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# *GESAMP: Environmental capacity: an approach to marine pollution prevention*

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# PREFACE

GESAMP, the Joint Group of Experts on the Scientific Aspects of Marine Pollution, was established in 1969 and is today co-sponsored by the International Maritime Organization (IMO), Food and Agriculture Organization of the United Nations (FAO), United Nations Educational, Scientific and Cultural Organization (UNESCO), World Meteorological Organization (WMO), World Health Organizaton (WHO),International Atomic Energy Agency (IAEA), United Nations and United Nations Environment Programme (UNEP). According to its present terms of reference, the functions of GESAMP are:

- to provide advice relating to the scientific aspects of marine pollution[1/]; and
- to prepare periodic reviews of the state of the marine environment as regards marine pollution and to identify problem areas requiring special attention.

Since its beginning GESAMP involved a large number of experts as members of GESAMP or GESAMP Working Groups and produced, at the request of the sponsoring organizations, numerous reports[2/].

This document is the Report of the GESAMP Working Group on the Methodologies and Guidelines for the Assessment of the Impact of Pollutants on the Marine Environment, which met from 26 to 30 September 1983 in Rome, Italy, from 29 October to 9 November 1984 in Bangkok, Thailand, and from 23 to 27 September 1985 in Rome, Italy.

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The sessions of the Working Group were jointly sponsored by the Food and Agriculture Organization of the United Nations (FAO), the United Nations Educational, Scientific and Cultural Organization (UNESCO), the World Health Organization (WHO), the International Maritime Organization (IMO), the International Atomic Energy Agency (IAEA) and the United Nations Environment Programme (UNEP). The activities of the Working Group were organized by FAO, acting as the "lead agency".

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1/ GESAMP defined marine pollution as "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."

2/ V. Pravdic: GESAMP, The First Dozen Years. UNEP, 1981.

## EXECUTIVE SUMMARY

The aim of this Report is to provide guidelines for the assessment of the impact of potentially harmful substances released into the marine environment.

The Environmental (also known as receiving, absorptive or assimilative) Capacity is defined as a property of the environment, a measurement of its ability to accommodate a particular activity or rate of an activity, such as the discharge of contaminants, without unacceptable impact. The Environmental Capacity can be apportioned for various uses.

The Report proposes the use of a strategy to combat marine pollution based on this concept of Environmental Capacity. It provides the scientific rationale for the assessment of this entity, the methodology of calculation based on modelling, guidelines for its systematic application, monitoring and reassessment, and provides a number of case studies in the form of examples involving various contaminants and different geographical areas.

The Report opens with a short introduction outlining the basic concepts and premisses which lie behind the acceptance of disposal of wastes in the sea. When a development is first proposed, its impact on the whole environment, together with the costs and benefits to society as a whole, must be taken into account before the plans are actually implemented. The procedure is often now known as environmental impact assessment (EIA). This wide-ranging procedure embraces far more than the scientific assessment of the impact of pollutants on the environment and as such lies outside the terms of reference of GESAMP.

Accordingly, this Report concentrates on describing the parameters and processes which have to be taken into account in the assessment of the impact of pollutants on marine organisms, ecosystems, amenities and human health, as a consequence of any discharges to the marine environment.

The methodology of assessment of Environmental Capacity as proposed in the Report, involves critical pathway analysis for both conservative and non-conservative contaminants, establishment of environmental and water quality objectives, criteria and standards. Faced with the inevitability of several sources of uncertainty in real-life conditions, a probabilistic approach is proposed as an alternative to deterministic analysis. The approach proposed is Decision Analysis, and this is exemplified by a flow diagram.

The Report does not describe in detail how to gather the basic data or to carry out practical tasks such as conducting toxicity tests or measuring water movements. To have done so would simply have duplicated material which is already available in the open literature and therefore accessible to those persons who will be brought in to advise or otherwise provide expert opinon on any project. The Report does, however, provide guidelines on how to utilize information to assess the overall impact of the activity on the marine environment. Guidance is provided on those procedures wich are most likely to ensure that the activity can be contained within the capacity of the marine environment to receive wastes without causing unacceptable effects.

The methodology of assessment of the Environmental Capacity is based on scientific research and resulting data. It is, by definition, site- and contaminant-specific. It is accomplished in stages, the preliminary assessment can be accomplished using approximations such as single-box and simple mass-balance models, and by averaging over larger time scales on the assumption of steady-state conditions. As more data become available and transport and modification processes become better understood, more accurate values of Environmental Capacity will be obtained. These can then be used in environmentally compatible development planning and project implementation. The need for monitoring and iterative assessment is emphasized as an essential component of the procedure proposed, both as a safeguard against errors and as a means of fine tuning the controls so as to be less conservative and make them fit the precise conditions of each situation.

The strategy based on the concept of Environmental Capacity is presented as a high order interactive environmental management technique. The traditionally used complex strategy based on environmental quality objectives, or the simple but readily enforceable strategies such as those based on uniform emission standards, maximum allowable concentrations in effluents, the black/grey lists of contaminants or the application of the principles of best available technology or best practical means available, are shown to be but simple components of the adaptive, interactive strategy proposed.

The examples given in the final section illustrate how the concepts and premisses are put into practice and how the guidelines can be applied.

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# 1. INTRODUCTION

Environmental management consists of formulating and applying strategies by which the resources of a given ecosystem can be utilized in an efficient and sustainable manner in the context of the overall and specific socio-economic and political goals of a society. The use of the marine environment for waste disposal must only be undertaken after first conducting as rigorous an assessment as possible of the probable impact. The procedures by which this assessment is conducted should be based on a comprehensive scientific assessment of the local environment as well as on forecasting the potential effects that an activity might impose on that environment and human well-being dependent on it.

Recognizing the importance of social, economic and political considerations in the ultimate policy decisions, this document has been restricted as far as practicable to a description of an approach to a comprehensive scientific assessment in which 'hard' scientific data on local conditions are often limited. Because the criteria used in the scientific assessment must make reference to, and in many cases will change in response to, larger social decisions about the relative value of various amenities and uses, the report touches on how the scientific assessment process can be placed within the context of a generalized, illustrative, social evaluation process. To this end, the document describes the application of probabilistic analysis in decision-making.

The process by which the final decision is taken often centres on a document known by different names - Environmental Impact Report, Environmental Impact Assessment, Environmental Impact Statement. These documents contain the results of wide-ranging investigations. Input is required from economists, social scientists, engineers, scientists and other specialists.

The type of assessment undertaken in environmental impact assessment can follow one of two approaches:

(1) To make a 'deterministic' assessment of permissible effluent or water quality standards based on relatively simple techniques and applying empirical safety factors, and making conservative assumptions where uncertainties exist (Section 3.2).

(2) To perform a probabilistic assessment of the Environmental Capacity for the contaminant, based on the techniques described in Section 3.4. This permits an explicit weighing of risks associated with each effluent standard.

There can be many reasons for adopting one or other approach, but the planners should be aware that the choice between them should be a conscious step in the management process. The second approach is preferable when costs and risks can be explicitly balanced.

The assessment process may be enhanced by ranking options in social preference so that the appropriate research priorities for scientists are clear. It is essential that monitoring is undertaken as a follow up of the initial assessments, once the project has been implemented, in order to permit the accuracy of the assessment to be checked and correction made if necessary.

There is no methodology of assessment, which in itself would remove the requirement for difficult and often controversial decisions. The process of impact assessment serves to clarify objectives, quantifying potential impacts and risks, helps identify the opportunities for reducing undesirable consequences and assists in the decision-making process by systematizing information. The Environmental Impact Assessment process involves more than scientific considerations, and consequently is beyond the terms of reference of GESAMP, in that it considers political, economic and social, as well as scientific components.

Scientific input to the process of environmental impact assessment may be required, first when the scope of the investigations is being determined, secondly in the specific investigations required to provide the necessary data and, finally, in direct advice to decision-makers in interpreting scientific data and in allaying public concern. Further scientific input is required as follow-up action such as monitoring and review.

The wastes of society can be placed on land, in the atmosphere or in the water. It seems only reasonable to consider the comparative consequences of disposal in each of these receiving environments and to choose between them on the basis of scientific, technical, economic and social grounds. While GESAMP's brief is limited to the marine environment, other disposal options cannot be ignored.

The disposal of wastes in the marine environment, even those produced by the best available technologies and after extensive treatment, may have an impact on the marine ecosystem and resources, human health, amenities and other legitimate uses of the marine environment.

Identifying and assessing such potential impacts in view of the characteristics of the wastes and of the receiving environment, as well as available waste management options, is basically a scientific exercise requiring close harmonization with other aspects of environmental management.

The scientific concepts and methodologies discussed in the following sections and the guidelines put foward are intended for the scientific assessment of the impacts produced or expected by the disposal of wastes in the marine environments.

## 2. PREMISSES, CONCEPTS AND DEFINITIONS

The basic premisses for this document are that:

(1) a certain level of any contaminant will not produce any unacceptable effect on the marine environment or its various uses;

(2) the environment consequently has a finite capacity to accommodate wastes;

(3) such capacity can be quantified.

The last of these may prove difficult to achieve in practice but in principle is always possible.

### 2.1 Acceptability of Impact

Acceptability of impact is a subjective judgement often reflected in water quality standards and objectives which are set nationally or internationally within the political process. However, acceptability can be determined from a more scientific perspective, based on the GESAMP definition of pollution. According to this definition, any discharge which does not cause pollution would be deemed as acceptable from the scientific point of view.

The concentration (level) of a substance (or waste) at which deleterious effects on one of the various components of the ecosystem or uses of the marine environment occur may be defined through toxicological, epidemiological or other studies.

In some cases, that concentration (level) may be based on the acceptability or risk of exceeding the point at which deleterious effects actually occur.

### 2.2 Environmental Capacity