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

REPORTS AND STUDIES

No. 27

REPORT OF THE SIXTEENTH SESSION
LONDON, 17-21 MARCH 1986

INTERNATIONAL MARITIME ORGANIZATION

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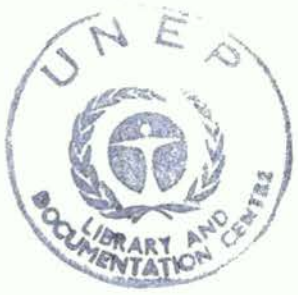

INTERNATIONAL MARITIME ORGANIZATION
London, 1986

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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Report of the sixteenth session held at IMO Headquarters, London, 17-21 March 1986. Reports and Studies GESAMP (27).

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ANNEXES (continued)

1 OPENING OF THE MEETING

1.1 The Joint Group of Experts on the Scientific Aspects of Marine Pollution (GESAMP) held its sixteenth session at the Headquarters of the International Maritime Organization (IMO), London, from 17 to 21 March 1986, under the Chairmanship of Mr. E. D. Gomez. Mrs. G. D. Howells was Vice-Chairman.

1.2 At the opening of the session, the Secretary-General of the International Maritime Organization, Mr. C. P. Srivastava, welcomed the participants. The Secretary-General, noting that the first session of GESAMP had been convened seventeen years ago on the same date at IMO Headquarters, expressed his congratulations to the Group on this birthday, and also on the achievements of GESAMP throughout these years. The Secretary-General emphasized the importance of GESAMP's work for the implementation of a number of international conventions administered by IMO. Many of the requirements and recommendations developed by IMO are based on the results of GESAMP, such as those related to discharges at sea of residues from chemical tankers, the carriage of chemicals by certain ship types, the identification of dangerous packaged goods as marine pollutants, the development of categories for the search and recovery of packaged goods accidentally lost at sea, as well as criteria for the selection of ocean dumping sites and the identification of hazards of substances dumped at sea. These have been incorporated in legal instruments, guidelines and resolutions adopted by IMO Member States. Emphasizing also the important work carried out by GESAMP for the other sponsoring agencies, the Secretary-General on their behalf expressed his gratitude to the scientists who either directly or indirectly have contributed to GESAMP work. In conclusion, the Secretary-General wished the Group every success at this session.

1.3 The Chairman of GESAMP thanked the Secretary-General of IMO on behalf of the participants for his good wishes for the success of the session, for hosting the session and for the provision of secretariat facilities.

1.4 The agenda for the session as adopted by the Group is given in Annex I. The list of documents submitted to the session relating to particular items of the agenda, is given in Annex II.

1.5 The list of participants is shown in Annex III.

2 REVIEW OF POTENTIALLY HARMFUL SUBSTANCES (Working Group 13)

2.1 The WHO Technical Secretary in introducing the intersessional work accomplished by the Working Group on the Review of Potentially Harmful Substances emphasized in particular the diversity of activities of the Working Group and the variety of harmful substances and groups of substances addressed (i.e. arsenic, mercury, selenium, organosilicons and carcinogenic substances). The Chairman of the Working Group then outlined the scope and content of the draft documents and summarized the conclusions of each of them. Great importance had been assigned to problems related to the quality of the data base used in the evaluation of each substance or group of substances as well as to ecotoxicological aspects. A summary of the report of the Working Group is attached as Annex IV.

2.2 Estimation of fish consumption patterns as a basis for assessing the dietary route of exposure to harmful substances was one of the crucial tasks of the Working Group. In the discussion of different approaches to this task the Group reviewed the advantages and disadvantages of two principally

different methods, viz. the estimation of percentiles of the average fish consumption and the critical group concept as used in radiation protection. The Working Group was invited to seek advice on the latter approach from the International Commission on Radiation Protection (ICRP).

2.3 The Group then discussed the documents containing the review of arsenic, mercury and selenium. The document on the evaluation of arsenic was accepted as drafted. As concerns the mercury document, the discussion focussed on the high levels of mercury concentration recorded in the open oceans which, it was considered, may be inaccurate. One member of the Group offered to provide recent references together with his comments on this subject to the Working Group for inclusion in the final version of this section. Discussion of the selenium document highlighted the importance of excessive as well as deficient levels, and also the mercury-selenium interaction.

2.4 The Group, after discussion, approved the documents on arsenic, mercury and selenium to be published as a combined report in the series of GESAMP Reports and Studies as No. 28. Further editorial comments and points for clarification should be provided to the WHO Technical Secretary to be duly taken into account in the finalization of the document. Authorship of the various draft sections could be recognized jointly in an acknowledgement. Special attention should be given to the lay-out and possible illustrative material to improve the presentation of the document. A list of contents of GESAMP Reports and Studies No.28 is included in Annex IV to this report.

2.5 In discussing the draft review of organosilicons the Group noted the difficulties which the Working Group has had with the open-ended nature of organosilicons as a chemical classification. It was considered realistic to limit the evaluation to certain specific sub-groups, notably silanes and siloxanes, which are at present of commercial significance. The Group also noted with concern the scarcity of the ecotoxicological data base and that this has been established mainly by the organosilicon manufacturing industry. The Group concurred, however, that the review be completed in spite of these limitations, and that the final report should clearly spell these out.

2.6 Members of the Group prepared a supplementary statement in the conclusions section of the organosilicon document which summarizes the above reservations and which is based on the initial findings of the Working Group as already stated at the fourteenth session of GESAMP (GESAMP Reports and Studies No.21, paragraphs 2.6 and 2.7). With this amendment and a shortened introductory section the Group approved this review document for publication in the series of GESAMP Reports and Studies as No. 29. A list of contents of this document is set out in Annex IV to this report.

2.7 The Chairman of the Working Group then introduced the results and recommendations made by two expert meetings (sub-groups) on carcinogens, including a recommendation that the organizations concerned consider, as a matter of urgency, the mobilization of the necessary support for the further development and acceleration of work on the impact of carcinogenic substances on marine organisms and their implications concerning public health and to place into perspective recent studies on DNA disruption and repair processes. The need for an in-depth review of the various aspects of the problem was stressed, an exercise which would stretch over at least three years and require substantial external funding. The Group was informed that a national research authority had expressed interest in the subject in light of its potential future implications, and that the support of other national or international institutions should be sought.

2.8 In the ensuing discussion the Group recognized the potential severity of the problem and also the diversity and complexity of the subject and its dual focus on the occurrence of tumours in fish as well as on human carcinogenicity in relation to seafood consumption. Further study within GESAMP of the subject of carcinogens in the marine environment should therefore focus on specific aspects which might be addressed sequentially. In the first instance, more emphasis may have to be put on aquatic organisms, whereas human intakes of carcinogens may be dealt with in a later phase. Also a selection of only few or a specific group of carcinogens may have to be made in the initial review process.

2.9 The Group was informed of the activities of an ICES expert group of fish pathologists who have considered the incidence of fish tumours in the North Sea. Liaison between the Working Group and the relevant ICES experts was advocated, as well as the inclusion of marine biologists with experience on fish tumours in the GESAMP Working Group. Co-operation should also be developed with the GESAMP Working Group on the State of the Marine Environment.

2.10 In light of the Group's observations and suggestions the Chairman of the Working Group proposed to critically review the recommendations of the two meetings of the sub-group of experts held so far, with particular regard to possible future activities within the framework of GESAMP and its Working Group on the Review of Potentially Harmful Substances. He also offered to explore the interest of other organizations in this respect and the feasibility of external support. He undertook to submit a proposal for the future work related to the evaluation of carcinogens to the next session of GESAMP.

2.11 The review of nutrients, phosphorus and nitrogen was also one of the activities initiated earlier by the Working Group but not pursued further during the intersessional period. The Group was nevertheless provided with some background information in the form of a preliminary expert review paper on the evaluation of nutrients and algal blooms. In addition, the Unesco Technical Secretary submitted a paper to the Group which outlined the growing concern over the eutrophication of coastal waters and observed changes in related ecosystems, as well as the need for GESAMP to deal with this problem.

2.12 The Group, in discussing these two papers, in principle shared the views expressed in both of them and confirmed the serious concern over eutrophication as an aggravating phenomenon of increasingly widespread occurrence. Causative linkage to increased influx of nutrients from land-based sources was recognized although other factors were considered to be probably of equal importance.

2.13 The work undertaken so far within the framework of the Working Group on the Review of Potentially Harmful Substances was noted and the terms of reference of this working group considered adequate for a first review of the subject area. In light of the complex nature of eutrophication and algal blooms and their impact on marine/coastal ecosystems, however, the Group proposed that a separate working group on the subject be established. This approach would allow for discussion of new terms of reference, including specific aspects of the phenomena which were beyond the mere consideration of nutrients. Specific suggestions to this effect were made, including an expansion of the terms of reference for the existing working group.

2.14 Further discussion on this matter is reflected in Chapter 10 of this report (Future Work Programme).

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

3.1 The IMO Technical Secretary informed the Group that the Working Group on the Evaluation of the Hazards of Harmful Substances Carried by Ships had held its eighteenth meeting during the intersessional period in London from 7 to 11 October 1985. He presented a short summary of the work that had been carried out, drawing attention to those issues which needed particular action or decision by the Group. In this connection the Group noted that there were still quite a number of substances carried by ships which have not yet been evaluated and that every day IMO receives requests for the evaluation of new substances proposed for carriage by ships. Thus the evaluation of the hazards of harmful substances carried by ships was a continuing task to be carried out by GESAMP. A summary of the report of the eighteenth meeting of the Working Group on the Evaluation of the Hazards of Harmful Substances Carried by Ships is shown in Annex V.

3.2 The Chairman of the Working Group introduced the report of the intersessional work. He noted that the work of the Working Group in establishing guidelines for the assessment of taint in sea food had been used by the European Chemical Industry Ecology and Toxicology Centre (ECETOC) to prepare a draft protocol for the assessment of the ability of a chemical to cause taint, and that a series of tests were currently being undertaken in respect of four substances selected for validating the protocol. These chemicals represent a range of tainting potentials. The Working Group looked forward to the completion of this work which would materially assist it in finalizing its guidelines for the assessment of taint.

3.3 The Group noted that all substances evaluated so far by the Working Group had been screened with regard to their effects on reproductive systems and teratogenic effects. Where necessary such effects have been recorded in the remarks column of hazard profiles.

3.4 With regard to the evaluation of substances of low density, high volatility and low solubility, the Chairman reported that because such materials might be rapidly removed from the marine environment, this did not indicate that there was no harm to marine species. Tests carried out with Low Aromatic White Spirit (LAWS) had indicated that damage to test animals ultimately leading to mortality accrued at an early stage of exposure. In light of a number of enquiries by the chemical industry concerning the appropriateness of the test procedures used by the Working Group in evaluating such substances, the Working Group had emphasized the need to use LC_{50} values obtained by recognized procedures such as those described in the OECD Guidelines for the testing of chemicals. These require the exposure of the test organisms to known concentrations of the substance for certain fixed periods of time. LC_{50} values obtained by such testing should be regarded as intrinsic properties of the substances concerned. Such results might in a few cases not reflect what might occur in an actual spill at sea or when tank residues from ships were discharged into the sea. However, it was considered to be the task of the responsible IMO bodies to take such matters into account when developing shipping requirements on the basis of GESAMP hazard profiles, rather than of GESAMP itself.

3.5 With regard to the evaluation of mixtures, the Working Group had noted that it would be impractical to test every formulation. The Working Group was sympathetic to the grouping of the components into classes which can be chemically described and which would have similar effects. Further

information was however required before the Working Group could proceed further, especially on chemical structures and properties, and on eco- and mammalian toxicology. The Working Group had agreed to look in greater detail at two of the classes proposed when this information had been provided.

3.6 In discussion, attention was drawn to the hazard profiles, some of which were incomplete. The Chairman of the Working Group reiterated the comment made at the fifteenth session of GESAMP which noted the difficulties in obtaining relevant data for the evaluation of hazards of certain substances, particularly on their aquatic toxicity. The Group noted that due to the efforts made by the IMO Technical Secretary in developing close co-operation between the Working Group and IMO bodies, national maritime administrations and chemical manufacturers' associations, the situation is continuously improving.

3.7 A number of comments were made on those columns of the hazard profiles which indicated hazards to human health. It was argued that the hazard profiles in this respect did not reflect all the circumstances and conditions under which the background data have been obtained and accordingly presented only a very rough estimate of the true situation. In response the Chairman of the Working Group pointed out that detailed information on how the hazard profiles are being established was given in GESAMP Reports and Studies No.17. He also emphasized that the hazard profiles have been established to develop various shipping requirements and should not be applied for any other purpose. The attention of the Group was drawn to the Introduction to the IMO Composite List of Hazard Profiles which contained wording to this end.

3.8 In approving the report, the Group adopted the hazard profiles revised and completed by the Working Group, noted the ongoing discussion concerning the evaluation of mixtures and confirmed the views of the Working Group concerning the use of established, recognized test procedures (such as those given in the OECD Guidelines) for substances of low density, high volatility and low solubility.

3.9 The Group also approved the future work programme of the Working Group as follows:

.1 the continued evaluation of the hazards of substances carried by ships or proposed for inclusion in the relevant IMO Codes;

.2 the review and updating of GESAMP Reports and Studies No.17 with a view to the preparation and publication of a revised version;

.3 the finalization of the tainting guidelines on the basis of results from tainting tests;

.4 the detailed consideration of proposals related to the carriage of mixtures at sea;

.5 the revision of profiles of alkanes and carboxylic acids;

.6 the consideration of a review of the problems associated with those compounds in homologous series that are of high toxicity but low solubility (examples include alkanes, alkenes, carboxylic acids, alcohols and alkylbenzenes);

.7 the review and updating of data sheets;

.8 the review of the whole composite list with respect to carcinogenicity, teratogenicity, reproductive effects and sensitization; and

.9 the establishment of a computerized data base.

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

4.1 The WMO Technical Secretary informed the Group that the sixth session of the Working Group had been held in Paris, France from 6 to 9 January 1986. The session was mainly devoted to consideration of the first two tasks of the terms of reference approved by the fifteenth session of GESAMP (GESAMP Reports and Studies No.25, paragraph 4.5). The Working Group had also discussed the effects of contaminants in modification of physical, chemical and biological processes in the troposphere, at the air-sea interface and in the sea. It had prepared a statement on process modification by pollutants requested by the twelfth and fifteenth sessions of GESAMP. The Group was reminded that this request had arisen from a preliminary proposal of the Working Group to amend the GESAMP definition of marine pollution to take into account possible effects of pollutants on ocean-related physical processes, especially those pertinent to climate. Having considered this matter, the Working Group postponed any decision concerning the changing of the GESAMP definition of marine pollution.

4.2 In the absence of the Chairman of the Working Group, the report of its sixth session was presented by the Rapporteur of that session. The effect of atmospheric carbon dioxide increase on climatic change had been reviewed by the Working Group. In particular the role of the global ocean in influencing the magnitude and variations of tropospheric carbon dioxide concentrations, the knowledge of which is indispensable for modelling and predicting any resulting climatic changes and anomalies, had been discussed. Some trace gases and aerosols were also considered in terms of climatic changes, as well as the chemistry and physics of the atmosphere-ocean boundary layer and their effect on air-sea exchange of substances. The importance of surface films in air-sea exchange was emphasized, and it was noted that their physico-chemical characteristics can greatly influence this exchange. The potential of remote sensing for making measurements of sea-surface phenomena, e.g. slicks, ripples, and of phytoplankton abundance, was briefly discussed.

4.3 The Group noted that the Working Group had clearly demonstrated the complexity of the problem of pollutant modification of atmosphere and ocean-related processes and their possible effect on climate. The appropriateness of such studies within GESAMP was confirmed by the Group.

4.4 The Group expressed concern about the adequacy of reliable data on fluxes of carbon dioxide and some other gases between the atmosphere and the oceans on which most models were based. The difficulties in development and application of appropriate sampling and analytical techniques, and the possibility of spurious results from sampling and analytical errors were mentioned in this respect.

4.5 The opinion was expressed by some members of the Group that processes of carbon dioxide uptake and removal in the ocean should be given more consideration to better understand the role of the ocean as a sink for carbon dioxide. It was stressed that greater attention should be paid to certain trace gases such as chlorofluorocarbons and hydrocarbons, nitrous oxide, ozone

and others in the assessment of the "greenhouse" warming. In this connection it was mentioned that by the mid-1990s a temperature increase of 0.25-0.30°C could be reached from the combined effect of carbon dioxide and those other trace gases. This increase could be measured above background fluctuations. The question was asked whether it would be possible to verify the present model predictions and assumptions on the basis of this potential near-term temperature increase.

4.6 One member of the Group noted a deficiency in the report in that the role of marine sediments as a sink for carbon dioxide was not taken fully into account. He offered to provide references to recent publications.

4.7 Another member raised the question that the report submitted by the Working Group dealt with potential effects of constituents which may not necessarily be pollutants and that this matter might be to some extent beyond the scope of GESAMP.

4.8 The need for the Working Group to continue making efforts towards assessing atmospheric transport of pollutants into specific regions was reaffirmed by the Group.

4.9 The Group endorsed the report in principle and recommended that the Working Group should continue its work during the intersessional period under the terms of reference adopted at the fifteenth session of GESAMP and that it should present a more complete and updated report at that session. The members of the Group were requested to send their comments on the report to the WMO Technical Secretary.

4.10 A summary of the report of the sixth session of the Working Group on the Interchange of Pollutants between the Atmosphere and the Oceans is shown at Annex VI.

5 LAND-SEA BOUNDARY FLUX OF POLLUTANTS (Working Group 22)

5.1 The Unesco Technical Secretary informed the Group that the Working Group had held its first full scale meeting in Roscoff, France, from 8 to 12 July 1985. It was noted that the progress report presented to the Group had originally been produced at the Roscoff meeting, but had been subsequently elaborated on intersessionally and completed during an editorial meeting at the Skidaway Institute of Oceanography in January 1986. The Unesco Technical Secretary reminded the Group of the Terms of Reference of the Working Group (GESAMP Reports and Studies No.18, paragraph 10.1), noting that the substantial scientific information summarized in the report mainly addressed the first and second Terms of Reference.

5.2 At its meeting in Roscoff the Working Group identified the work required for the completion of its task, following which the Chairman took the initial step of soliciting inputs from selected members. Several limited-size case studies would be examined, one specific case being considered at the IOC Workshop on Riverine Inputs of Contaminants, Thailand, April-May 1986.

5.3 The aim was to compose a report during a core group meeting at the end of 1986 or early 1987 for adoption by the Group at its seventeenth session.

5.4 The Chairman of the Working Group introduced the scientific substance of the progress report and explained the approach adopted by the Working Group. Referring to specific matters addressed by the Working Group, he stated that

the Working Group had agreed on the method of carrying out the work, including considerations of hydrological factors, definitions of the upstream and coastal zone-open ocean boundaries, and delineation of the basic processes involved in the salinity gradient transfer zone. The use of distribution coefficients in describing the partition between the dissolved and particulate phases of the suite of substances selected for consideration would be focussed on, so as to arrive at global estimates of gross and net fluxes for specific substances. He further emphasized that the Working Group is dealing with riverine inputs *per se* and was neither treating specific anthropogenic inputs nor specific inputs associated with islands and ground water transfer.

5.5 Extensive coverage of existing information on riverine inputs was being obtained through the use of a questionnaire approach for which a network of contacts had been developed with encouraging returns. The Chairman also stated that the Working Group had undertaken, *inter alia*, to define observations required to assess the flux and to make comparisons of the relative importance of river and atmospheric inputs (noting that this would partly depend on the characteristics of the substances considered) and to assess the quality of existing data to determine fluxes.

5.6 Several members of the Group commented on the progress report, generally expressing satisfaction with the approach, the substantive work so far accomplished, and the plans for its completion.

5.7 Some reservation was expressed as regards the approach being based on the use of distribution coefficients. It was acknowledged that this method could be used for some substances, that it was a simplified approach, and that difference in sources could be reflected in different values for the same fraction of particulates. The concern was particularly valid on a local scale. It was also realized that the assumptions inherent in the use of partition coefficients were not always fulfilled. It was emphasized that degradation of organic contaminants occurs along transport gradients, implying a spatial variation of the distribution coefficients. The difference between organic and inorganic substances in this respect was noted. The kinetics and dynamics of the system must be considered for specific substances as appropriate. The opinion was expressed that partition coefficients can be used for hydrophobic type substances; for others only with great reservation.

5.8 The Group noted the necessity of taking the range of heterogeneity into account as manifested in different mixing ratios in estuarine and coastal zones. It was acknowledged that stratified conditions often prevail and that these need proper consideration.

5.9 The Group realized that the Working Group was addressing only river inputs and that these were not sufficient to judge all land-based sources of contaminant input to the sea. It was further noted that the Working Group had realized this, but would refrain from considering anything but river inputs due to the need to focus on an attainable objective and the requirement for a reasonably coherent approach.

5.10 A question was raised concerning the coverage obtained through the questionnaire, the quality control of the information given, and the possibility of using the established networks of contacts for other but similar purposes. It was recognized that quality control could be achieved partly by identifying patterns of similarity on regional and global scales. It was acknowledged that the coverage was rather good and that the part of the network consisting of oceanographic institutions could also be used for other

similar purposes. Nevertheless to increase coverage all sponsoring agencies were invited to distribute the questionnaire to their focal points. The questionnaire was not being revised at this stage.

5.11 Information was given that UNEP, with WHO as the leading organization and in co-operation with other relevant UN organizations, was in the process of preparing a survey of land-based sources and amounts of pollutants reaching the Mediterranean Sea. This survey, which should be accomplished by the end of 1986, would improve and update a similar excercise performed in 1977. Information gathered, particularly on contaminants entering the Mediterranean Sea through rivers, might be of interest to the Working Group on Land-Sea Boundary Flux of Pollutants.

5.12 The Chairman of the Working Group acknowledged the comments made, stated that they would be taken into account to the extent possible, and solicited further comments in writing from the experts.

5.13 The Chairman of the Group concluded that the opinions expressed showed the satisfaction of GESAMP with the progress made, that endorsement was given to the further schedule and work programme, and that GESAMP expected to see a report presented at its seventeenth session for possible final adoption.

5.14 A summary of the report of the meeting of the Working Group on Land-Sea Boundary Flux of Pollutants is shown in Annex VII.

6 METHODOLOGY AND GUIDELINES FOR THE ASSESSMENT OF THE IMPACT OF POLLUTANTS ON THE MARINE ENVIRONMENT (Working Group 23)

6.1 The FAO Technical Secretary informed the Group that the Working Group had held its third session in Rome from 23 to 27 September 1985. He recalled that at the fifteenth session of GESAMP the main body of the report of the Working Group had been endorsed, thus supporting the approach taken. It had been requested that a number of case studies be attached to the report to verify the applicability of the environmental capacity concept in preventing marine pollution, and to give guidance to users on how to apply this concept in practice. The FAO Technical Secretary expressed the view that these tasks had been completed by the Working Group. The report was subsequently introduced by the Chairman of the Working Group.

6.2 The UNEP Technical Secretary recalled that the Working Group had been established at the request of UNEP during the thirteenth session of GESAMP. UNEP as the organization providing the Secretariat for several regional marine pollution control conventions, required guidelines for the assessment of the waste receiving capacity of the marine environment and of the environmental impact of pollution on the marine and coastal environment, which could be used in the implementation of the regional conventions, particularly in developing countries. Consequently, the Working Group had been expressly asked to "concentrate on providing practical advice to developing countries". He expressed the view that the report as presented although being a valid scientific document, does not fully meet UNEP's needs for practical guidelines applicable in the context of the regional conventions for which UNEP acts as the Secretariat.

6.3 It was explained that the Working Group, although fully aware of its specific terms of reference, did not feel able to prepare more simplified instructions on how to calculate the waste receiving capacity of the marine environment, in view of the complexity and uniqueness of each receiving

environment. While the report clearly states the validity of the approach to use the strategy based on the environmental capacity for the disposal of wastes, the examples provided would help to give general directions on how to proceed in principle.

6.4 The report was discussed extensively by members of the Group, and specific comments were made on the need to improve on some of the examples given for the application of the environmental capacity concept. In response to reservations expressed concerning the treatment of the interaction between scientific advice and the decision process, a proposal was made to clarify this aspect, including socio-economic considerations. The majority felt that the report in its present form was a valuable contribution to the work of GESAMP and would constitute a step in the right direction, although the calculation of the environmental capacity still faces several sources of uncertainties in quantifying some of the parameters which have been addressed in the report by the use of probabilistic techniques. One problem was the identification of targets which would ensure adequate protection of an ecosystem. It was, however, noted that the process as proposed by the Working Group provides for ample safety margins, e.g. through the introduction of safety factors in defining water quality criteria. The introduction of mandatory monitoring of effects of the discharge of wastes to the marine environment and the recommended reassessment procedures would ensure that corrective measures can be taken if necessary.

6.5 It was concluded that specific proposals for amendments to the report should be handed in before the end of the session to the FAO Technical Secretary who would undertake, jointly with the Chairman and the Rapporteur of the Working Group, to incorporate them into the revised Report, which would subsequently be circulated among the members of GESAMP. Subject to this condition the report was approved for publication as GESAMP Reports and Studies No.30. A summary of the report together with a list of contents as well as a list of contributors is contained in Annex VIII.

7 INTEGRATED GLOBAL OCEAN MONITORING (IGOM) (Working Group 24)

7.1 The UNEP Technical Secretary briefly reviewed the history of the Working Group since its establishment at the fourteenth session of GESAMP. He informed the Group that the first meeting of the Working Group had been held in Batumi, USSR, from 2 to 5 December 1985. Eleven experts, two observers and two GESAMP Technical Secretaries (UNEP and WMO) participated in the meeting.

7.2 The Chairman of the Working Group introduced the report of the Working Group and highlighted its main conclusions and recommendations.

7.3 The Unesco Technical Secretary introduced a note on IOC Global Investigation of Pollution in the Marine Environment (GIPME) with reference to integrated global ocean monitoring. He drew the attention of the Group to the possibility of co-operation between GIPME and the GESAMP Working Group, in particular to the possibility of using GIPME as a mechanism for the implementation of the integrated global ocean monitoring (IGOM) programme.

7.4 In the ensuing discussion the following comments and suggestions were made:

.1 the Working Group had not fully taken into account many of the available documents describing programmes and approaches relevant to IGOM;

.2 the aims of IGOM, as defined in the report, seemed too ambitious and over-optimistic as to their feasibility; they may require closer definition and justification;

.3 the Working Group in its future work should concentrate on providing better justification for IGOM and should consider the other items of its terms of reference as of secondary importance;

.4 the need for open ocean baseline data against which the future changes could be compared and the present unpredictability of ecological changes as well as low-level persistent contamination in some areas of the ocean may be among the best justifications for IGOM;

.5 extrapolation from coastal research and monitoring programmes may be more difficult than it seems;

.6 the sampling and analytical techniques available today may not be applicable and useful for all variables proposed to be used in the context of IGOM;

.7 the importance of boundary fluxes in IGOM should be given greater recognition;

.8 the applicability of remote sensing techniques for IGOM may be overrated although the advantages of these techniques have been recognized for certain biological parameters;

.9 the assumption that the levels of contaminants are regularly higher in coastal waters than in open ocean may not necessarily be true;

.10 the knowledge about processes governing the fate and determining the effect of pollutants in open oceans may be better than in coastal waters due to the complexity of the situation in the latter;

.11 the usefulness and global applicability of "mussel-watch" type of monitoring should be better documented;

.12 the inclusion of sea bottom monitoring in IGOM would need to be justified;

.13 due to the long residence time of some contaminants in open oceans, irreversible changes may have already occurred in open ocean in respect of such contaminants;

.14 intercalibration of sampling and analytical techniques and quality control of data should be mandatory for all participants in IGOM;

.15 stress on biological variables in IGOM is justifiable since previous similar proposals did not include them adequately.

7.5 The Unesco and UNEP Technical Secretaries clarified the role of the Working Group in relation to the IOC Global Investigation of Pollution in the Marine Environment (GIPME) and to UNEP Earthwatch and the Global Environment Monitoring System (GEMS) in particular.

7.6 Taking into account the status of the report submitted by the Working Group and the comments and suggestions made by the members of the Group at this session, as well as the information provided by the Technical Secretaries of UNEP and Unesco, the Group decided that the Working Group should continue its activity and report to the next session of GESAMP. It was also agreed that the present report of the Working Group will be reviewed by the forthcoming meeting of GIPME (September 1986) together with the comments and suggestions offered by the Group at this session, and that the Chairman of GIPME will be invited to join the Working Group as a member. The Unesco Technical Secretary informed the Group that Unesco will join the Working Group as co-operating agency.

7.7 A summary of the report of the Working Group on Integrated Global Ocean Monitoring is shown at Annex IX.

8 COASTAL MODELLING (Working Group 25)

8.1 The IAEA Secretariat introduced the report of the first meeting of the Working Group on Coastal Modelling which had been established by GESAMP at its fifteenth session. The meeting had been held in Vienna, from 27 to 31 January 1986. A summary of the report is shown in Annex X. The Chairman of the Working Group sought guidance from GESAMP members on three matters raised in the meeting report:

.1 the modified terms of reference;

.2 the conceptual model as set out in the meeting report; and

.3 the proposed outline of the final report.

8.2 Discussion of these items resulted in the following actions:

.1 the modified terms of reference as stated in the meeting report were adopted;

.2 the term "regeneration" as used in the conceptual model was changed to "release" as several members thought that this term more accurately described the transfer of material from biota to water; and

.3 there were no substantive comments on the proposed report outline. It was suggested that GESAMP members submit comments later in writing to the IAEA Secretariat.

8.3 Several GESAMP members expressed interest in coastal modelling and wished to be kept informed as tasks of the Working Group proceeded. One member suggested that modellers from Belgium would provide valuable input to the work of the Group. The Chairman of the Working Group said that he was aware of the work being conducted by Belgian oceanographers and would seek ways in which their work and experience might be made available to the Working Group.

9 STATE OF THE MARINE ENVIRONMENT (Working Group 26)

9.1 The UNEP Technical Secretary introduced the report of the second meeting of the Core Group of GESAMP Working Group 26 on the State of the Marine Environment. The terms of reference of this Working Group had been set out in the Report of the fifteenth session of GESAMP (Reports and Studies No.25,

paragraphs 8.2.4 and 8.2.5). In pursuance of them a Core Group met in New York at the UNEP Liaison Office in July 1985 and in Rome at FAO Headquarters in December 1985. At the latter meeting the Core Group finalized the outline of the planned report on the state of the marine environment.

9.2 The Chairman of the Working Group highlighted the main points of the outline which was organized around four main themes: levels of pollutants in the marine environment, human activities contributing to the pollution load of the oceans, their effects on both marine ecosystems and human health, and the trends in both levels and effects. A number of additional issues, he emphasized, would also be dealt with in the review, as clearly indicated in the outline. He added that the report would take full account of the earlier report on the health of the oceans (GESAMP Reports and Studies No.15) and would in particular deal with new issues which have emerged and re-evaluate those issues for which significant new information had accrued or new developments occurred. Among these were the major advances in analytical techniques which may have rendered a number of the earlier data obsolete and called for their re-evaluation in the light of the new criteria that can now be applied.

9.3 The ensuing discussion indicated broad support for the production of a report based on the outline introduced by the Chairman of the Working Group. The following main points were raised by the members of GESAMP:

.1 most members agreed that the scope of the proposed report was very broad and ambitious and required a clear conceptual approach, considerable human and financial resources and firm secretariat support;

.2 misgivings were voiced about the elaboration and validity of global models that might enable prediction of future pollution patterns and it was suggested that these should be treated with caution;

.3 while the outline made repeated references to prediction of the state of the marine environment, it was emphasized that the main thrust of the review should be on the current state of the environment and that great caution should be exercised in venturing into the state expected in the future.

.4 the outline, and GESAMP itself at its fifteenth session, had emphasized the need to make full use of the results of a number of other working groups. It was noted that the results of working groups were sometimes controversial. This, however, should not prevent the Working Group on the State of the Marine Environment from utilizing their work, as long as any unresolved issue was reflected as such in the review as still being unresolved;

.5 concern was expressed about the difficulties in evaluating contaminant build-up leading to long-term biological impact. Reassurance was provided by the decision to establish a new working group, precisely to consider that issue (see paragraphs 10.3 - 10.7);

.6 in this connection it was proposed that GESAMP pay greater attention to the analogues to the collective dose as used in radiological protection applications (see also paragraph 12.3);

.7 the importance of considering the possibilities offered by the oceans as a disposal ground was underlined;

.8 the planned chapter on control strategies should not so much discuss which strategies are desirable or feasible, but the achievements of current ones, from international conventions to national policies, in improving the marine environment;

.9 the publication possibilities and alternatives, taking into account that the review will be first and foremost a report to GESAMP, will need to be explored thoroughly and in good time; and

.10 the need to keep the outline flexible in the light of emerging needs and changing environmental situations was mentioned.

9.4 After considering the comments and suggestions relevant to the report of the Working Group, the Group:

.1 endorsed the draft outline as contained in document GESAMP XVI/9;

.2 reconfirmed the terms of reference of the Working Group as adopted at the fifteenth session of GESAMP; and

.3 invited the Working Group to prepare for the seventeenth session of GESAMP an interim report on the progress achieved towards preparing the report on the state of the marine environment.

9.5 The UNEP Technical Secretary informed the Group that the preparation of regional reviews on the state of the marine environment will be initiated by UNEP in all ten regions covered by the Regional Seas Programme. These regional reviews will follow the same basic outline as the review to be prepared by the Working Group and will be expected to provide factual information as input into that report.

9.6 A summary of the report of the Core Group of the Working Group on the State of the Marine Environment is shown at Annex XI.

10 FUTURE WORK PROGRAMME

Eutrophication

10.1 Recalling a proposal made under item 2 of the Agenda concerning the establishment of a Working Group on Eutrophication (see paragraph 2.13 above), the Group considered procedures and mechanisms on how to organize such a working group. After discussion the Group agreed that at this stage it would be more appropriate to set up a sub-group on "nutrients" under the Working Group on the Review of Potentially Harmful Substances (Working Group 13) rather than establishing a new working group. The sub-group would initially operate with the same terms of reference as the Working Group on the Review of Potentially Harmful Substances. It was also agreed that a later stage the Group would consider again the desirability of setting up a separate working group with different terms of reference, taking into account the results and progress made by the sub-group.

10.2 The Group noted that there were now two sub-groups of the Working Group on the Review of Potentially Harmful Substances, one on the evaluation of hazardous effects of carcinogens and another on the evaluation of nutrients

and algal blooms. The WHO Technical Secretary informed the Group that the chairmen of the sub-groups and their members would be nominated during the intersessional period in consultation with co-operating agencies and the Chairman of the Working Group on the Review of Potentially Harmful Substances.

Long-term ecological consequences of low-level contamination of the marine environment

10.3 The Unesco Technical Secretary pointed out that a major problem in determining the influence of human inputs on the marine environment may derive from the long-term effects of persistent low levels of contamination and the possible long-term build-up of continuous low level inputs. This may concern organic compounds, nutrients, metals, radionuclides etc., entering the sea from coastal discharges, dumping, atmospheric inputs and accidents. A critical concern is the possible effects at the population level on marine species or communities. In this respect an important question is: what can be said about large-scale, long-term responses of marine populations to alterations in their environment? The FAO Technical Secretary drew the attention of the Group to the importance of such changes to fisheries.

10.4 The Unesco Technical Secretary proposed that a working group on long-term ecological consequences of low-level contamination of the marine environment be created with a view to developing the conceptual framework for the determination of the effects of long-term, low-level contamination and the possibly associated build-up of contamination levels. This would involve case studies on habitats which have been subject to long-term inputs and would include documented effects, including recovery or not after stopping the inputs together with an appropriate consideration of time and space scales.

10.5 It was further noted that the proposed new working group should work in close collaboration with the Working Groups on Integrated Global Ocean Monitoring (Working Group 24) and on the State of the Marine Environment (Working Group 26).

10.6 The Group, in light of the above arguments, agreed that a Working Group on Long-term Ecological Consequences of Low-level Contamination of the Marine Environment (Working Group 27) be established with the following 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, including 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 contaminations; and

.4 to identify gaps in knowledge where additional studies were needed.

Economic aspects of marine pollution

10.7 The United Nations Technical Secretary noted that the relevance of economic considerations to the work of GESAMP had been a subject of discussion during this session. He invited the Group to consider the possible terms of reference for a new working group dealing with the economic aspects of marine pollution, to be established at the seventeenth session of GESAMP. Ideas for draft terms of reference were set out in document GESAMP XVI/10/1.

10.8 The Group was also informed by one of its members of the status of current economic research dealing with marine pollution and further noted that "marine pollution" as construed by GESAMP and terms such as "deleterious effects", "resources", "hindrance to marine activities", "quality for use" and "amenities" were unavoidably determined or conditioned subject to economic considerations.

10.9 The Group noted the importance of economic considerations within GESAMP's multidisciplinary structure. Concern was expressed with regard to establishing a working group which would focus upon a single discipline. Further clarification of underlying issues would be required to formulate concise terms of reference for the tasks to be undertaken by the new working group.

10.10 The Group requested the United Nations Technical Secretary to prepare a background paper and draft terms of reference for the proposed working group well in advance of the seventeenth session of GESAMP to allow for careful consideration. In this regard, it was requested that GESAMP members send further comments and suggestions to the United Nations Technical Secretary within the next two months.

Other intersessional work

10.11 Following the above decisions on the establishment of one new working group, the Group noted that intersessional work would take place on the subjects listed below. The sponsoring organizations responsible for co-ordinating the intersessional work and the GESAMP members assigned to each working group are indicated. Additional GESAMP members and experts from outside GESAMP will be selected by the Chairmen of the Working Groups, in consultation with the relevant organizations.

(a) Evaluation of the Hazards of Harmful Substances Carried by Ships (Working Group No.1)

Lead Agency	: IMO
Co-operating Agency	: UNEP
Chairman	: P. Jeffery
Member	: W. Ernst

(b) Review of Potentially Harmful Substances (Working Group No.13)

Lead Agency	: WHO
Co-operating Agencies	: UNEP, FAO, IMO and Unesco
Chairman	: L. Friberg
Members	: Not yet identified

(c) Interchange of Pollutants between the Atmosphere and the Oceans (Working Group No.14)

Lead Agency	:	WMO
Co-operating Agencies	:	UNEP and Unesco
Chairman	:	W. D. Garrett
Members	:	V. Koropalov
		M. Waldichuk

(d) Land-Sea Boundary Flux of Pollutants (Working Group No.22)

Lead Agency	:	Unesco
Co-operating Agencies	:	UNEP and IAEA
Chairman	:	H. Windom
Member	:	J. M. Bewers

(e) Integrated Global Ocean Monitoring (Working Group No.24)

Lead Agency	:	UNEP
Co-operating Agencies	:	WMO and Unesco
Chairman	:	A. Tsyban
Members	:	M. Waldichuk
		V. Koropalov

(f) Coastal Modelling (Working Group No.25)

Lead Agency	:	IAEA
Co-operating Agencies	:	UNEP, Unesco and IMO
Chairman	:	J. Blanton
Member	:	J. M. Bewers

(g) State of the Marine Environment (Core Group of Working Group No.26)

Lead Agency	:	UNEP
Co-operating Agencies	:	UN, FAO, WHO, WMO, IMO
		IAEA and Unesco
Chairman	:	A. D. McIntyre
Members of core group	:	E. Gomez
		J. Broadus
		H. Windom
		G. D. Howells

(h) Long-term Ecological Consequences of Low-level Contamination of the Marine Environment (Working Group No.27)

Lead Agency	:	FAO
Co-operating Agency	:	UNEP, Unesco
Chairman	:	G. D. Howells
Member	:	A. Tsyban

11 DATE AND PLACE OF NEXT SESSION

11.1 The Group noted that the seventeenth session of GESAMP would be held at FAO Headquarters, Rome from 30 March to 3 April 1987, commencing on Monday, 30 March 1987 at 2 p.m. The Group urged the Technical Secretaries to distribute documents for consideration at the seventeenth session no later than 15 February 1987.

12 OTHER MATTERS

Definition of "marine pollution"

12.1 The publication "Defining Marine Pollution - A comparison of definitions used by international conventions" by M. Tomczak, Jr. (Marine Policy, October 1984) was brought to the attention of the Group through the Secretariat. The author had concluded that the current GESAMP definition of "marine pollution" involved an ethical or ideological concept which was therefore of a non-scientific nature. He therefore strongly recommended that GESAMP should revise its definition with a view to adopting the Law of the Sea Convention definition.

12.2 The Group noted that from the viewpoint of the sponsoring agencies of GESAMP, there was for the time being no need to amend the current GESAMP definition. Nevertheless, all members of the Group were invited to study the publication and to submit their comments to the Chairman, if they feel this to be appropriate. The Chairman in co-operation with the Administrative Secretary undertook to inform the Group at its next session of any comments received.

Analogues to the "collective dose" approach

12.3 During the course of the meeting suggestions had been made that some attention to analogues of the collective dose concept, as used in radiological protection, might be warranted. Much of the work of GESAMP has involved concerns for the effects upon individuals, both Man, animal and other life, but there is increasing interest in effects at the population level. The optimization process, as advocated for application to radiological protection, involves considerations based upon the dose to populations. Therefore, any application of the optimization principle to non-radioactive marine contamination/ pollution issues might be preceded by an examination of collective dose analogues for non-radioactive materials realizing that the exposed populations are those of human beings, fauna and flora. The sponsoring agencies of GESAMP were requested to consider this proposal with a view to initiating future discussion by the Group.

13 ELECTION OF CHAIRMAN AND VICE-CHAIRMAN FOR THE NEXT INTERSESSIONAL PERIOD AND THE SEVENTEENTH SESSION

13.1 The Group unanimously elected Mrs. G. D. Howells as Chairman and Mr. H. Windom as Vice-Chairman for the next intersessional period and for the seventeenth session of GESAMP.

14 CONSIDERATION AND APPROVAL OF THE REPORT OF THE MEETING

14.1 The report of the sixteenth session of GESAMP was considered and approved by the Group on the final day of the session. The report contains in Annexes IV to XI summaries of reports prepared by Working Groups. These summaries are included for information and were not submitted to the Group for approval.

ANNEX I

AGENDA

Opening of the session

1 Adoption of the Agenda

2 Review of potentially harmful substances

3 Evaluation of the hazards of harmful substances carried by ships

4 Interchange of pollutants between the atmosphere and the oceans

5 Land-sea boundary flux of pollutants

6 Methodology and guidelines for the assessment of the impact of pollutants on the marine environment

7 Integrated global ocean monitoring

8 Coastal modelling

9 State of the marine environment

10 Future work programme

11 Date and place of next session

12 Other matters

13 Election of Chairman and Vice-Chairman for the next intersessional period and for the seventeenth session

14 Consideration and approval of the report of the session

ANNEX II

LIST OF DOCUMENTS

AGENDA ITEM	GESAMP NO.	AUTHOR, SOURCE	TITLE OF PAPER
1	XVI/1	Administrative Secretary	Provisional Agenda
2	XVI/2	Working Group	Report of the fifth meeting of the Working Group on the Review of Potentially Harmful Substances
	XVI/2/1	Working Group	Hazard evaluation for Arsenic, Mercury and Selenium
	XVI/2/2	Working Group	Hazard evaluation for Organosilicon Compounds (Silanes and Siloxanes)
	XVI/2/2/Corr.1	Working Group	Hazard evaluation for Organosilicon Compounds (Silanes and Siloxanes)
	XVI/2/3	Expert Group on Carcinogens	Report of the first meeting
	XVI/2/4	Expert Group on Carcinogens	Report of the second meeting
	XVI/2/5	WHO	Evaluation of nutrients and algal blooms
	XVI/2/6	Unesco	Eutrophication: effects on the marine environment of changes of inputs of nutrients
3	XVI/3	Working Group	Report of the eighteenth session of the Working Group on the Evaluation of the Hazards of Harmful Substances Carried by Ships

AGENDA ITEM	GESAMP NO.	AUTHOR, SOURCE	TITLE OF PAPER
4	XVI/4	Working Group	Report of the sixth session of the Working Group on the Interchange of Pollutants between the Atmosphere and the Oceans
5	XVI/5	Working Group	Report of the second session of the Working Group on Land-Sea Boundary Flux of Pollutants
6	XVI/6	Working Group	Environmental Capacity, an Approach to Marine Pollution Prevention
7	XVI/7	Working Group	Report on Integrated Global Ocean Monitoring
	XVI/7/1	Unesco	Note on the IOC Global Investigations of Pollution in the Marine Environment with reference to Integrated Global Ocean Monitoring
8	XVI/8	Working Group	Report of the first meeting of the Working Group on Coastal Modelling
9	XVI/9	Working Group	Report of the second meeting of Core Group of the Working Group on the State of the Marine Environment
10	XVI/10	Unesco - FAO - UNEP	Long-term ecological consequences of low-level contamination of the marine environment
	XVI/10/1	UN	Economic aspects of marine pollution

ANNEX III

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ANNEX IV

SUMMARY OF THE REPORT OF THE WORKING GROUP ON THE REVIEW OF POTENTIALLY HARMFUL SUBSTANCES (WORKING GROUP 13)

1 The fifth meeting of the Working Group was held at WHO Headquarters in Geneva from 4 to 8 November 1985, with the main objective to review the draft evaluation reports prepared so far and to make arrangements for their completion and submission to GESAMP XVI. In particular, the Working Group reviewed the introductory chapter with sections on the quality of the data base and on dietary intake considerations, substantive reviews on arsenic, mercury and selenium, as well as a draft review of organosilicon compounds.

2 The quality of the data base used for the evaluation of the different substances was critically assessed by the Working Group and errors potentially introduced by inadequate analytical quality control identified. Inter-laboratory comparison studies, particularly for the determination of mercury, were reviewed and their limited number stated as a matter of general concern. The discussion of ecotoxicological data quality revealed the lack of data relevant to food chains and the difficulties in studying marine species under experimental conditions.

3 Different approaches for studying fish consumption patterns were reviewed by the Working Group, one based on estimating percentiles from dietary surveys, another based on defining critical groups with known high fish consumption. The Working Group decided that both approaches should be considered and included in the review document on arsenic, mercury and selenium. Some illustrative examples of very high fish consumption were discussed and included in the draft report.

4 The draft review document on arsenic was considered to be in an advanced state and the Working Group was in a position to complete its discussion during its fifth session. The author of the draft document was charged to incorporate all comments and suggestions and to prepare a final draft version for submission to GESAMP XVI.

5 The draft review document on mercury was subject to intensive debate at the Working Group session during which the health effects section was revised and finalized. As concerns the effects on marine biota, detailed revisions were considered necessary which one of the Working Group members undertook subsequent to the meeting. This revision also included the expansion and critical screening of the list of references as well as additional data on the levels of mercury in fish in different parts of the world's oceans.

6 The draft review document on selenium was discussed and finalized with regard to its marine section at the Working Group meeting. Completion of the human health effects section, however, had to await the outcome of the Task Group meeting on selenium which was convened by the International Programme on Chemical Safety, Geneva, 2-6 December 1985. One Working Group member subsequently completed the health section of the draft selenium document in consultation with the Chairman of the Task Group.

7 The draft review document on organosilicon compounds was discussed in great detail by the Working Group and the necessary revisions were identified. In particular, the Working Group recognized the limitations of this review to certain groups of organosilicons only and, consequently, added "silanes and siloxanes" to the title of the review document. It was also agreed to publish this document as a separate one in light of its different purpose.

8 The impact of carcinogenic substances on marine organisms and implications concerning public health was the subject of the first meeting of the sub-group on carcinogens which was hosted by the International Agency for Research on Cancer in Lyon, 18-19 September 1985. The sub-group reviewed currently available evidence concerning the risk for cancer induction in exposed marine organisms and concerning the risk of human consumption of seafood containing carcinogenic substances. Several recommendations were formulated regarding the need for collection, review and assessment of data on tumours in marine organisms as well as on cancer occurrence in human population groups with different seafood consumption.

9 The occurrence of potential carcinogens and tumours in marine organisms was the main focus of the second meeting of the sub-group on carcinogens which was hosted by the International Council for Exploration of the Sea at Copenhagen, 22-23 January 1986. The sub-group endorsed the recommendations of its first meeting and specified the gaps in knowledge which should be covered by specific studies. The sub-group also reviewed a literature survey and evaluation of carcinogenic substances in the marine environment and implications concerning carcinogenesis in aquatic organisms.

10 As concerns the review of nutrients the Working Group was not able to consider this subject during the intersessional period. It was recognized that a group of experts with different backgrounds, particularly including marine biology, would be required to undertake an evaluation of nutrients and algal blooms. Consequently, the earlier consultant report on this subject was submitted to GESAMP XVI as background information and contacts with other sponsoring agencies established to discuss at the intersecretariat level future work on this subject.

11 The lists of contents of the two studies currently being prepared for publication - Review of Potentially Harmful Substances: Arsenic, Mercury and Selenium (GESAMP Reports and Studies No.28), and Review of Potentially Harmful Substances: Organosilicon Compounds (Silanes and Siloxanes) (GESAMP Reports and Studies No.29) - are set out in the following pages.

GESAMP REPORTS AND STUDIES NO.28

REVIEW OF POTENTIALLY HARMFUL SUBSTANCES:

ARSENIC, MERCURY AND SELENIUM

List of contents

II. ARSENIC

1. ARSENIC IN THE MARINE ENVIRONMENT

    1.1 Reference documentation
    1.2 General facts
    1.3 Sources
    1.4 Transport, transformation and bioaccumulation
        1.4.1 Transport
        1.4.2 Transformation
        1.4.3 Bioaccumulation
    1.5 Concentrations of arsenic in the marine environment
        1.5.1 Sea water
        1.5.2 Sediments
        1.5.3 Marine biota

2. EFFECTS OF ARSENIC ON MARINE BIOTA

    2.1 Reference documentation
    2.2 Effects on marine biota

3. HUMAN HEALTH ASPECTS

    3.1 Introduction and reference documentation
    3.2 Toxicokinetic properties
        3.2.1 Absorption
        3.2.2 Biotransformation
        3.2.3 Tissue distribution
        3.2.4 Excretion and biological half-time
        3.2.5 Indicators of exposure
    3.3 Health effects
        3.3.1 Inorganic arsenic compounds
        3.3.2 Organic arsenic compounds
    3.4 Total exposure to arsenic
        3.4.1 Air
        3.4.2 Drinking water and beverages
        3.4.3 Food
        3.4.4 Total daily intake
    3.5 Evaluation of potential health effects

4. CONCLUSIONS ON ARSENIC

    4.1 Potential harm to living resources
    4.2 Potential hazards to human health

5. REFERENCES

III. MERCURY

1. MERCURY IN THE MARINE EVIRONMENT

    1.1 Reference documentation
    1.2 General facts
    1.3 Sources
    1.4 Transport, Transformation and Bioaccumulation
        1.4.1 Transport
        1.4.2 Transformation
        1.4.3 Bioaccumulation
    1.5 Mercury in atmosphere, sea water, sediments and marine biota
        1.5.1 Mercury concentration in the atmosphere
        1.5.2 Mercury concentration in sea water
        1.5.3 Mercury concentration in sediments
        1.5.4 Mercury concentration in phytoplankton and seaweeds
        1.5.5 Mercury concentration in zooplankton
        1.5.6 Mercury concentration in molluscs
        1.5.7 Mercury concentration in crustaceans
        1.5.8 Mercury concentration in fish
        1.5.9 Mercury concentration in marine birds
        1.5.10 Mercury concentrations in marine mammals

2. EFFECTS OF MERCURY ON MARINE BIOTA

    2.1 Reference documentation
    2.2 Methodology for studying effects of mercury on marine biota
    2.3 Phyto- and Zooplankton
    2.4 Macrophytes
    2.5 Bacteria
    2.6 Crustaceans
    2.7 Molluscs
    2.8 Fish
    2.9 Marine mammals
    2.10 Enclosed pelagic ecosystems

3. HUMAN HEALTH ASPECTS

    3.1 Reference documentation
    3.2 Toxicokinetic properties
    3.3 Health effects
    3.4 Total exposure to mercury
        3.4.1 Dietary mercury intake
        3.4.2 Exposure from water and air
    3.5 Contribution of mercury from marine food
        3.5.1 Primary route - Description Data
        3.5.2 Primary route - Calculation of Intake
        3.5.3 Secondary route
    3.6 Evaluation of potential health effects

4. CONCLUSIONS ON MERCURY

    4.1 Potential harm to living resources
    4.2 Potential hazards to human health

5. REFERENCES

IV. SELENIUM

1. SELENIUM IN THE MARINE ENVIRONMENT

    1.1 Reference Documentation
    1.2 General Facts
    1.3 Sources
    1.4 Transport, transformation and bioaccumulation
        1.4.1 Transport
        1.4.2 Transformation
        1.4.3 Bioaccumulation
    1.5 Selenium in sea water, sediments and marine biota
        1.5.1 Sea water
        1.5.2 Sediments
        1.5.3 Marine biota
        1.5.4 Selenium/mercury correlation
        1.5.5 Other correlations

2. EFFECTS OF SELENIUM ON MARINE BIOTA

    2.1 Reference Documentation
    2.2 Effects on marine biota

3. HUMAN HEALTH ASPECTS

    3.1 Introduction and reference documentation
    3.2 Metabolism of selenium
        3.2.1 Absorption
        3.2.2 Excretion and clearance half times
        3.2.3 Metabolic pathways
        3.2.4 Selemium in blood
        3.2.5 Gluthathione peroxidase
    3.3 Health effects
        3.3.1 Selemium deficiency
        3.3.2 Selenium toxicity
            3.3.2.1 Occupational exposure
            3.3.2.2 Self medication
            3.3.2.3 Dietary exposure in seleniferous areas
    3.4 Total exposure to selenium
    3.5 Contribution of selenium from marine food
    3.6 Evaluation of potential health effects
        3.6.1 Seafood as a source of nutritionally desirable selenium levels
        3.6.2 Seafood as a source of potentially hazardous levels of selenium intake
        3.6.3 Carcinogenecity and human reproduction
        3.6.4 Interaction of selenium with other elements

4. CONCLUSIONS ON SELENIUM

    4.1 Potential harm to living resources
    4.2 Potential hazards to human health

5. REFERENCES

GESAMP REPORTS AND STUDIES NO. 29

REVIEW OF POTENTIALLY HARMFUL SUBSTANCES:

ORGANOSILICON COMPOUNDS (SILANES AND SILOXANES)

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ANNEX V

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

1 Hazard profiles

The Working Group reviewed quite a number of hazard profiles and also evaluated many new substances proposed by IMO Members for carriage in bulk. A list of substances considered by the Working Group is shown in Annex to the report of its eighteenth session.

2 Evaluation of substances of low density, high volatility and low solubility

2.1 Tests with "Low Aromatic White Spirits (LAWS)" had been commissioned by the chemical industry under different conditions in order to demonstrate that for substances of low density, high volatility, poor solubility and relatively rapid biodegradation, the generally used closed system tests would result in data which would not be representative of what would occur "in an actual spill at sea" or when tank residues from ships would be discharged into the sea.

2.2 The Working Group noted that there were apparently different LC_{50} values resulting from tests with White Spirit carried out under differing test conditions. After discussion of the various test conditions used and the results derived therefrom the Working Group made a general statement, emphasizing that in its evaluation of harm to living marine resources GESAMP has used the LC_{50} values obtained by recognized procedures such as those described in the OECD Guidelines for testing of chemicals. This requires the exposure of the test organism to known concentrations of the substance, for the required periods of time. These Guidelines point out that the test conditions must be designed to keep the concentrations constant. Tests in which the concentration falls to 20% of its initial value cannot be accepted. The results obtained should be regarded as an intrinsic property of the substance concerned.

2.3 The Working Group was sympathetic to the view that substances with the characteristics mentioned above could behave in the marine environment in a way that the hazard profile might not take into account. However, it was considered the task of the IMO expert groups to take such matters into account when allocating specific requirements for the carriage of these substances and for their discharge at sea.

3 Mixtures

3.1 The Working Group noted that the IMO Sub-Committee on Bulk Chemicals had expressed the view that in light of the large number of mixtures of lube oil additives, testing and rating of each individual additive mixture would create a very heavy workload and be impractical and that the Sub-Committee had agreed that a method which reduced the number of tests required, and which was scientifically valid, would be desirable. In a submission from the chemical industry to the meeting of the Working Group a grouping system was provided

based on a classification scheme which took into account mainly mammalian hazards rather than aquatic toxicity data.

3.2 The Working Group, asked to consider the classification system and to identify components which would be representative for each group with regard to testing, expressed the view that no straightforward advice can be given but that more information was needed on the physical and chemical properties of the components of at least two of the classes, as well as on their eco- and mammalian toxicity.

4 Future work

The Working Group identified items for consideration at future meetings. The next meeting of the Working Group will be convened from 26 to 30 May 1986. In light of the rather heavy action plan the Secretariat was requested to investigate the possibility of convening two meetings in 1986.

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ANNEX VI

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

1 The sixth session of the Working Group was held in Paris from 6 to 9 January 1986 to address the first two tasks of the terms of reference which specified that the Working Group should:

.1 provide a continuing review of air-sea material interchange with emphasis on the pollutant modification of atmosphere and ocean-related processes, especially those pertinent to climate, and the energy balance of the oceans; and

.2 study certain properties of the ocean mixed layer and the surface microlayer, which are modified by pollutants, to clarify mechanisms of mass and energy transfer between the atmosphere and the oceans, and to assess the potential for the remote detection of pollutants as a result of these surface and near-surface effects.

The Working Group decided that at the first stage of studying these problems, the main attention should be paid to the role of the global ocean in influencing the magnitude and variations of tropospheric carbon dioxide concentrations, which is vital for understanding and modelling any associated climatic changes and anomalies.

2 In the statement on process modification by pollutants prepared by the Working Group, it was noted that the pollutant modification of certain atmosphere and ocean-related processes might influence weather and climate, either regionally or on a global scale. Some examples of pollutant effects on such processes are as follows:

.1 changes in type, number and redistribution of organisms in the marine biosphere due to increased nutrient inputs and CO_2-induced ocean heating;

.2 changes in thermal characteristics of the sea caused by atmospheric carbonaceous particles through the alteration of direct solar input to the sea;

.3 changes in the reflectivity of clouds and the earth's albedo resulting from the introduction of cloud-condensation nuclei;

.4 modification of a number of air-sea interfacial properties by organic films that can influence the ocean-atmosphere exchange of CO_2, Freons and other gases; and

.5 alteration of ocean thermal structure due to decrease in light penetration caused by man-mobilized solids entering the seas through rivers.

3 In the first part of the interim report on specific problems in interchange of pollutants between the atmosphere and the oceans prepared during the session, the following matters devoted to the carbon dioxide problem were considered: the global carbon cycle, ocean carbonate chemistry, models of the oceanic carbon cycle, the effect of the biosphere on CO_2, oceanic modification of climatic effects of increasing CO_2, including the development of sea-surface temperature anomalies, changes in the ocean circulation and distribution of temperature and salinity, and changes in the atmospheric forcing at the surface due directly to the increase in CO_2 partial pressure.

4 The influence of some radiatively active trace gases on climate was briefly considered by the Working Group. The common understanding was that trace species, many of which are quite reactive, play key roles in tropospheric chemistry and air quality. They could cause a warming of the surface-tropospheric system, which could be of the same magnitude as the warming due to the projected increases in CO_2.

5 While considering the role of man-made and natural aerosols in the chemical cycles of constituents in the atmosphere and the global climate, the Working Group noted that changing the earth's albedo by aerosol interaction with cloud processes could have a more important impact on climate than the direct reduction of insolation of the earth's surface.

6 The Working Group noted again that the understanding of the chemistry of the atmosphere-ocean boundary and the exchange processes between the atmosphere and the ocean involves knowledge of the properties of the surface microlayer. In this sense, molecular-level phenomena require special attention and further research. A number of recommendations was made on research and field measurements in this field.

7 The possibility of using the space-based satellite imagery to detect petroleum slicks on the sea surface and to monitor effects of climatic change, arising from increasing CO_2, on oceanic primary productivity, was discussed. It was considered important to continue testing these methodologies to improve their capabilities.

8 Needs in future research were determined by the Working Group for a better understanding of the impact of contaminants on atmosphere and ocean-related processes and climate.

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ANNEX VII

SUMMARY OF THE REPORT OF THE WORKING GROUP ON THE LAND-SEA BOUNDARY FLUX OF POLLUTANTS (WORKING GROUP 22)

1 At the second meeting of Working Group 22 in Roscoff, France (8-12 July 1985) the main aim was to establish agreement among the Working Group members on requirements for estimating gross river fluxes, definition of boundaries and important processes that influence the flux at the various contaminant types across the land-sea boundary. The group also reviewed the results of the questionnaire to evaluate ways to increase its circulation. The work was conducted primarily in sub-groups and the results are briefly discussed below.

2 Members took the questionnaire returns for their region and agreed to augment them with additional information on the activities of laboratories not having received or responded to the original questionnaire. This will enable the Working Group to produce a more comprehensive and authoritative evaluation of river studies worldwide. Dr. Yu Gua-Hui, for example, will attempt to provide additional activities on China; Dr. Roland Wollast will cover activities of Western European laboratories in both Europe and other areas of the world, e.g. Africa; and Dr. Y. Gordeev will cover activities within the USSR. Equally it was proposed that Dr. Bruce Webb provide more information on river hydrology research activities.

3 Dr. Webb was requested to provide a presentation on the hydrologic aspects of estimating gross river fluxes. Dr. Webb then gave a most valuable presentation on various aspects of riverine hydrology and compositional characteristics. This included discussions on subjects such as sediment transport estimates and discharge distributions, temporal and spatial variability in constituent transport, procedures for discharge flux calculation and their associated uncertainties, both with respect to accuracy and precision. The Group then embarked on a wide-ranging discussion of the content and impact of Dr. Webb's presentation in an attempt to distinguish, to the extent possible, between the various hydrologic influences on discharge flux estimation for chemical constituents. Source and reactivity were proposed as factors in the categorization of the problems and procedures associated with flux measurement. It was then pointed out that the purpose for which chemical flux measurements were being made would influence to a considerable degree the nature of the approach used. The discussion then turned to a preliminary analysis of other techniques for examining the relationships between individual constituents that might provide some insights into sources and transport mechanisms. After considerable discussion and exchange of ideas it was agreed that it would be possible for a sessional sub-group to develop and amplify procedures for estimating the river transport of different types of chemical constituent for the purposes of chemical flux estimation. The results of the efforts by this sub-group and related plenary discussions are included in Annex V of the Working Group report.

4 The Working Group should agree on a definition of the river/estuarine boundary. A sessional sub-group was established for this purpose. The sub-group considered two boundaries, one based on unidirectional river flow and one based on the limit of marine salt intrusion. Such boundary definitions are provided in the Working Group report (Annex VI) together with a discussion of the use and applicability of these definitions.

5 The Chairman introduced the paper entitled "The Land/Sea Boundary" circulated with the background material for the meeting. This document was distributed as a "straw man" for discussions. The discussion opened with consideration of the uniqueness of processes in estuaries and continental shelves that might permit identification of suitable boundaries for estuarine and shelf regions. It was felt that such a classification was possible from the perspective of nutrients and metals but categorizing marginal sea processes was likely to be difficult because of the heterogeneity of marginal seas. This problem was regarded as soluble in terms of defining types of, or individual, marginal seas which had contained components of estuarine and/or shelf environments. It was questioned to what degree boundaries in the estuarine/shelf region were needed - what was their purpose realizing that any such definitions were likely to be very arbitrary? It was explained that the Group had been asked to examine methods of assessing net fluxes to the ocean and this would require the definition of at least one boundary. Could such boundaries be defined on the basis of the dominance of particular processes such as mixing versus biological activity? Biologists define estuaries on the basis of species diversity and types whereas physicists define estuaries on the basis of mixing features. Could these be used in this connection? Some reluctance to define boundaries was evident since these boundaries, however defined, were likely to be wholly arbitrary and probably meaningless.

6 Sub-groups were formed to consider the various categories of pollutants. The Chairman pointed out to the Group that satisfying the Terms of Reference would require the definition of some boundary or boundaries for the purposes of estimating "net" fluxes through the coastal zone. However, he proposed that there must first be a discussion of processes in sub-group created for different types of chemical constituent. Because of the limited backgrounds of the participants only three sub-groups were formed. These groups considered trace metals, organic contaminants and nutrients. The results of the deliberations of these groups are presented in the Working Group Report, Annexes VII-IX.

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ANNEX VIII

SUMMARY OF THE REPORT OF THE WORKING GROUP ON THE METHODOLOGY AND GUIDELINES FOR THE ASSESSMENT OF THE IMPACT OF POLLUTANTS ON THE MARINE ENVIRONMENT (WORKING GROUP 23)

1 The Working Group met from 26-30 September 1983 in Rome, from 29 October to 9 November 1984 in Bangkok, and from 23-27 September 1985 in Rome, under the Chairmanship of Mr. V. Pravdic. Rapporteurs were Messrs. E.D. Gomez (first session) and J.E. Portmann (second and third sessions). The Working Group presented the final report which is entitled "Environmental Capacity - An Approach to Marine Pollution Prevention" and will be published as GESAMP Reports and Studies No. 30.

2 The Report introduces the Environmental Capacity concept, a property of the environment to receive and deal with pollutants, as a viable strategy to prevent marine pollution.

3 It is a multi-faceted Report which in its final sections provides guidelines and examples for immediate and practical use. Each concept, premise, and definition is, however, elaborated in depth within a framework of a dynamic approach to the properties of the marine ecosystem.

4 The content of the Report is sub-divided into six chapters.

5 In the Introduction the conceptual approach is outlined with the scientific rationale as its cornerstone. Accordingly, it emphasizes that the scope of this Report is basically different from the process of Environmental Impact Assessment, which includes, in addition to scientific considerations also political, social, and economic components in decision making.

6 Chapter 2 on Premises, Concepts, and Definitions outlines the basics of the whole conceptual framework. It defines Environmental Capacity in the dynamic sense as the maximum rate at which a part of the marine environment can accept and deal with contaminants without unacceptable effects, i.e. pollution.

7 Chapter 3 on the Scientific Rationale and Methodology for the Assessment of the Impact on the Marine Environment ranks the various traditional strategies for combating pollution, indicating their advantages and shortcomings in the light of the concept proposed. In the first part of the chapter, the deterministic approach is demonstrated by an appropriate flowsheet of decision making. It explains the use and the necessary level of modelling, the choice of objective, targets and critical pathways. As an orthogonal component, the probabilistic approach, based on Decision Analysis, is outlined. A corresponding flowsheet follows the steps of the assessment process, based on socio-economic input in decision criteria and the value system. Components of cost/benefit and risk analysis are incorporated within this probabilistic approach.

8 Chapter 4 deals with Verification of the Assessment made and of the Environmental Quality Criteria Adopted. It introduces the component and the essence of monitoring targets and the quality and quantity of effluents. The

procedure of reassessment is specified as a crucial component in the process of optimization of any pollution prevention measures, but especially that which involves assessment and utilization of environmental capacity.

9 Chapter 5 gives the Guidelines for the Scientific Assessment of the Impact of Pollutants on the Marine Environment. It guides the user, step by step, in five sub-chapters to the decision making, and to the continuous process of monitoring, validation, and reassessment.

10 The final chapter contains eleven examples of application of the concept of Environmental Capacity as a strategy to prevent marine pollution. The first is a simple modelling exercise using simple kinetic equations for the case of an unspecified degradable contaminant. The second example is a fully elaborated case of a multiple development project in a coastal area. It exemplifies the choice of the most important contaminant, target, pathway, and the calculation of the environmental capacity with apportionment for specific uses. The following examples deal with detergents, sewage, mercury, pesticides, organometals, arsenic, and organochlorines as problem contaminants. The final two examples deal with power plants and their influence on the marine environment, such as abstraction, use, and discharge of water, and the chlorination of cooling water with its subsequent discharge.

11 The list of contents of the report on the Environmental Capacity - An Approach to Marine Pollution Prevention is as follows:

1. INTRODUCTION

2. PREMISES, CONCEPTS AND DEFINITIONS
   - 2.1 Acceptability of Impact
   - 2.2 Environmental Capacity
   - 2.3 Recovery of Polluted Ecosystems

3. SCIENTIFIC RATIONALE AND METHODOLOGY FOR THE ASSESSMENT OF THE IMPACT OF POLLUTION ON THE MARINE ENVIRONMENT
   - 3.1 Approaches to Effluent Control
     - 3.1.1 Removal/reduction of contaminant levels by effluent treatment
     - 3.1.2 Water quality classification systems/water quality criteria
   - 3.2 Quantification and Derivation of Environmental Capacity
     - 3.2.1 Characteristics of the contaminant
     - 3.2.2 Classification of pollutants
     - 3.2.3 Environmental distribution
     - 3.2.4 Environmental fate
     - 3.2.5 Definition of boundaries of the impacted ecosystem
     - 3.2.6 On the calculation of Environmental Capacity
   - 3.3 Choice of Objectives, Targets and Pathways
   - 3.4 Probabilistic Analysis as Applied to the Assessment of Environmental Capacity
   - 3.5 Presentation of Scientific Results

4. VERIFICATION OF THE ASSESSMENT MADE AND ENVIRONMENTAL QUALITY CRITERIA ADOPTED
   - 4.1 Monitoring of Primary and/or Other Targets
   - 4.2 Monitoring of Qualities and Quantities of Effluent
   - 4.3 Incorporation of New Information and Reassessment

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ANNEX IX

SUMMARY OF THE REPORT OF THE WORKING GROUP ON
INTEGRATED GLOBAL OCEAN MONITORING
(WORKING GROUP 24)

1 The Working Group met in Batumi, USSR from 2 to 5 December 1985 under the chairmanship of Mrs. A. Tsyban. Messrs. S. Keckes and A. Soudine acted as Technical Secretaries. The Rapporteur was Mr. E. D. Schneider.

2 Taking into account the present understanding of the problems facing the world ocean, the ongoing and planned national and international research and monitoring programmes, the Working Group defined as the overall aim of IGOM a better understanding of global oceanic processes, both natural and those influenced by anthropogenic contaminants, and the preparation of a scientific data base which may lead to forecasting adverse ecological consequences. The Working Group concluded that this aim should be achieved through a system of long-term continuous observations and measurements using a methodology yielding comparable results in order to:

- assess the levels and fluxes of contaminants in the oceans on a global scale;

- study and document changes in ecosystems in various geographical zones of the world ocean;

- understand the cause-effect relationship between the level of contaminants and the observed ecological changes and to reveal the "critical levels" of contaminants which may lead to ecological changes; and

- develop capabilities for prediction of adverse changes in marine ecosystems.

3 The Working Group examined the scientific justification for IGOM and being aware of the many gaps in the knowledge about open ocean system concluded that the presently observed level of contaminants and inadequacy of information on ecological changes in the open ocean do not seem to justify, for the time being, a continuous global and intensive monitoring of the open oceans. However, in order to develop capabilities for an integrated global ocean monitoring and to establish a baseline for future references, the Working Group proposed, as components of IGOM:

- the launching of a pilot international research monitoring programme in the open ocean; and

- a globally co-ordinated regional research and monitoring programme.

4 The Working Group recommended for investigations regions exposed to anthropogenic impact and regions generally out of the influence of contaminants.

5 The Working Group also defined the type of observations and measurements which could be included in IGOM and proposed a generalized conceptual diagram for ecosystem response to contaminants. Interdisciplinary approach to

investigation of near-surface atmospheric layer, surface water microlayer, water column, particulate fluxes and sea-bottom was recommended.

6 Globally applicable sampling and analytical techniques should be formulated and applied as the "reference methods" to be used in both components of IGOM. Tested "reference methods" and intensive intercalibration exercises should ensure the global comparability of data. Intercalibration excercises should be made mandatory, as far as feasible, for participants in the pollution monitoring and research programmes carried out in the framework of IGOM.

7 The regional measurement of contaminant levels in marine organisms should be combined in a globally co-ordinated "mussel watch" programme, which should also cover geographical areas not yet covered by existing regional programmes.

8 Considering the large scale of the open ocean areas the advantage of applying existing and of developing new technologies and techniques for remote sensing analysis from aircraft and satellites, in addition to measurements from ships on the ocean surface was advocated. The Working Group concluded that the information gained from field observation should be used for calibrating satellite data to obtain quantitative characteristics of the state of the ocean under anthropogenic effects. These data collected from ships at sea provide a most important link between observations from remote sensing and the actual state of parameters in the ocean.

9 The importance and scale of IGOM indicates that for the implementation of the programme, internationally co-ordinated world-wide efforts would be required. The Working Group proposed to set up an effective mechanism for the co-ordination of the global open ocean research and monitoring programme.

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ANNEX X

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

1 The first meeting of the GESAMP Working Group on Coastal Modelling under the chairmanship of Mr. J. Blanton was held in Vienna at IAEA Headquarters from 27 to 31 January 1986.

2 The Working Group reviewed the Terms of Reference developed at the fifteenth session of GESAMP and proposed some changes for clarification. These changes are underlined in the following text:

.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.

The Working Group proposed the changes because it felt that it was important to specify that the models were to apply to dumping at sea and to discharges into the marine environment from land-based sources such as rivers and pipelines. After discussion it was also felt necessary to include reference to the specificity of different types of contaminants, since the effort was to apply to contaminants such as radionuclides, heavy metals and organic compounds.

3 The Working Group was informed of modelling activities in Canada that have predictive ability for some radioactive and organic contaminants and saw a demonstration of a tritium model. They were also informed of a model being developed for the Irish Sea that is to be completed at the end of the year. In discussions concerning the use of models it was emphasized many times that it was very important to select the appropriate model for the specific question, environment and contaminant.

4 The Working Group was also informed of recent developments in the IAEA concerning criteria for setting exemption limits. These criteria would be the radiological basis for application to models recommended by the Working Group.

5 The Working Group examined the range of coastal regimes that it should consider. It was decided that since there were parts of the continental slope that could be of importance, the open ocean itself would be used as a boundary condition for the slope. Similarly, fresh water inflow from rivers would be considered as a boundary condition for the near shore region. The coastal regimes to be examined were therefore defined (moving from the slope, shoreward) as: the continental slope, the continental shelf, constrained marginal seas and embayments on the continental shelf and estuaries. The Working Group realized the need to further subclassify this regime.

6 In discussing the types of model required and the process parameterization needed, it was agreed that a hydrodynamic transport model would be the minimum requirement. The specific regime and contaminant would then impose a need to include, in addition to the hydrodynamic transport model, sediment and biological transport model components. Each type of model could be developed separately and linked by contaminant-specific transfer equations. A diagramatic representation of a conceptual model is included as Figure 1. It was continuously emphasized that the appropriate model would be dependent on the question to be answered, the nature of the contaminant and the hydro-geological regime into which the contaminant is introduced.

7 The conditions existing in a variety of specific coastal regions were assessed as a means of identifying the processes that will be required to be modelled at the highest level of complexity. These conditions were as follows: the balance between buoyancy inputs and mixing energy (stratification), sediment transport pathways, sedimentary composition and mixing, biological productivity, and physical chemical conditions in the water column and sediments. Those parameters required to describe the source term were also discussed and some preliminary judgements were made as to the type of models that would be required for specific contaminant types.

8 A preliminary outline of the report of the Working Group was made as follows:

OUTLINE OF REPORT

GESAMP WORKING GROUP 25

COASTAL MODELLING

I. INTRODUCTION

- A. Background
- B. Terms of Reference

II. COASTAL SITE CHARACTERISTICS

- A. Definition of Coastal Regimes
- B. Boundary Conditions
- C. Heterogeneity of Regimes
- D. Subclassification of Regimes
- E. Methods of Handling Regimes and Boundary Conditions

III. OCEANOGRAPHY OF COASTAL REGIMES

- A. Range of Oceanographic Processes in Regimes (and Subregimes)
  - 1. Physics
  - 2. Sediment Transport
  - 3. Geochemistry
  - 4. Biology

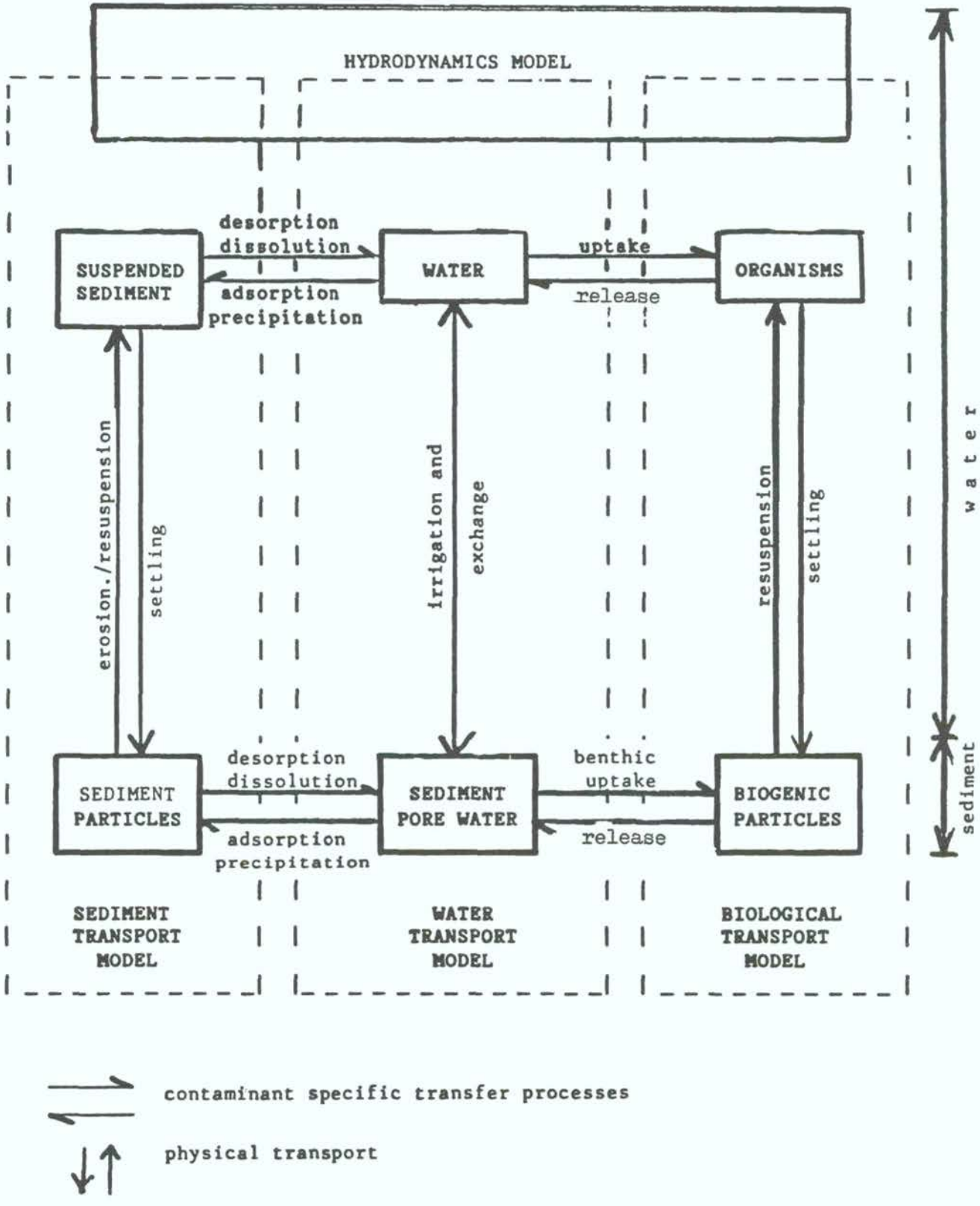

FIG.1 CONCEPTUAL MODEL

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ANNEX XI

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

1 At the first meeting of the Core Group held in New York in July 1985 an outline of the Review of the State of the Marine Environment was discussed and this was further elaborated at the second meeting in Rome in December 1985.

2 It was agreed that the Review should consist of a main text supported by technical annexes that would contain the evidence on which the main text is based. While the main text will be the responsibility of Working Group 26, the efforts of other GESAMP Working Groups - numbers 13, 14, 22, 23 and 24 will be utilized. In addition, the possibility of establishing appropriate sub-groups or engaging specialists to examine particular aspects will be considered.

3 In the outline it was proposed that the Review should consist of ten chapters, the first of which would present the background and set out the aims and the general approach.

4 Chapter 2 would deal with the levels and distribution of contaminants in the oceans - in water, sediments and biota, and will examine the transport and flux of contaminants across the major boundaries (air/sea, land/sea and sediment/water), attempting to demonstrate the balance between source and sink. A section will be included on specific pollutants which constitute current or potential problems. Emphasis will be placed on good data validation and management.

5 Chapter 3 will examine the human uses of the sea causing pollution. Among the topics included will be the disposal of urban waste waters, industrial wastes, contaminated sediments and litter. The impact of coastal development, of the exploitation of living and non-living marine resources and of marine transportation will also be considered.

6 Chapter 4, central to the Review, will focus on biological effects of pollution. It will recognize that eutrophication may be a potential problem on a global scale causing effects at the ecosystem level. It will also identify the long term build-up of contaminants from diverse sources possibly producing effects which although initially subtle could result eventually in population changes. Attack on this issue will demand understanding of how marine populations react to natural events at least on the scale of decades. This chapter will include a consideration of the effect of accidents and episodic events, of the terrestrial impact of marine pollutants and of the rehabilitation and recovery of damaged habitat.

7 The broad topic of climatic change effects will be covered in Chapter 5. While this is a matter of major importance, it will be noted that there is already a great deal of activity at the international level in the field (e.g. by WCRP and CCCO) and that much can be gained from drawing on this experience. The Working Group will not attempt to duplicate ongoing work, but will pay particular attention to the effects on marine populations of temperature and sea-level alteration, and of change in the carbon cycle.

8 Chapter 6 will be concerned with geographical areas and specific habitats and will make regional comparisons based on detailed material in the Annexes. A major question will be whether pollution effects are building up or reducing, giving a trend in environmental degradation, and this will be dealt with in Chapter 7 which will also examine the possible value of models of world population growth and changing pattern of industrial and agricultural development.

9 Finally, in Chapters 8 and 9 the lessons to be learnt from existing national and international control strategies will be evaluated and the input from economic expertise will be examined, while Chapter 10 will review the overall results of the Working Group, summarize discussions, draw conclusions and make recommendations for future action.

10 The Core Group made a start at identifying those subjects which would be appropriate for annexes, case histories or special sub-groups, but accepted that these details would be part of its first task in 1986.

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2	Review of Harmful Substances	1976	E
3	Scientific Criteria for the Selection of Sites for Dumping Wastes into the Sea	1975	E, F, R, S
4	Report of the Eighth Session	1976	E, F, R
5	Principles for Developing Coastal Water Quality Criteria	1976	E
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9	Report of the Tenth Session	1978	E, F, R, S
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14	Report of the Twelfth Session	1981	E, F, R
15	The Review of the Health of the Oceans	1982	E
16	Scientific Criteria for the Selection of Waste Disposal Sites at Sea	1982	E
17	The Evaluation of Hazards of Harmful Substances Carried by Ships	1982	E

Rep.& Stud. No.	Title	Date	Language
18	Report of the Thirteenth Session	1983	E, F, S
19	An Oceanographic Model for the Dispersion of Wastes Disposed of in the Deep Sea	1983	E
20	Marine Pollution Implications of Ocean Energy Development	1984	E
21	Report of the Fourteenth Session	1984	E, F, S
22	Review of Potentially Harmful Substances - Cadmium, Lead and Tin	1985	E
23	Interchange of Pollutants Between the Atmosphere and the Oceans	1985	E
24	Thermal Discharges in the Marine Environment	1985	E
25	Report of the Fifteenth Session	1985	E, F, S, R
26	Atmospheric Transport of Contaminants into the Mediterranean Region	1985	E
27	Report of the Sixteenth Session	1986	E (F, S, R in preparation)
28	Review of Potentially Harmful Substances - Arsenic, Mercury and Selenium	in preparation	
29	Review of Potentially Harmful Substances - Organosilicon Compounds (Silanes and Siloxanes)	in preparation	
30	Environmental Capacity - An Approach to Marine Pollution Prevention	in preparation	

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