant-induced change;
 - (c) to evaluate the case histories/data sets of changes in marine ecosystems that might be, in part, due to low-level contaminant(s) exposure, but where such changes are masked by natural factors and complexity, or by data limitations; and
 - (d) to identify a putative agent and establish a dose-effect relation by observations and testing.
8. On the basis of the cases selected, the evidence has justified the concern that low-level contamination can result in long-term ecological degradation. It is believed that this is a useful and practical scheme by which further, independent assessments of ecological change attributed to low-level contamination can be made.

TERMS OF REFERENCE

1. To examine the evidence for the slow but long-term ecological changes which may be due to low persistent concentrations or slow build-up of contaminants in the marine environment. (This would include, for instance, changes in species composition and abundance, in physiological and reproductive and genetic functions affecting ecosystems at population level, in physical and chemical conditions of affected habitats, etc.);
2. To examine the evidence for rehabilitation and recovery of altered (damaged) ecosystems and habitats, and to study and define the key elements and processes involved;
3. To develop the concepts needed for understanding long-term ecosystem changes influenced by persistent low-level contamination; and
4. To identify gaps in knowledge where additional studies were needed.

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Annex XII

SUMMARY OF THE DISCUSSION DOCUMENT ON THE IMPACTS OF ANTHROPOGENICALLY
MOBILIZED SEDIMENTS IN THE COASTAL ENVIRONMENT

A brief review of sediments as pollutants in the coastal environment was presented for discussion by GESAMP. The review, whilst neither exhaustive nor complete, demonstrates that anthropogenically derived sediments cause problems world-wide for fisheries, for human use of the coastal zone and for the productivity of various coastal ecosystems. Direct and indirect impacts include smothering of benthic communities; reduced primary productivity through increased turbidity; reduction in mariculture productivity; and siltation of harbours and waterways. Highly susceptible communities include mangroves and coral reefs in tropical areas.

In reviewing the causes of increased sediment flux, a wide variety of human activities, often taking place at some distance from the coast, were identified as contributing to the problem. Such activities include various forms of mining, deforestation, over-grazing, commercial and subsistence agriculture, construction and urbanization in the coastal zone.

The scale of human interference in the natural processes of weathering, erosion and sediment deposition is sufficiently high to be a cause for concern. This fact, combined with the wide geographic distribution of sediment problems in both the northern and southern hemisphere suggest that GESAMP should further evaluate the problem.

Reports and Studies GESAMP

The following reports and studies have been published so far. They are available from any of the organizations sponsoring GESAMP.

1. Report of the seventh session, London, 24-30 April 1975. (1975) Rep.Stud.GESAMP, (1):pag.var. Available also in French, Spanish and Russian
2. Review of harmful substances. (1976) Rep.Stud.GESAMP, (2):80p.
3. Scientific criteria for the selection of sites for dumping of wastes into the sea. (1975) Rep.Stud.GESAMP, (3):21p. Available also in French, Spanish and Russian
4. Report of the eighth session, Rome, 21-27 April 1976. (1976) Rep.Stud.GESAMP, (4):pag.var. Available also in French and Russian
5. Principles for developing coastal water quality criteria. (1976) Rep.Stud.GESAMP, (5):23p. Published also as UNEP Regional Seas Reports and Studies No. 42
6. Impact of oil on the marine environment. (1977) Rep.Stud.GESAMP, (6):250p.
7. Scientific aspects of pollution arising from the exploration and exploitation of the sea-bed. (1977) Rep.Stud.GESAMP, (7):37p.
8. Report of the ninth session, New York, 7-11 March 1977. (1977) Rep.Stud.GESAMP, (8):33p. Available also in French, Spanish and Russian
9. Report of the tenth session, Paris, 29 May - 2 June 1978. (1978) Rep.Stud.GESAMP, (9):pag.var. Available also in French, Spanish and Russian
10. Report of the eleventh session, Dubrovnik, 25-29 February 1980. (1980) Rep.Stud.GESAMP, (10):pag.var. Available also in French and Spanish
11. Marine pollution implications of coastal area development. (1980) Rep.Stud.GESAMP, (12):22p.
12. Monitoring biological variables related to marine pollution. (1980) Rep.Stud.GESAMP, (12):22p.
13. Interchange of pollutants between the atmosphere and the oceans. (1980) Rep.Stud.GESAMP, (13):55p.
14. Report of the twelfth session, Geneva, 22-29 October 1981. (1981) Rep.Stud.GESAMP, (14):pag.var. Available also in French and Russian
15. The review of the health of the oceans. (1982) Rep.Stud.GESAMP, (15):108p. Published also as UNEP Regional Seas Reports and Studies No. 16
16. Scientific criteria for the selection of waste disposal sites at sea. (1982) Rep.Stud.GESAMP, (16):60p.
17. The evaluation of the hazards of harmful substances carried by ships. (1982) Rep.Stud.GESAMP, (17):pag.var.
18. Report of the thirteenth session, Geneva, 28 February - 4 March 1983. (1983) Rep.Stud.GESAMP, (18):50p. Available also in French and Spanish

19. An oceanographic model for the dispersion of wastes disposed of in the deep sea. (1983) Rep.Stud.GESAMP, (19):182p.
20. Marine pollution implications of ocean energy development. (1984) Rep.Stud.GESAMP, (20):44p.
21. Report of the fourteenth session, Vienna, 26-30 March 1984. (1984) Rep.Stud.GESAMP, (21):42p. Available also in French, Spanish and Russian
22. Review of potentially harmful substances. Cadmium, lead and tin. (1985) Rep.Stud.GESAMP, (22):114p. Published also as UNEP Regional Seas Reports and Studies No. 56
23. Interchange of pollutants between the atmosphere and the oceans (part II). (1985) Rep.Stud.GESAMP, (23):55p.
24. Thermal discharges in the marine environment. (1984) Rep.Stud.GESAMP, (24):44p. Published also as UNEP Regional Seas Reports and Studies No. 45
25. Report of the fifteenth session, New York, 25-29 March 1985. (1985) Rep.Stud.GESAMP, (25):49p. Available also in French, Spanish and Russian
26. Atmospheric transport of contaminants into the Mediterranean region. (1985) Rep.Stud.GESAMP, (26):53p. Published also as UNEP Regional Seas Reports and Studies No. 68
27. Report of the sixteenth session, London, 17-21 March 1986. (1986) Rep.Stud.GESAMP, (27):72p. Available also in French, Spanish and Russian
28. Review of potentially harmful substances. Arsenic, mercury and selenium. (1986) Rep.Stud.GESAMP, (28):pag.var. Published also as UNEP Regional Seas Reports and Studies No. 92
29. Review of potentially harmful substances. Organosilicon compounds (Silanes and Siloxanes). (1986) Printed in limited number only by IMO. Published also as UNEP Regional Seas Reports and Studies No. 78
30. Environmental capacity. An approach to marine pollution prevention. (1986) Rep.Stud.GESAMP, (30):49p. Published also as UNEP Regional Seas Reports and Studies No. 80
31. Report of the seventeenth session, Rome, 30 March - 3 April 1987. (1987) Rep.Stud.GESAMP, (31):36p. Available also in French, Spanish and Russian
32. Land-sea boundary flux of contaminants: contributions from rivers. (1987) Rep.Stud.GESAMP, (32):172p.
33. Report of the eighteenth session, Paris, 11-15 April 1988. (1988) Rep.Stud.GESAMP, (33):56p. Available also in French, Spanish and Russian
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35. The evaluation of the hazards of harmful substances carried by ships: revision of GESAMP Reports and Studies No. 17. (1989) Rep.Stud.GESAMP, (35):211p.
36. Pollutant modification of atmospheric and oceanic processes and climate: some aspects of the problem. (in press). Rep.Stud.GESAMP, (36)
37. Report of the nineteenth session, Athens, 8-12 May 1989. (1989) Rep.Stud.GESAMP, (37):47p.