ECO-information in European ports
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<u>WORK PACKAGE 9 *(WP9)*:</u>

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CREOCEAN

METHODOLOGICAL GUIDE FOR MONITORING AND MANAGEMENT OF ENVIRONMENTAL ASPECTS IN PORT AREAS

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co-ordinated by ANPA

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WORK PACKAGE 9

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Introduction to the environmental problems in ports

1 COASTAL SUSTAINABILITY

The aim of this guide is the definition of a methodology that drive the managers of port activities towards the sustainability, stressing the respect to the environment. Three basic principles forged by the United Nation Conference on Environment and Development (UNCED, 1992) can be used to join this aim and structure the methodological process:

i) Ecosystem components and functions protection (i.e. environmental objectives);
ii) Social equity as a characteristic of our and future generations (i.e. social objectives);
iii) Economical efficiency (i.e. economics objectives).

Sustainable development means to apply those principles in a management level (figure 1). **Integrated coastal management** is regarded by Chapter 17 of Agenda 21 (UNCED, 1992) as the basic tool to pursue the sustainable development of coastal areas. Making a Coastal Management Plan means to understand the coastal system. The basic idea which sustain this approach is that management is concerned with coastal system composed by one ecosystem (or a set of contiguous ecosystems) and a human community. This bi-modular system must be studied and managed only according to an integrated approach (Vallega, 1992; Vallega, 1993).

The Coastal Management Plan (figure 2) guidelines are:

a) Clearly show the possible conflicts between different uses in coastal areas.
b) Investigate all the potential sources of environmental impact; refer an impact to become significant if uncontrollable; define the control strategy.
c) Define the permitted activities in different areas.
d) Zoning the coastal area according to possible uses.
e) Decide the incentives for green activities and sustainable industries.
f) Make an environmental impact assessment (plan assessment) to evaluate the impacts on the long-term sustainability of the plan. In this phase, the public participation to the assessment processes is fundamental.

Practical methods for a ***Coastal Management Plan:***

i) Determining the dynamic interaction between human society and ecosystems.
ii) Understanding the biophysical limits for human exploitation of natural processes.
iii) Improving energy and economic performance.
iv) Adopting different methods of market regulation.

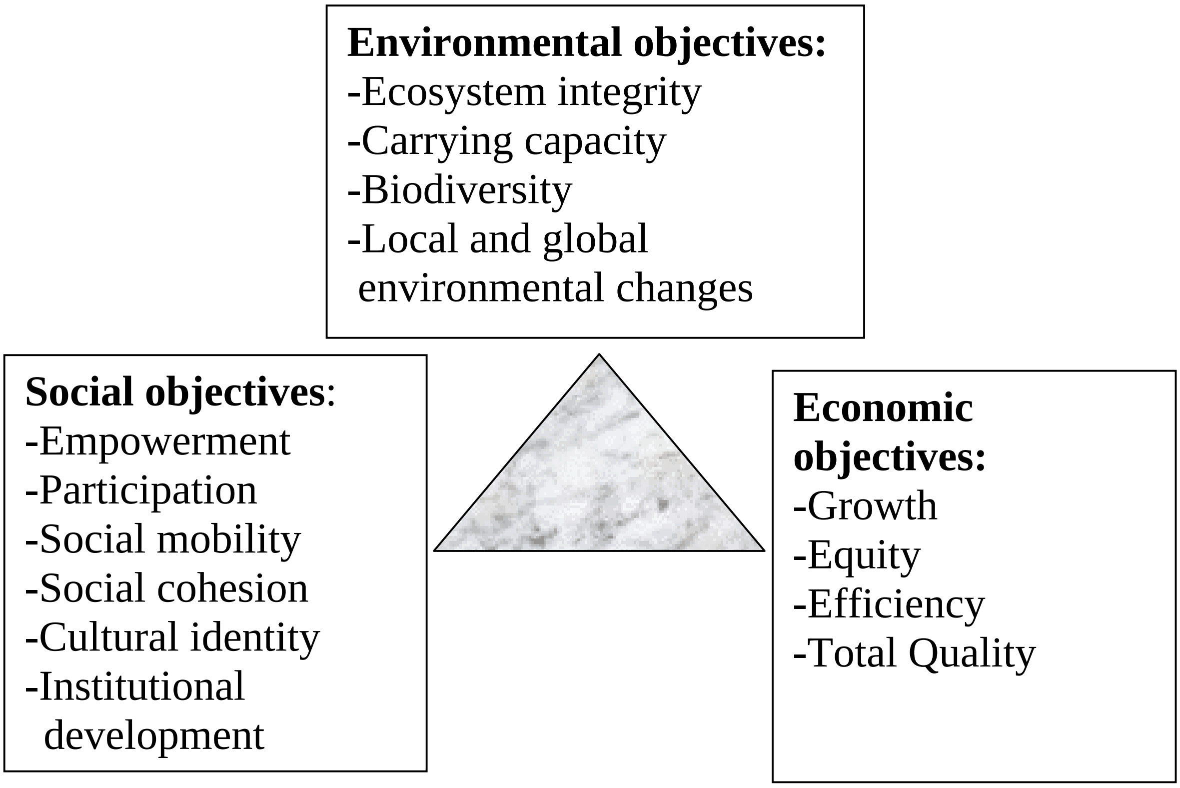

Figure 1. Compare of social, economical, environmental objectives for sustainable development (modified from Seralgedin, 1993)

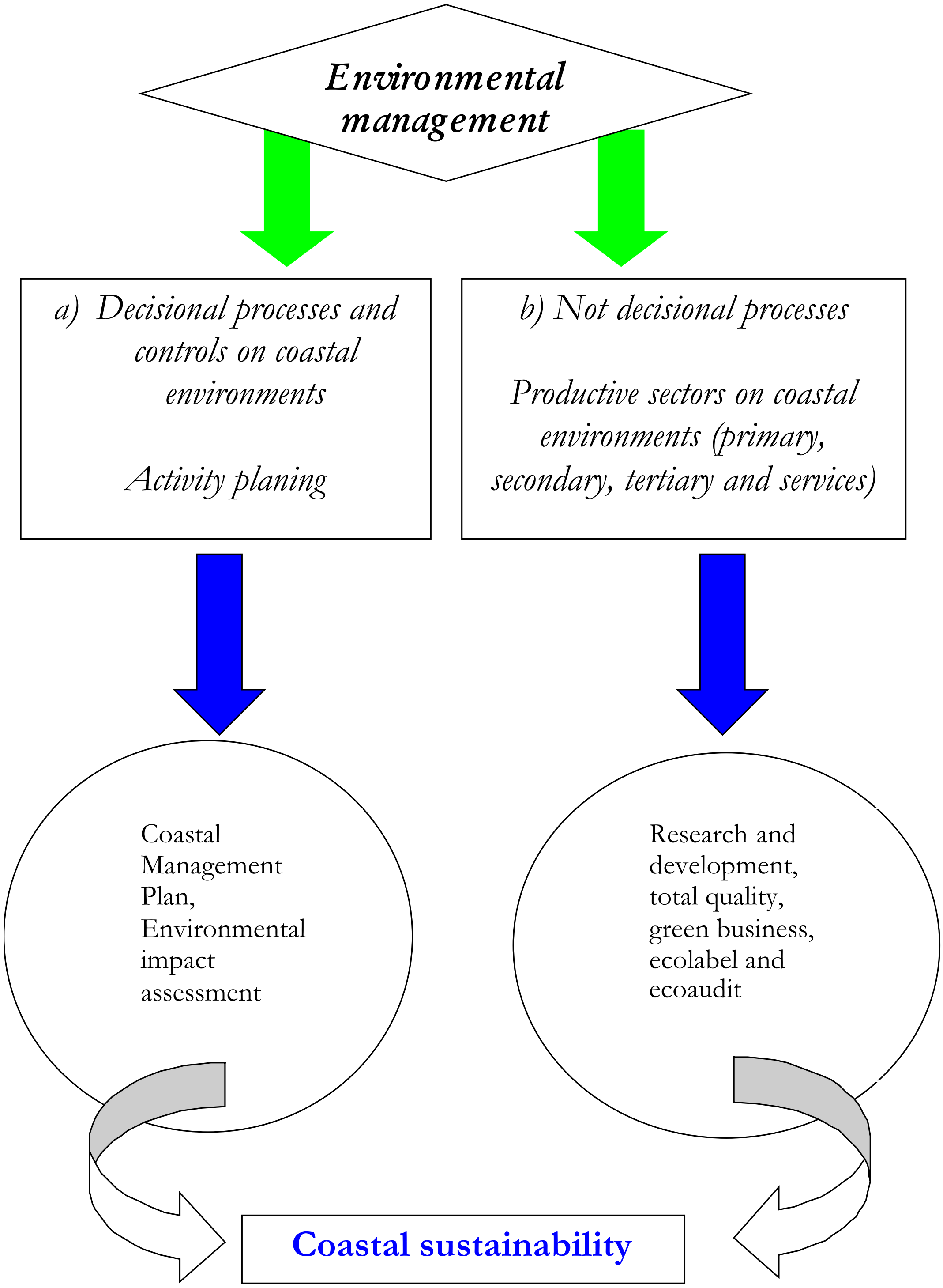

Figure 2. The path for coastal sustainability

Sustainable coastal management is achievable through

balanced linking of industrial activities to ecosystem preservation.

Marine industries have considerable impacts on the coastal environment as well as having the potential to act as its custodian.
In this case the Sciences are called to play a fundamental role in education, training and research for business, aimed to ecosystem safeguard and understanding.

Starting from this principle a methodological document was studied to guide portuary actors for improving the Port environment management.

2 PORT SUSTAINABILITY AND MANAGEMENT

A Port can produce a high environmental impact, involving both the facilities inside the harbour line, and outside the wharves and other structures (peri-portual sea in the coastal zone).The impact in both cases is quite different according to the variety of the sensitivity of the components to be affected. Indeed:

- Harbour in the town, i.e. city port structures; can have effects in the area composed from the urban waterfront (port, city, industry); activities can have particular social effect, i.e. damages on public health.
- Harbour outside of the town, i.e. port structures can have environmental effects on the wide surrounding environment.

Each of both categories of ports can be classified in four functional types (Fondazione Agnelli, 1990):

1. Commercial ports.
2. Industrial ports.
3. Mixed activity (commercial and industrial) ports.
4. Marinas.

The commercial ports impact comes from three different factors (Fondazione Agnelli, 1990) due to:

- the kind of goods shipped (bulk materials, liquid materials, containers);
- the kind of cargo ship and terrestrial vectors involved in transport;
- the kind of harbour facilities.

The industrial and the mixed activity ports impact come from both the harbour activities and from the industrial activities.
The marinas have a lower impact, restricted normally on organic marine pollution in the harbour waters.
The Port management after *United Nations Conference on Environment and Development* (UNCED, 1992) must be involved in the sustainable development models (Vallega, 1993).
This guide here proposed is the first steps in this direction. It allows an integrated approach for the port management taking into account every situation due to the city port relationships, in terms of health protection people, of protection of the waters, the soil and the atmosphere.

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Methodology

1 INTRODUCTION TO THE METHODOLOGY

A Port, through its activities can produce a more or less high impact on the environment where it is settled. A code of good practice is then requested to limit or avoid this impact. This kind of behaviour must be applied with respect to the wished port sustainability and management. Moreover, to perform this action, it is necessary to adopt a global approach taking into account the Port **integrated** in its entire environmental context.

The impact can bear various forms, apart its intensity, according to the general configuration of the Port in the environment and the intrinsic features of the activities developed in such area. With regards to these factors, impact processes can be displayed as follows (figure 1):

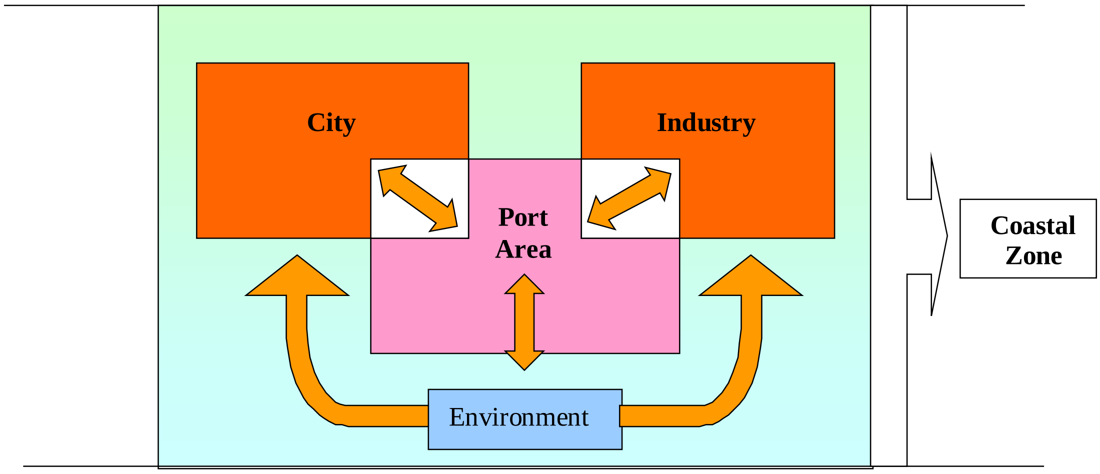


Figure 1. Various impacts in Port areas

Regarding the configuration, the location or the port and its associated activities is important in relation with the distance of urban areas. In deed, if Port structures are close or remote to cities, the impact mode will be rather social (related to public health) or environmental (related to natural resources), economic impact being valid in both cases.

Regarding the features, several types of Ports can be distinguished (Fondazione Agnelli, 1990) on a functional point of view:

- commercial ports;
- industrial ports;
- mixed ports (commercial and industrial);
- marinas.

Consequently, the ports impacts will be shaded by these feature according to:

- the kind of goods shipped (bulk materials, liquid materials, containers);
- the kind of cargo ship and terrestrial vectors involved in transport;
- the kind of harbour facilities.

In the case of industrial and the mixed ports, impact come from both the harbour activities and from the industrial activities. Their influence on the environment is then pronounced and need a particular analysis. This must be tackled on two levels, a global one and a specific another one.

The aim of this guide is to propose the global approach of such problems in Port areas, the specific approach being taking into account the worksheets.

Methodological approaches

This guide is the section providing a methodology to deal with environmental monitoring and assessment in the framework of the port areas management.

The guide should help people facing for the first time with environmental problems occurring globally in port area. If somebody has to deal with a « technical » problem related to the impact of an industrial activity as "painting" or with a "dredging" problem, he can use directly the specific worksheet which describe accurately such activities present in the port area.

A good interrelation exists then between the methodology and the worksheets (figure 2). Worksheets are coherent with the methodology and vice versa, regarding their respective and crossed structures.

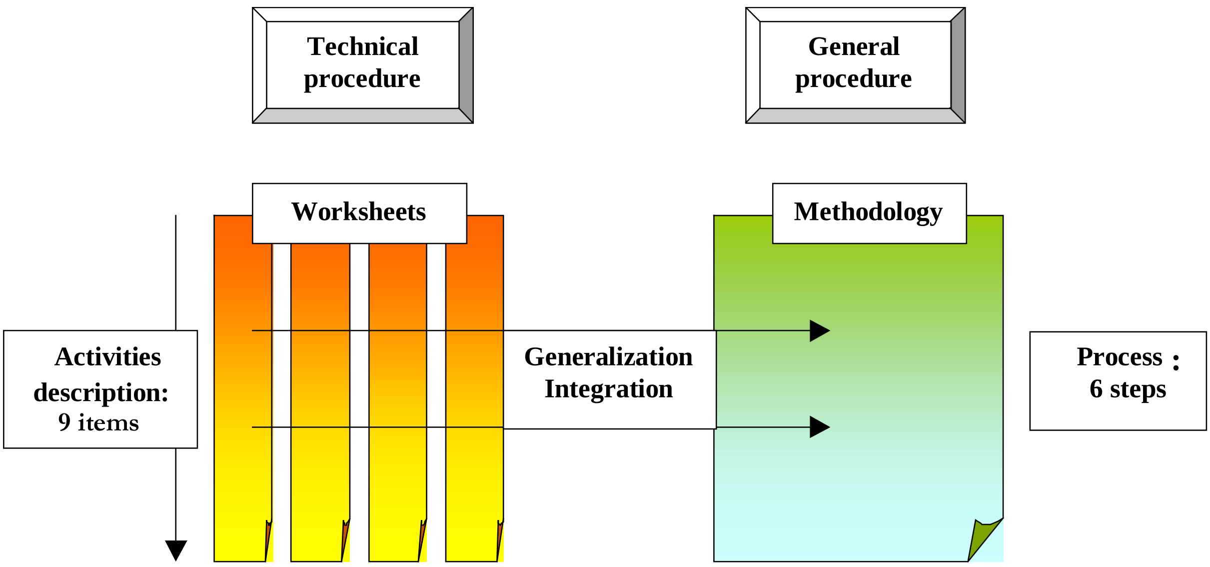


Figure 2. The crossed structures of the worksheets and the methodology

Each worksheet analyses industrial activities through 9 items, as follows:

1. *description of the activity*
- situation of the activity
- activity presentation
- laws

2. *pollution sources*
- sites of discharge
- nature and characteristics of the sewage

3. consequences
- effects on the environment
- impacts on the environment

4. *monitoring*
- how to plan environmental controls on the activity
- how to plan environmental controls in the environment

5. *monitoring costs*

6. *definition of indicators*
- assessment and evaluation of monitoring results

7. *principles and guidelines for improvement*
- environmental monitoring
- information management
- technological innovation

8. *analysis of training needs*

9. *public communication*

Each worksheet covers individually the environmental aspects involving problems that the corresponding activity can produce. In the methodology, a global and synthetic presentation of these environmental aspects is performed, thanks to the principle of generalisation and integration of information to the entire port area.
This environmental concern takes part in a complete process described in the methodology. The description of such process is achieved here after.

2 THE METHODOLOGY

The general procedure which constitute the methodology is structured along a step by step process. This architecture composed of 6 steps is the central body of the guide that port managers have to follow in order to tackle environmental concern in port areas. The help brought by such methodology represents the upstream actions to achieve before the establishment of any management plan.
The clearing of each step demands particular attention on specific topics. They are presented in the following figure (figure 3). The analyse of these topics needs the collection of information in numerous domains. The type of the requested information is materialised in “**information sheets**” (*reference elements*) which help to the search and the collect of it. According to the site to be treated, local information (*local elements*) will be used to customise such case study. At the beginning of the project, the conception of the methodology have been based on the Marseille case study in order to draw from it a general methodology justified by a standardisation of the process.
In the following, each step is described in the frame of the information sheets.

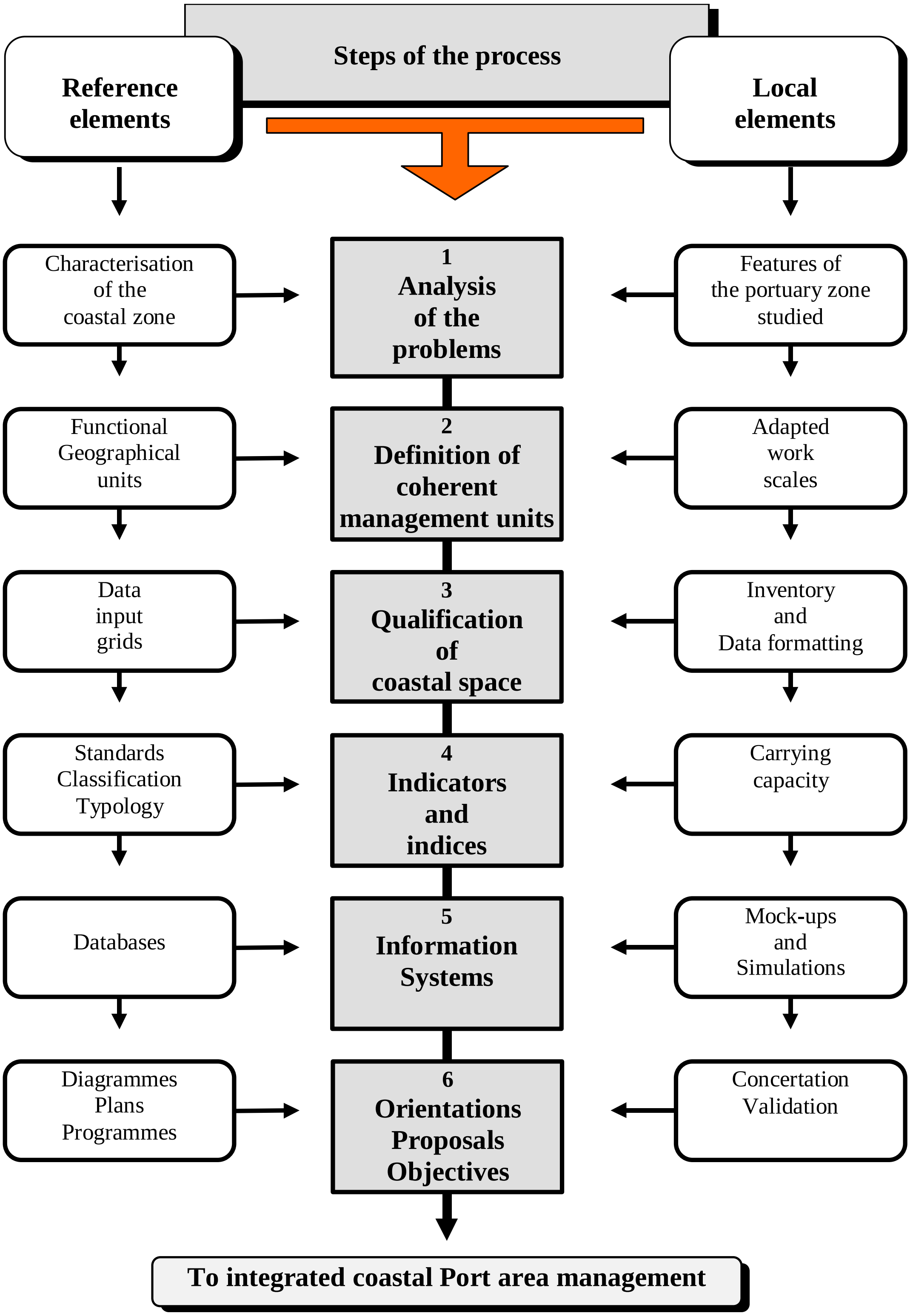
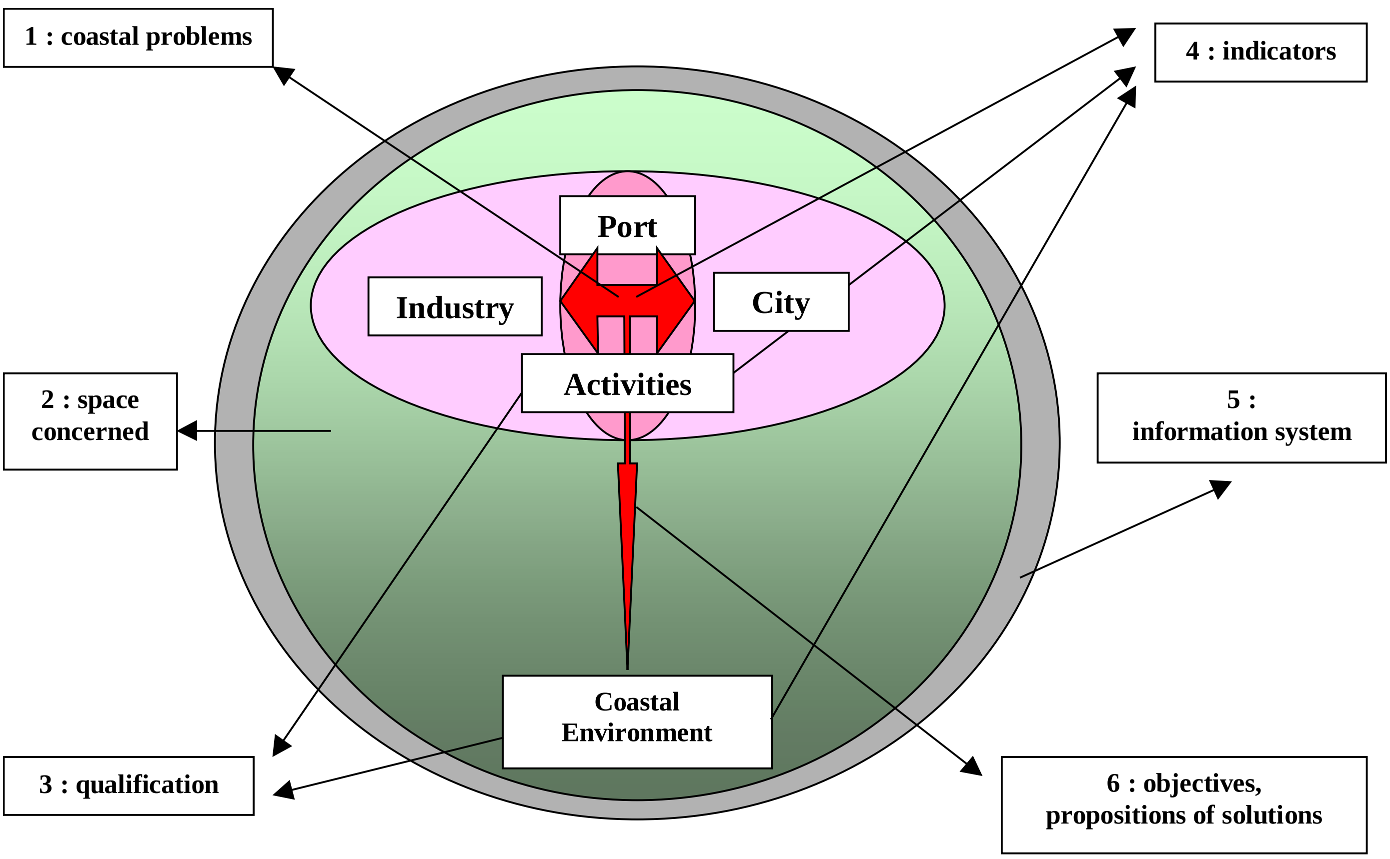


Figure 3. General diagram of the methodology

Guidance:

1. The coastal problems come from relations between human activities related to port development and the environment of the port area.
2. A delimited space is concerned by such activities and problems, it has been defined.
3. The port area must be characterised in the delimited space according its various features.
4. Tools are needed to give indications on the port situation, regarding the activities, the environment and their relations (pressure, state, impact, response).
5. The whole useful environmental information must by managed by a dedicated system.
6. The good understanding of the situation and information use gives decision elements as objectives and propositions of solutions.



The usage of the information sheets allows to analyse local environmental situation in the Port area towards a better management of the relations between Port/Industry and Port/City with the Environment.

These information sheets will take the place of specifications dedicated to any other Port application.

Sheet 1: Analysis of the problems

In any Port area, environmental components, as natural and human ones, are present and closely fit in each other.
This environmental context must be defined through its physical, biological and socio-economic features according to referenced descriptions or typologies:

- the **general configuration** implies to have a wide vision of the whole environment in which the Port area is included. It must describe it through its characteristic forms which will give geographic references, as deltas, estuaries, lagoons, ponds, etc.

- the **physical features** is essentially determined by the geomorphology of the coast, the hinterland and the sea bed. The shape of the coastline (open to closed, straight or uneven) must be taking into account because it conditions quiet much the waters dynamism and pollution distribution.

- The **biological features** concern every living resource as fauna and flora species or communities. The structure and the functioning of specific ecosystems or habitats is useful for the global environmental knowledge of the Port area. Moreover, this knowledge will help the evaluation of the sensitivity of such environment towards various pollutant inputs.

- The **socio-economic features** must cover the whole scope of the activities present in the port area, those which are directly concerned by the port (traffic, port facilities) and the others which are developed with regard to urban settings up and other economic activities in the port area (fishery or marine cultures, tourism, etc.).

- The **actors**: the inventory and the roles of each actor category is essential to analyse in order to understand the functioning and the management of the Port itself and of the Port area. In deed, it is necessary to know who decide by which process, who control regarding the legal standards (security, environment, etc.), who study the environment, who use or who work in the area, etc. This analyse of such processes taking into account all the actors categories (port managers, administrations, professionals, scientists and experts, public) will help later the decisions making thanks to a good knowledge of the active actors in the management of the port area.

- The **regulations**: the main laws in effect on the port area must be known, through their application domain (discharges, protection, uses, etc.), scale (international to local), geographic cover (limits). This context will define the legal level of the responses dedicated to the preservation of the port environment.

- The **environmental problems**: according to the general situation implementing environment and activities, the main risks of disturbance can be evaluate. Three categories of consequent problems can be range, as:

1. Problems generated by the direct effects of anthropogenic activities on the environment;
2. Problems generated by the effects of natural phenomena (floods, erosion, etc.) on human settlements or activities;
3. Problems generated by the interaction of the multiple activities in the coastal area.

The first category concerns essentially chronic and accidental pollution induced by regular domestic or industrials process permanently or in case of emergency by a default or wrong functioning of any activity (industrial facility, maritime traffic, etc.).
The second one must be into account because it can cause important impacts and consequences in the social and economic domains with regard to the public health and protection and productive activities.
The third one is directly linked with management concerns. In deed, in case of conflicting spatial occupations; contradictory uses of the space and eventually discordant regulations, needs of management are very high. The TABLE here after presents the hierarchy in the potential conflicts and interactions met between the activities which may occur in port areas.

- The **management problems**: according to the difficulties described above, they are essentially due to the respect of the environmental quality. Coherent uses of the environment must be established in order to preserve any activity regarding the environmental quality. To help this analysis and diagnostic at this step, the recourse and the link with the **ENVIRONMENTAL AUTODIAGNOSTIC QUESTIONNAIRE** will be of high interest.

<table>
<tr><th colspan="6">Sheet 1: Analysis of the problems</th></tr>
<tr><td colspan="2">General configuration
General situation and configuration of the global port area.</td><td colspan="2">Biophysical features
Types of coastline, sea bed, living resources, specific ecosystems.</td><td colspan="2">Socio-economic features
Most important activities and uses of the coastal port area.</td></tr>
<tr><td colspan="3">The actors
- the port authorities: studies, pollution response, environmental service, management.
- other professionals: fishery and marine culture, tourism.
- administrations and governmental services: Maritime administration, water Agency, Industrial Agency.
- scientists and coastal experts : University, specialised institutes.
- associations and public: ecological associations.</td><td colspan="3">The regulations
- International: Barcelone 1976, Mediterranean Protection Convention 1978, MARPOL 73-78.
- European: Directives (discharges, sewage, etc.).
- National: Water law, Coast law, etc.
- Local: maritime concessions (shell fishes), Port Authority area, Ecological areas.</td></tr>
<tr><td colspan="3">The environmental problems

Direct and chronic or accidental effects of the activities on the environment:
- from industrial activities: chemical pollution (heavy metals, hydrocarbons, organic contaminants), waste disposal, marine resources loses, habitats disappearing, biodiversity decreasing.
- from maritime traffic: oil spilling, chemicals spilling, solid waste.

LINK WITH THE ENVIRONMENTAL AUTODIAGNOSTIC QUESTIONNAIRE</td><td colspan="3">The management problems

- Interactions between activities, space occupations, uses conflicts.

SEE FOLLOWING TABLE
(as example)</td></tr>
</table>

Activities interactions

Summary table

Interact on	traffic	dredging	industry	urbanisation	tourism	aquaculture	fishery
traffic	/	+	+	+	+	-	-
dredging	-	/	-	**0**	**0**	-	-
industry	+	+	/	+	**0**	**0**	+
urbanisation	+	**0**	-	/	+	+	+
tourism	+	-	-	+/-	/	+	+
aquaculture	-	-	-	+/-	+	/	+/-
fishery	-	-	+/-	+/-	+	+/-	/

Legend:

+: positive interaction, assist industry activities
-: negative interaction, disturb industry activities
+/-: no particular interactivity
0: no object

Sheet 2: Zoning of the concerned area

The delimitation of the coastal territory where environmental problems are identified in the port area is of high concern. This task is necessary to achieve as soon as possible in the management process in order to give a spatial frame and an information structure to the management preparedness actions. Moreover from this step, the zoning operation will precise the best scale to approach environmental problems and to propose also a coherent area where coastal actors are really concerned by the problems and their management.

The environmental and management zoning must take into account the global space which is under influence of the port activities. This is a global level in which the restricted port zone is included (local zoning).
The elaboration of such zoning begin by the analyse of the various existing zonings in the port area. Several zoning objectives exist at both levels and can be applied, as administrative and economic ones, and environmental other ones.

- At the local level, various zonings are defined by regulations (administrative and economic) or knowledge (environmental).
- At the global level, some ones exist but generally less than the local level especially regarding zonings dedicated to management objectives. This zoning level is the most important with regards to the environmental management. The global influence on sea side of the activities must be approached by the integration of the individual influences of each activity, each of them **described in the corresponding worksheets**. The external limit will be drawn from this information base crossed by dynamical data.

Some time, such management zoning can exist. It can be then adopted responding directly the need. Such zoning takes into account a land area which is first the restricted port area completed by administrative entities as communes which bring some influence on the quality of the port area.

Sheet 2: Zoning of the concerned area

Search of a coherent coastal territory regarding an integrated management.
Zoning defined according to the specific objective oriented on the environmental quality of the port area.

Local zoning:	**Global zoning:**
Administrative zoning: - regulating activities and uses (concessions); - port competence and authority area; - protected areas; - healthy areas; - sewage areas. *Economic zoning:* - activities or uses limits. N*atural zoning:* - ecological units; - particular habitats.	*Economic zoning:* - geographical extension of maritime activities; - economic exclusive area. *Administrative zoning:* - communal authority limits; - master plan zoning. *Environmental zoning:* - maximal marine influence of port and industrial activities; - monitored areas. **REFER TO WORKSHEETS (§ 4)**

Reference zoning for management:
If existing (master plan, or other planning actions).

Sheet 3: Parameters for the qualification of the defined zone

The aim of this step is to characterise and qualify the delimited space. It will be achieved from a complete inventory on the necessary and useful information requested for environmental management, followed by the collect of the whole set of data. A “check-list” of parameters to be informed by data is proposed in order to cover the main components of the environment, natural and human ones. They are organised under bio-physical and anthropogenic criteria. Without any pretence as to its comprehensiveness and by way of example, a certain number of parameters have been grouped together in **grids** to provide an evaluation of these different criteria. The interest of these grids is that they enable data associated with each of these parameters to be examined, with a view to their subsequent acquisition and restitution in coded form (step after). The level of precision of the data should be adapted to the working scale. The average level of precision should enable the majority of environments to be described adequately.

These grids are showed here after:

- Physical criterion: it brings together several series of parameters (grid 1) among which may be found those which are descriptive in nature and those which are dynamic, that is to say which designate the factors of the possible evolution of the environment.

- Biological criterion: it gathers the main parameters indicative of the level of the environment (grid 2). The priority themes touches on the notion of biodiversity, recognised as being the most reliable indicator of the complexity of the expression of the productivity. Care should therefore be taken to ensure that zones qualified being particularly sensitive are not neglected, whether they concern terrestrial or marine fauna or flora on the coastal zone (original spaces containing rare species, biotopes propitious for the survival of a species otherwise under threat, etc.). From a legal point of view, the existence of one or several statutory forms of protection for a same zone may be an indication of its high ecological value which should be taken into account in the later typological analysis.

- Socio-economic criteria: two types of criteria are used. The “human activity” criterion brings together the main parameters indicative of the level of anthropogenic pressure (grid 3). Account is taken of the way in which man is implanted and interacts with his surroundings. In terms of the space he occupies and how he uses it. The “environmental status” criterion brings together the main parameters indicative of disturbances or impacts on the environment which are both natural and human (grids 4a and 4b). The impacts on the environment are more or less measurable, the exercise becomes more difficult as soon as the human environment is involved, that is to say the socio-economic domain. The corresponding descriptive parameters are still rarely or badly defined.

The collected data can present various forms as qualitative ones codified by presence/absence and quantitative ones, measured.

Among the various coastal activities, particular attention is put on the industrial domain, seeing that the objectives of the guide are focused on the impact of industry in ports. Referring to the worksheets, a set of selected activities is then completely described.

GRID 1

Criterion	Themes	Parameters
Physical criterion	Geomorphology	Geometry Type of coast Nature of coast
	Coastal oceanography	Swell Tide Currents Sedimentary dynamics General parameters
	Coastal climatology	Winds Precipitation's General parameters
	Hydrography	Catchment area Sedimentology input
	Surface hydrology	Fluvial volumes Hydric status Zoning Hydrodynamic parameters
	Pedology	Soil typology
	Hydrogeology	Reserves Flows Hydrochemistry
	Geochemistry	Mineral elements

GRID 2

Criterion	Themes	Parameters
Biological criterion	Biological wealth	Nutrients Chlorophyll Biomass Productivity
	Sites of reproduction	Hatcheries Nurseries Feeding areas Interchange zones Nidification
	Living resources	Diversity Abundance
	Biodiversity	Specific areas Notworthly areas Protected areas

GRID 3

Criterion	Themes	Parameters
Human activity criterion	Population	Residents Temporary Employment
	Developments	Communication channels Infrastructures
	Uses	Urbanisation Industry Tourism Health Fishing Marine culture Agriculture
	Management	Landscape Cultural Property

GRID 4a

<table>
<tr><th>Criterion</th><th>Sub-criterion</th><th>Themes</th><th>Parameters</th></tr>
<tr><td rowspan="5">Environmental status criterion</td><td rowspan="4">Natural environment</td><td>Inputs</td><td>Terrestrial
Hydrosystems
Atmosphere
Open sea
Urban and industrial waste discharges</td></tr>
<tr><td>Monitoring</td><td>General parameters
Chemical parameters
Microbiological parameters
Phytoplanctonic parameters
Radioelements
Pathogenic elements
Biological indicators</td></tr>
<tr><td>Events</td><td>Vegetal and animal proliferations
Shipwrecks</td></tr>
<tr><td>Developments</td><td>Coastline occupied
Over frequentation</td></tr>
<tr><td>Human environment</td><td colspan="2">See GRID 4b</td></tr>
</table>

GRID 4b

Criterion	Sub-criterion	Themes	Parameters
Environmental status criterion	**Natural environment**	See GRID 4a	
	Human environment	Heritage	Landscape Cultural Property
		Conflicts	Occupancy of space Uses Regulation
		Activities	Health Fishing Tourism

Sheet 3: Parameters for the qualification of the defined zone

Qualification defined from 4 criteria, characterised by several parameters, informed by various types of data.

Parameters of the physical criterion and types of data	**Parameters of the biological criterion and types of data**
Nature of coast and seabed substrate. Type of coastline (low, relief, free water surfaces). Climatology, meteorology. Coastal currents. Clear water inflows. Hydrology.	Wetlands features (fauna and flora species or communities). Ecological areas (referenced classification). Specific ecosystems (posidonia). Marine resources (fishes, shells, etc.). Breeding and growing areas.
Parameters of the socio-economic criterion and types of data	**Parameters of the environmental state criterion and types of data**
Port activities: maritime and terrestrial traffic, settlements. *Industrial activities*: plants, types of activities (oil, chemicals, ores, etc.). Usage activities: urbanisation, tourism, fishery, heritage management (protected areas).	Monitoring: various parameters (chemical, microbiological, photoplanctonical, etc.). Algae blooms. Solid wastes. Any other unexpected events.

Particular industrial activities in the port area:
REFERENCE TO THE WORKSHEETS AND THE DESCRIPTION INDEX

Oil storage
Dredging
Industrial polluted water
Ore dry bulk
Cleaning activity
Deballasting treatment
Port planning and development

Sheet 4: Building of indicators specifying the environmental situation

In any sustainable environmental management plan, the difference between the real environmental status and an ideal reference status, should firstly be measured so as to provide a target situation. The reference status represents a notion which may result from the application of existing regulations or the achievement of the objectives to be met.

To characterise the status of any environment, natural or human, observations and measurements are necessary to supply an objective system of information and evaluation (step 3). These parameters defined according to the problems encountered, bring to light indicators in relation to the expertise of the community of actors. As a result of the complexity of the environment, the expression of the phenomena present requires recourse to a limited choice of specific indicators (levels of nitrates, mercury or lead, etc., the presence of species of bird, diversity of the flora, etc.) or more global indicator which, in the form of indices, incorporate a range of information. What is most important here is that a trend is defined than a precise situation.

This stage consist then in transforming the data in information in order to allow:
- The transfer of the criteria and parameters in indicators to establish a reference state;
- The transformation of the indicators into indices so as to range the criteria;
- The comparison of the indices to classify the environmental status.

The operation consist in codification the raw data and integration into synthesised form of information.

The role of the indicators is fundamental for the messages to be able to pass to the decision-making or public levels. They satisfy the need for synthetic information for purposes of comprehension, communication, evaluation and finally for decision making. The information sought in the context of the management of a territory concerns the dynamics and interactivity existing within the “eco-sociosystem”. It is necessary at this stage to be able to measure and evaluate the pressure brought to bear on the environment by human activities, especially industrial ones, and the changes caused. This prepare the way for a later step (step 6) concerning the answers given to avoid or limit these impacts.

The principle of causality alone leads to the definition of a set of “pressure” (according to the stress factors as industrial activities), “status” (regarding the quality of the environment and the resources, and the impacts of the changes on the natural and human environment) and “response” (measures and actions taken in reaction to the impacts exerted on the environment) indicators.

Faced to a well-defined set of problems, the indices should highlight the status of the environment and the nature of the pressure brought on it. Knowledge of the limit values of these indices on themes such as nutrients, domestic refuse, dredging, seasonal variations, etc. establishes the notion of carrying capacity. Depending on the themes handled, it determines the range of acceptability beyond which the environment is in danger or irreversibly condemned. The analysis of the problem in step 1, particularly the analysis of the regulations status in effect, bring partly the knowledge of some limits as standards. But, the real carrying capacity of a zone is more difficult to assess because it depends on the dynamic combination of various factors.

Indicators and indices conception and building represents a major task but a very difficult one to succeed. It depends on a very close co-operation between the decisional and expert actors of the port area.

Sheet 4: Building of indicators specifying the environmental situation

Scheme : Driving forces → Pressure → State → Impact

Response

Indicators built for each environmental problems. Ex: heavy metals.

Pressure: Examples: - Total load T/year; - Number of dredging operations / year; - Quantity of dredged sediment.	**State:** Examples: Concentration in the sediment and in living organisms: - vegetal / posidonia; - animal / mussels; - networks results: chemical, biological, phytoplancton, parameters.
Impact : Examples: Change in ecosystem structure: Ex : posidonia, benthic macrofauna. Change in ecosystem function: Ex : number of day of shell marketing stop.	**Response:** Examples: - Gap variation between norms and results; - New environmental monitoring points; - Enforcement of norms/number of controls.

Sheet 5: Structural and functional elements of an information system as a support for decision making

The optimal and durable management of the information necessary for decision-making requires adapted tools as Geographic Information Systems (GIS). The formalisation of such tools must be achieved at the latest at this step because the real need of information exploitation for management occurs here in the process preparing the decision making (step 6). That doesn't mean that the development of this tool must not be started before. On the contrary, its conception begins as soon as the port area (included in the management unit) is delimited (step 2) and the data collected (step 3). Spatial data must be defined and integrated in priority, completed as will by descriptive data attached to the first ones.

The current functions encountered in GIS are:

- the acquisition of spatial and thematic data composing a base of geographical information;
- the archival storage of information in the form of rapidly accessible thematic covers;
- the analysis of data using spatial parameters and operators which provide original information;
- the display and representation of the results obtained in various forms (tables, reports, maps and on-screen consultation).

An operational information system dedicated to the environmental management has to assume the organisation and the consistent formatting of the basic data. It should be able to give an account of the environmental situations encountered offering a synoptic displaying of relevant information (role of the indicators and indices elaborated in step 4).

Such a tool, other than a good data management of its own base (port data bases), must be able to make easier every connection with other external data bases or information producer systems (models). All the data producing systems owned by various local public or private organisations of scientific or administrative nature, should be identified so as to initiate the interfaces necessary for data interchange. This data collection task should be considered over the long term with the idea of preparing a durable information base able to supply the above mentioned management system on a permanent or regular (update) basis. Management of the information means that the data likely to correspond to the requirements of the managers be collected according to specific protocols, established in relation to the problems to be dealt with. It is within this context that the observatory function could be justified.

To best overcome the problem of developing such sophisticate tools, a mock-up phase is generally recommended. This task takes on a number of interesting aspects for the local actors seeking such a system. They may be resume as follows:

- identification of the difficulties inherent in the management of multiform information;
- initialisation of a collective reflection on the role of an information system, in particular on the relevant types of indicators;
- a precise definition of the problems to be dealt with, the types and formats of information necessary, as well as the processing required for the chosen indicators;
- a more profound study of the notion of coastal space, namely by working on the definition of the geographical management unit and the associated typology;

- implementation of a concerted collective approach (user groups, exchanges and data access mechanisms, decision making process);
- progressive establishment of a catalogue of information (metadata) on the port area (with respect to an European standard).

The performance of this kind of information management tool depends on the technical level of the components of the implemented system. First of all, the GIS software must be chosen according to the required functionalities and the available competencies. Moreover, the linking to networks as INTERNET (in addition to INTRANET generally in place) gives high advantages to the information management (thanks to efficient exchanges).

In the particular case of ports, the GIS will facilitate the management of the environmental information related to the industrial facilities as for example the monitoring (sampling stations, results, quality maps) or the integration of various impacts coming from different disturbing sources. The identification of areas of conflicts and of interest is therefore possible, thanks to the feasibility of simulations. It appears essential that such system should be connected to the ECO-INFO data base in order to have advantage of the detailed information existing on the environmental problems raised by industrial activities.

Sheet 5: Structural and functional elements of an information system as a support for decision making

Main components: Data Bases, Softwares, Networks.

The Port information system:

Data bases:

- bathymetry;
- industrial facilities (networks);
- local monitoring.

Softwares:

- port exploitation;
- traffic control;
- hydrodynamic models.

Networks:
- INTRANET

External information flows:

- meteorology;
- oil spill models;
- monitoring (institutional agencies).

Technological level:

- digital data;
- digital atlas;
- GIS software(s): information mapping (thematic or synthetic levels).

SEE EXAMPLES OF MAPS IN THE WORKSHEETS

- public network: INTERNET (WEB site).

LINK WITH THE ECO-INFO DATA BASE

Sheet 6: Formalisation of management objectives and solutions proposals

Thanks to the elements of information collected and elaborated in the previous steps, it is possible at that step to define orientations and to fix objectives for a better management of the port area. To help this task, a negotiated approach should comply the following stages:

1. *Identification of the problems to be solved in priority and analysis of the causes of these problems*: these tasks generally call upon an audit or an environmental diagnosis applied to the whole delimited port area. Operationally, it is not normally possible to consider all the problems at the same time. Choice criteria need to be determined, regarding for example the physical amplitude of a problem or the amplitude of its effects. Establishing the priorities calls as much upon negotiations as upon analysis techniques. In this way, the Self Diagnosis Method may help port managers to analyse and classify such problems.

2. *Designation of a geographical area concerned by the management plan*: all approaches are possible in the coastal space to be found at the land/sea interface. Such a space forms the frame of the future sustainable management plan.

3. *Identification of the appropriate management modes to solve these problems*: the management modes are summarised in the use of prevention techniques, but are above all linked to the behaviour of the groups and individuals concerned, whether economic actors or administrative agencies. A sustainable action plan will be based on a certain number of management mechanisms or procedures linked to development activities, to regulations, to persuasion, to incitation, to planning, to research and to monitoring of activities and their effects.

4. *Identification of the institutional arrangements and the administrative procedures necessary for the implementation of a management plan*: this point is the answer to the question “how is the set of techniques/tools to be implemented so as to achieve integrated management in port area ?”. Before making a proposal, it is important to know what already exists on which the future will be built, by asking the following questions “what management strategy is followed in such law or regulation ?”, “what are the behaviour changes aimed at in such individual or group by such management practice ?”, “what are the criteria for the attribution of licences or other types of regulatory decision ?”, “what information is used for decision-making ?, how is it gathered ?”, what are the legal, organisational and administrative conditions which prevent good management ?”.

5. *Provide feedback*: It should be remembered that this is a dynamic process which requires the consensus of all the parties involved in each point raised. There should be a close link between all actions and a repositioning of the problems in relation to the results.

Practically, on an other hand, the elaboration and formalisation of management objectives may take advantage of the methodology process by the following analysis:

- to verify the adequacy between the various regulations in effect in the port area, thanks to the geographic displaying of the spatial application of the regulations;
- to optimise the monitoring effort applied to various surveys, thanks to the possible integration (spatial and thematic) of the different monitoring actions;

- to assess the sensitivity of the port area compartments regarding various threats as chemicals, oil, bacteria, etc., thanks to the feasibility to interpret information, to codify and range it on sensitivity scales. The real environmental risks which threat the area can be assessed from the Self Diagnosis Method;
- to qualify the data managed in the information system thanks to a good definition and harmonisation of them, completed by a good coherence in their formats;
- to facilitate the exchanges of homogeneous data files and geographic information thanks to the effective implementation of a dedicated network;
- to check existing management structures thanks to the analyse of the roles of the concerned actors in the port area;
- to analyse specific industrial problems with predefined solutions, thanks to the link with the solution forms.

Finally, the implementation of the methodology takes place of an information system until the step 4. From this level, elements are available to allow decision-making. The complementary part of the methodology takes place then in a Decision Support System (figure 4).

The operationality of such a system (basically for information and decision support at an upper level) will be reached thanks to the efficient linkages with other ECO-INFO developments as the worksheets, the data base, the solution forms and the Self Diagnosis Method.

Sheet 6: Formalisation of management objectives and solutions proposals	
Regulation adequacy: Comparison of various regulations in order to expect spatial conflicts in their areas application.	**Coherent displaying of the information** : Verification of: - the data quality; - the formats of the digital data files.
Monitoring effort: Comparison of the scope of parameters and their spatial location. Displaying of gaps on spatial (new area to be monitored) or thematic (new parameters) points of view. Ex: new stations in the remote space of the coastal zone. Ex: new tools indices to improve the evaluation of the coastal quality (benthic, halieutic indices).	**Exchanges and communication of information:** Verification of: - the compatibility between softwares (GIS or others softwares as mapping, data bases management, etc.) - the carrying capacity of the networks (ex: between INTRANET and INTERNET).
Risks evaluation: Industrial, sanitary, natural. **REFERENCE TO THE SELF DIAGNOSIS METHOD**	**Existing management structures:** Organisation, policy, strategy.
Sensitive areas assessment: Identification of « sensitive »factors to lead specific interpretation of environmental information on: - physical parameters; - biological parameters; - socio-economical parameters; - Ex : proposition of sensitivity mapping.	**Solutions proposals regarding industrial problems** **REFERENCE TO THE SOLUTION FORMS**

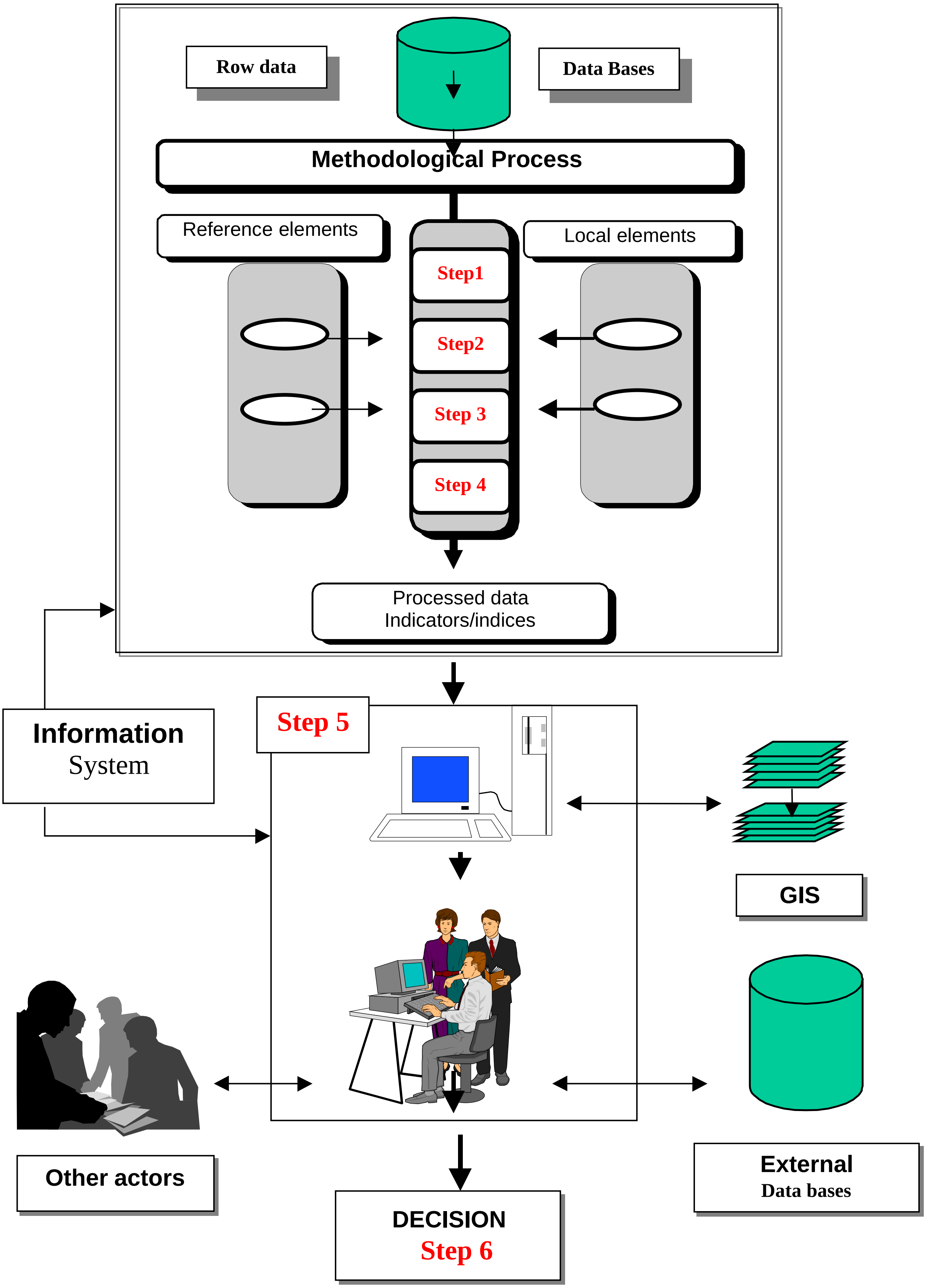


Figure 4. The integration of the methodology in the information system for decision support

Worksheets

PORT WATERS

PORT WATERS WORKSHEET

Contents *Page*

BACKGROUND

Remarks

According to EEC Directive 91/271 concerning urban waste water treatment, waste water is classified as follows:

- Domestic waste water
Means waste water from residential settlements and services which originates predominantly from the human metabolism and from household activities.

- Industrial waste water
Means any waste water which is discharged from premises used for carrying on any trade or industry, other than domestic waste water and run-off rain water.

- Urban waste water
Means domestic waste water or the mixture of domestic waste water with industrial waste water and/or run-off rain water.

1 DESCRIPTION OF THE ACTIVITY

1.1 Port activity

A consistent number of dangerous substances are discharged in port waters due to various industrial and non-industrial activities carried-out inside and outside port areas or due the release of chemical substances (paint antifouling) normally applied to boats and under water constructions to avoid the formation of phytoplankton (GESAMP Reports and Studies, 1995). These substances have a great influence on various marine species and for this reason, an extensive and constant monitoring of water pollution is required.
Port, industrial and urban activities which have the most serious impact on port waters are as follows:

- Dockyard: ship sand blasting, painting, etc.;
- Loading, unloading and storage: washing away of different materials (coal, kaolin, ferrous material, fertilisers);
- Iron and steel industry: discharging of process waters and slag unloading;
- Energy production activities: thermal pollution (FAO Food and Agriculture Organization of United Nations, 1984). An increase in temperature of only a few centigrade can cause problems for the marine environment (seaweed growth and change in the local flora and fauna);
- Percolations from solid waste disposal in dumps;
- Treatment of urban waste waters.

1.2 Legislation (European laws)

- Directive 76/160/EEC on quality of bathing water.

- Directive 76/464/EEC on pollution caused by certain dangerous substances discharged into the aquatic environment of the Community.

- Directive 82/176/EEC on limit values and quality objectives for mercury discharges by the chlor-alkali electrolysis industry.

- Directive 82/242/EEC and 243/EEC concerning the discharge of detergent.

- Directive 82/501/EEC called SEVESO I, concerns the risk of accident of some industrials activities. The Directive SEVESO II dated December 9th, 1996 n°96/82/EEC concerns the control of danger due to accident. This Directive substitute the Directive SEVESO I.

- Directive 83/513/EEC on limit values and quality objectives for cadmium discharges.

- Directive 84/156/EEC on limit values and quality objectives for mercury discharges by sectors other than the chlor-alkali electrolysis industry.

- Directive 84/491/EEC on limit values and quality objectives for discharges of hexachlorocyclohexane.

- Directive 86/280/EEC on limit values and quality objectives for discharges of certain dangerous substances included in List I of the Annex to Directive 76/464/EEC.

- Directive 88/347/EEC amending Annex II to Directive 86/280/EEC on limit values and quality objectives for discharges of certain dangerous substances included in List I of the Annex to Directive 76/464/EEC.

- Directive 90/164/EEC is there to prevent and reduce the environmental risk.

- Directive 90/415/EEC amending Annex II to Directive 86/280/EEC on limit values and quality objectives for discharges of certain dangerous substances included in list I of the Annex to Directive 76/464/EEC.

- Directive 91/271/EEC concerning urban waste-water treatment.

- Directive 91/676/EEC on water protection from nitrates pollution deriving from agricultural activities.

- Directive 96/61/EEC on Integrated Prevention Pollution and Control "IPPC" dated September 24th, 1996 permits the survey of the industrial polluted water.

2 POLLUTION SOURCES (CONCERNED SUBSTANCES AND BY PRODUCTS)

Products from single industrial activities are mixed with domestic waste waters (United Nations, 1980) which mainly contain organic material and phosphorus compounds from detergents. The high organic concentration in waste waters help the proliferation of a large number of bacteria. Apart from coliforms and streptococci, other dangerous toxins produced by some algae can be found, particularly in the case of water eutrophication. Other than the usual polluting elements, floating solids, smells and a large amount of sedimentary material can be found in port waters. Table 1 show main polluting substances and organisms that can be found in port waters.

Table 1: Main polluting substances and organisms in port waters

ORGANIC COMPOUNDS	Hydrocarbons (petroleum), aromatic polycyclic hydrocarbons Halogen hydrocarbons compounds (PCB, DDT or pesticides) Detergent Alcohol Surnatants Chlorinated paraffin Coal dust Mineral oils Substances from chemical syntheses Organotin chemicals
INORGANIC COMPOUNDS	($N\text{-}NH_4^+$) Nitrogen as nitrate ($N\text{-}NO_3^-$) Nitrogen as nitrite($N\text{-}NO_2^-$) Total phosphorus (P) and its salts Heavy metals and their by products (Hg, Pb, Cd, etc.) Kaolin dusts
PATHOGENIC MICRO-ORGANISMS	Total Coliforms, faecal coliforms, faecal streptococci

2.1 Industrial sources

The industrial polluted water discharged in the sea comes from different origins: chemical or metallurgic activities, treatments of oils products. They bring organic matter and toxic elements like pesticide, detergent, heavy metals, hydrocarbons, nutrients, and salts in the marine environment. Fresh water and the seawater have difficulties to mix at the emissary. The initial dilution will depend upon:

- the flow of discharged water;
- the difference in density of the effluent and the seawater;
- the presence of diffusers at the emissary;
- the depth of the emissary;
- the topographic conditions of the area.

The effluents will float at different sea layers, depending on the waters density at different depths. Winds and currents will disperse the effluent, increasing the vertical and horizontal dispersal.

2.1.1 Groups of pollutants found in industrial polluted water

1. Pesticides

Pesticides cover a wide range of chemical structures and exhibit a great variety of physic-chemical properties, which govern their fate in marine organisms. The majority of them are highly toxic for marine species as well as for human. Some pesticides containing chlorine or other halogens groups are known to be highly persistent in the marine environment. The most dangerous pesticides are the more stable because they give off stable and toxic elements. Organochlorinated compounds (DDT, DDE and PCB) are more stable so more toxic than organophosphorate, substances very toxic but rapidly hydrolysed by the seawater.
The insoluble pesticides in marine water have the tendency to get fixed on organic substances. Marine organisms play an important role on the concentration and on the transport of those pollutants. The marine organisms can be contaminated directly by the environment area or by eating preys already contaminated. The more dangerous effect are up in the food chain.

The pesticides absorbed by marine organisms are concentrated in fat corps (fat and liver). The marine organisms present different resistance to the pesticides. The larval forms are more sensitive than adult forms. The pesticides can affect the motor comportment of the fish. It is due to the inhibition of an essential enzyme for the functioning of the neuralgic system.
It can also affect the photosynthesis of the plankton. It is harmful for the fish because there is a decrease at the base of the food chain.
The pesticides get more concentrated in sediments containing important percentages of organic matter, but the concentration does decrease with the time. After a certain time of contact the pesticides are spread in the sea, and as a consequence they are disposable for other organisms.

2. Detergents

Detergents are complex molecules, composed with base products of adjuvants, and solvents charges. The variety of the detergent is due to the electrochemical property of the base products.

There are anionic (sulfates, sulfonates, phosphats, carbamates. are the most used in commercial products) cationic and non ionic detergents. Detergents bring important supplies of nutriment elements inducing a quick increase of the algae population, and eutrophication problem in an enclosed marine area. The most toxic detergent to marine organisms are first the cationic, then the non-ionic and at last the anionic. Cationic detergents are mainly used in the industrial field and are famous for their bactericide properties. The detergent affects the different phases of the biological cycle of the animal species and specially the laying and the maturation of eggs.

3. Alcohols

Alcohols above C7 are mobile waxy solids at mostly ambient temperatures and would, if released into the marine environment, cause some interference with the marine organisms. Primary saturated alcohols show an increase in toxicity to marine organisms with increase in carbon number, but in practice the extent of this increase is limited by their water solubility.

4. Chlorinated paraffins

They are produced in large quantity and have a wide use. They accumulate in mammals fat tissues and in the nervous system.
The carbon chain length is important for the bioaccumulation potential. Short chain and high level of chlorination give the slowest excretion rate, and retention could last for more than ten months. Low-chlorinated paraffins with short carbon chain length are the most toxic.

5. Heavy metals

Heavy metals correspond in the Mendeleiev classification to all the metals that are between the chrome and the zinc (manganese, iron, cobalt, nickel, and copper). Some other metals are also called heavy metals like cadmium, mercury, lead, arsenic and molybdenum.
The most toxic are the cadmium and the mercury. Cadmium is used in plating process (55 to 60%), pigment fabrication (30 to 60%), metallurgic industry (7 to 10%). Mercury is used for the fabrication of electronics displays, and painting fabrication.
The natural concentrations of the metallic trace elements in the seawater are (Kennish M. J., 1990; United Nations Environment Programme, 1989).

Heavy metal	**(Tenor) in μg/l**
Silver	0.5 - 1.5
Cadmium	0.02 - 0.25
Cobalt	0.05 - 0.4
Chrome	0.2 - 0.5
Copper	0.2 - 0.5
Iron	0.2 - 10
Mercury	0.01 - 0.2
Molybdenum	0.2 - 10
Manganese	0.2 - 4
Nickel	0.4 - 10
Lead	0.02 - 4
Zinc	2 - 12

The heavy metals discharged in the marine environment are absorbed by the sediments, and concentrated by the phytoplankton, the superior algae, the benthic and pelagic fauna all along the food chain.

The marine organisms accumulate toxic elements from the water but also by eating contaminated preys. The factor of transfer of the toxic elements to the marine biodiversity will depends upon the metallic elements, but also upon the marine species. The algae, first in the food chain is highly contaminated, so are the larval stages and the marine mollusc. This is due to their great capacity to filter the seawater. In fact, all those organisms are used to detect marine pollution.

The mercury is toxic but even more when it is in the form of methylmercury. The biological period of the methylmercury vary between 480 days and several years depending on the methyl form. The methylation is the result of the microbial activity. It is a very slow process, 10 to 100 years. If the animals are contaminated by the methylmercury there is a very slow elimination and so the muscles also get very contaminated.

The toxicity of the mercury elements is due to their great affinity to the grouping sulfiydryles (-SH) groups. The –SH group is vital for the enzyme and the cell of the membrane. Also in high concentration the mercury perturbs and inhibits the activity of the enzyme, it profoundly alliterates the organism.

The localisation of the zinc concentration in human beings are first in the liver, then in the spleen, and lest in the muscles and bones. The ionic forms of metal have the best assimilation because they can rapidly clear the biological membrane. The pollution forms in the sea are very variable. Synergistic or antagonistic effects can accelerate or stop the retention of the heavy metals.

The pathological effects of the cadmium manifest in marine organism by an hyperplaisie. The death can then occur by asphyxia. For low concentrations, cadmium can create morphologic and histological alteration of internal organs and in particular to the liver and the spleen.

6. Nitrogen, ammonium, nitrites, nitrates and phosphor (mineral)

The pollution induced by these minerals is an increase of water turbidity. This phenomenon induces a diminution of the primary production (algae, and phytoplankton). Too many minerals also bring about a sealing of the seabed with the modification of the benthic fauna and flora. But also too many mineral can induce an eutrophication of confined area with the development of a bloom algae.

3 CONSEQUENCES

3.1 Effects on the environment

The discharge of industrial water in the marine environment has three types of pollution effects:

- a superficial pollution (light products, oils) that will essential drift with the wind;
- a dissolved pollution in the water column;
- a settled pollution that will sediment and accumulate on the seabed.

Due to the presence of polluting substances, (high concentration of organic substances) in the vicinity of waste water discharging areas, a drastic alteration in water quality can be noted, especially during the summer, when the concentration of organic substances from domestic activities increases. Water is cloudy and smelly with a high concentration of pathogenic micro-organisms and there is a proliferation of seaweed, fish murrain, water biotic community and a general lack of oxygen. It is important, therefore, to define a maximum allowed concentration for toxic substances to be discharged in the water taking into account the natural background composition of the marine environment (mainly classified as seas subject or not to eutrophication). The definition of these parameters would allow the balance of the biological community to remain unaltered in their functional process and without side effects on the ecosystem.

3.2 Diffusion, accumulation and bioaccumulation of polluting substances

The study of the diffusion of polluting substances in the sea is based on a careful analysis of prevailing sea streams around the port. Nevertheless, water streams can vary and it is, therefore, necessary to carry out a regular and statistically sound monitoring activity. There is a possibility of accumulating heavy metals on the sea bed when industries using these on a large scale are located near the port (tannery factories, iron and steel industries, etc). Where water quality is very poor, pathogenic micro-organisms and toxic substances are found in seafood. A single muscle is able to filter up to 10-15 litres of water per hour, with a concentration of micro-organisms up to 100-200 times higher than the one related to the natural environment of the sea.

3.3 Impact on the environment and human activities

3.3.1 Impact on the marine environment

There is a large number of negative effects related to sea pollution. In the nearest coastal areas the concentrations are the highest, and the effects are clearly due to one origin. More the wind is strong and the sea rough, best will be the dilution of the industrial water. In the faraway areas, the pollution can be due to a reappearance of hydrodynamic flux. The pollution found can be caused by different industrial origins.

3.3.2 Biological impact

Active filtering organisms such as mussels, and organisms such as worms, characterise the area near the discharge. A thin layer of clay can recovers the organisms, worms are opportunists, feeding themselves by catching suspended particles brought by the discharges. Those organisms living in loose areas are a sign of instability.

3.3.3 The impact on the human activities

Polluting substances absorbed by human beings risk, in the future, entering the human food chain and other organisms, increasing the probability of spreading disease. The problems of micro-pollutants are their easy accumulation in marine organisms. The quality of fish (shellfish farming) products is, therefore, the first to be compromised.

Pollution also affects bathing coastal areas: pathogenic micro organisms and toxic algae are bad for the health of the bather, this problem conditions in tourist resorts. Last but not least, there are problems related to the corrosive effects of some substances (which might increase the corrosive effect if combined with other polluting substances diluted in the water) which erode underwater building structures and boats, shortening their life span. A similar effect is due to the friction of the high concentration of solid deposit caused by wave motion and currents.

4 MONITORING

The term 'monitoring' means observing and measuring the environment on a continuous basis using the correct scientific tools. This entails a collection of data on a limited number of parameters which serve for prevention and research. The term 'control' means checks done on parameters which are chosen depending on the problem at hand. In the latter case, the results depend on the technical time necessary for the collection and analysis of samples.

4.1 How to plan environmental controls on activities influencing the port waters pollution

4.1.1 Discharge of effluents from waste water treatment plants

Directive 271/91/EEC considers marine areas such as ports, bays, etc. where waste waters have no negative effects, as «less fragile areas», although some ports with specific structural and climatic characteristics are not included in this classification. On the contrary, lakes, estuaries and surface fresh waters are usually considered «fragile areas» when already eutrophicated or are potentially more exposed to eutrophication. Consequently, the number of samplings and parameters to be monitored depends on the characteristics of waste waters discharging areas and are directly related to the increase of the eutrophication risk.

Port areas are subject to sewage dumping, mainly from urban communities residing nearby the port. In order to monitor the water quality in outlets of water purification plants, the Directive requires a minimum of samples per year (see table 2) on which to carry-out the analysis of the most important parameters (see table 3).

The goal for the near future will be that of defining a single parameter which will qualify the state of eutrophication in the water. This parameter will surely be related to the concentration of chlorophyll, dissolved oxygen and to the nutritional factors in the water such as total nitrogen and phosphorus.

Table 2: Minimum number of samplings to carry-out on a effluent coming from a urban waste water treatment plant

NUMBER OF EQUIVALENT INHABITANTS (e. i.) [(a)]	NUMBER OF SAMPLINGS
2000 to 9999	12 [(b)]
10000 to 49999	12
50000 and more	24

Notes:
(a) One e. i. is the quantity of biodegradable organic material with a BOD_5 of 60 g of oxygen per day.
(b) This value is related to the first year. Than, if the water quality respects the limits, four samplings for the next years are considered enough. If only one of this does not respect the limits, twelve samplings are newly required for the next year (see point D, number 3, of attachment 1 to the Directive).

Table 3: Requisites of effluents from urban waste water treatment plants

PARAMETER	MAXIMUM CONCENTRATION ALLOWED	% OF MINIMUM REDUCTION [c]
BOD_5 [a] [b]	25 mg/l O_2	70 - 90
COD [a]	125 mg/l O_2	75
TSS [a]	35 mg/l [d] 35 mg/l (more than 10000 e.i.) [e] 70 mg/l (2000 to 10000 e.i.) [e]	90 [d] 90 [e] 70 [e]
Total Phosphorus [a] [f]	2 mg/l (10000 to 100000 e.i.) 1 mg/l (more than 1000000 e.i.)	80
Total Nitrogen [a] [f] [g]	15 mg/l (10000 to 100000 e.i.) 10 mg/l (more than 100000 e.i.) [h]	70 - 80

Notes:
(a) For definition see paragraph 4.2.
(b) This parameter can be replaced by TOC (Total Organic Carbonium) or TOD (Total Oxygen Demand) when a mathematical connection between the two parameters can be proved.
(c) Related to the original effluent concentration.
(d) No mandatory.
(e) Same as paragraph 2 of article 4 of Directive.
(f) Only for «fragile areas».
(g) The sum of: Kjeldahl (organic N plus NH_3), NO_3^- and NO_2^- is intended for total nitrogen.
(h) See note 3 of table 2 reported in attachment 1 to the Directive.

4.1.2 Discharge of industrial effluents directly to the sea

At each type of industries correspond a type of industrial polluted water. For example the steel plants discharge water poor in oxygen, with height percent of ammonium, cyanide, sulphur, phosphor, hydrocarbons. The industries processing chemical products discharge important quantities of chemical products that can be chlorine, vinyl chloride monomer, tertiary butyl alcohol, propylene oxide, polyethylene, glycol, methyl tertiary butyl ether. The oil refinerys discharge water with height level of hydrocarbons. The water discharged in the sea will have to correspond to the strict norms of the legislation. This is to avoid a pollution of the marine environment. So each industrial will have to treat his discharge water.

Waters from industrial waste water treatment plants are another source of potential pollution to marines and port waters. In order to keep this type of pollution under control, it is very important to identify the right sites for sampling nearby the discharge points.

The limit values of concentration for the most important dangerous substances, number of samplings per year and main quality goals for industrial waste water are regulated by Directive 76/464/EEC and the latest Directives: 82/176/EEC, 83/513/EEC, 84/156/EEC, 84/491/EEC, 88/347/EEC and 90/415/EEC.

Directive 76/464/EEC divides toxic substances into two list groups.

List I contains certain individual substances which belong to the following families and groups of substances, selected mainly on the basis of their toxicity, persistence and bioaccumulation, with the exception of those which are biologically harmless or which are rapidly converted into substances which are biologically harmless:

1. organohalogen compounds and substances which may form such compounds in the aquatic environment;

2. organophosphorus compounds;

3. organotin compounds;

4. substances in respect of which it has been proved that they possess carcinogenic properties in or via the aquatic environment (this category includes also those substances of List II in respect of which it has been proved that they possess carcinogenic properties);

5. mercury and its compounds;

6. cadmium and its compounds;

7. persistent mineral oils and hydrocarbons of petroleum origin;

8. persistent synthetic substances which may float, remain in suspension or sink and which may interfere with any use of the waters (these for the purposes of implementing articles 2, 8, 9 and 14 of Directive).

List II contains:

- substances belonging to the families and groups of substances in List I for which the limit values referred to in article 6 of the Directive have not been determined;

- certain individual substances and categories of substances belonging to the families and groups of substances listed below, and which have a deleterious effect on the aquatic environment, which can, however, be confined to a given area and which depend on the characteristics and location of the water into which they are discharged.

Families and groups of substances referred to in the second indent:

1. Metalloid, metals e related compounds:
   Zinc, Tin, Copper, Barium, Nickel, Beryelium, Chrome, Boron, Lead, Uranium, Selenium, Vanadium, Arsenic, Cobalt, Antimonic, Thallium, Molybdenum, Tellurium, Titanium, Silver.

2. Biocides and their derivatives not appearing in List I.

3. Substances which have a deleterious effect on the taste and/or smell of the products for human consumption derived from the aquatic environment, and compounds liable to give rise to such substances in water.

4. Toxic or persistent organic compounds of silicon, and substances which may give rise to such compounds in water, excluding those which are biologically harmless or are rapidly converted

in water into harmless substances. (1) Where certain substances in list II are carcinogenic, they are included in category 4 of this list.

5. Inorganic compounds of phosphorus and elemental phosphorus.

6. Non persistent mineral oils and hydrocarbons of petroleum origin.

7. Cyanides, fluorides.

8. Substances which have an adverse effect on the oxygen balance, particularly: ammonia, nitrites.

In particular, the discharge of some substances of List I typical in the industrial activity are regulated (monitoring and limit values for the emission are given) by the European Directives as follow:

- 82/176 EEC and 84/156/CEE concerns the discharge of mercury;

- 83/513 EEC concerns the cadmium discharge from industries;

- 84/491/EEC is about the HCH discharge;

- 88/347/EEC and 90/415/EEC concern substances: CCl_4, DDT, pentachlorophenol, hexachlorobenzene (HCB), hexachlorobuthadien (HCBD), chloroform ($CHCl_3$), 1,2 dichloroethan (EDC), trichloroethylene (TRI), perchloroethylenene (PER), trichlorobenzene (TCB) that are discharge from industries.

For the industrial activities which cause water pollution there should be:

- Diffusion of information and dialogue about environmental problems;
- Obligation of the transparency of the information about industrial polluted water;
- Application of the rules, to improve the environmental protection action.

Industries should be required to provide a comprehensive safety organisation involving a local contingency plan.

All industries should check own polluted waters and improve the techniques for marine environment pollution, in according to the laws.

The frequency, the characteristics of the pollutant analysed, the methods of analysis applied, would be defined in the industries authorisations.

The results of the industrial water quality should be computerised to allow a management of information.

Depending on the quantity of toxic substances rejected per day, the priority of monitoring discharge of toxic substances in the marine environment could be (Regional Direction in Industry and Environmental Research France):

Priority/toxicity	1 to 10 g/day	10 to 100 g/day	100 to 1 kg/day	> 1 kg/day
Very toxic substance and harmful (36 substances)	Priority 3	Priority 2	Priority 1	Priority 1
Toxic substance and harmful (39 substances)		Priority 3	Priority 2	Priority 1
Noxious substance for the organism, and low toxic substance (57 substances)		Priority 3	Priority 3	Priority 2

A survey on the effects of industrial waters discharge would be recommended, in order to evaluate the trend of environmental impact.

Objectives of the survey should be:

- Describe the industries treatment installations;
- Characterise the effluents;
- Describe the initial state of the environmental area;
- Analyse the direct and indirect effects (temporary or permanent) of the industrial discharges on the environment;
- Determine the discharge extends to put in evidence the area of influence and to evaluate the dilutions of pollution;
- Determine the physics-chemical quality of the sediments and the quality of the living matter by studying the benthic population, the macrofauna and macroflora, to establish the biological diagnosis of the area.

4.1.3 Other discharges

Besides the activities of urban waste water treatment and the industries, other activities (i.e. agriculture with pesticide) and natural events (i.e. alluvial materials) contribute to water pollution and environmental problems in port areas.
The marine traffic (civil and commercial) present in ports, is cause of damage for seaside system. The merchant ship in entry and in exit by industrial ports must be careful on the rigging to avoid catastrophes which spill in seaside transport goods. The areas of anchorage are particularly at risk during unloading of oil tankers and ships that transport chemical (GESAMP Reports and Studies, 1989), due to the easy dispersion of oil and to the particular toxicity of some its fractions (GESAMP Reports and Studies, 1993). Environmental problem are caused by discharging from the tankers deballasting waters into the sea. Some times deballasting waters are discharged into the sea (twelve mile far from the coast) with evident damage to the water quality. It is very important to arrange on the port facilities for the purification of the deballasting waters. Whereas oil tanker load ballast water during the operation of ballast water loading there is also the problem of atmospheric pollution due to the gas let off (volatile hydrocarbons). Fortunately, the new oil tankers are built with innovative technologies and does not need ballast water to navigate. In 1972 it was started the environmental hazards assessment of substances carried by ships, in response to a request made by the Sub-Committee on Marine Pollution of the International Maritime Organization (IMO) with regard to questions on hazard which might arise through the operational discharge at sea of tank washings by chemicals or through the accidental spillage of substances carried either in bulk or in

package form. A the beginning it was as preparatory work for the development of the International Convention for the Prevention Pollution from Ships 1973 (this subject will be treated in detail in the next worksheets: “Oil storage” and “Deballasting treatment”).
Therefore, in order to monitor water quality in these areas, it is important to identify the particular sites from where samples can be taken. Once the sites have been identified, it is reasonable to carry out one sampling per month or every fifteen days. The parameters to be monitored on these samplings is related to the above considerations (type of activity affecting the water quality), the seasonal period, the water exchanges due to marine currents and to the naturalistic interest on the area.

4.2 How to plan environmental monitoring on port waters

Besides the monitoring on activities affecting the quality of port water, it is important to carry-out the monitoring on samples taken directly from the port water area. To this end, the main sampling criteria and methodologies for related analysis are described below.

4.2.1 Choice of monitoring sites and guidelines to carry-out the sampling

The choice of monitoring sites is based on a careful analysis of the prevailing marine currents, wind direction, wind speed and of the geographical structure of the port (number of small bays, port size, etc.).
It is necessary to know the meteorological, climatic and environmental parameters affecting the transport and the diffusion of potentially dangerous substances. It is also necessary to carry-out a regular and statistically sound activity of monitoring.

Regarding depth, the classification of the marine waters suggested by Barnes and Hughes (Barnes and Hughes, 1988) and by final report European Commission Directorate General XI (WRc Ref: CO 4150, May 1996), are recommended:

1. shallow marine waters (0 to 30 m)
2. intermediate marine waters (30 to 200 m)
3. deep marine waters (200 m and more)

The first area is the zone nearest to the coast. It corresponds to the area where there is a dilution of the rejects. The intermediate area is that one where the pollutants concentration is mixed up. The last area is related to the background noise.
For a continuous monitoring of port water areas it is recommended to site the equipment in correspondence with the intermediate marine waters.
For a discontinuous monitoring, it is recommendable to carry-out the sampling in correspondence with the shallow marine waters. For every sampling site, it is recommended to define the vertical profile of all the water column in terms of temperature, salinity and dissolved oxygen, taking a sample every 5 meters of water depth.
The parameters to be monitored are also related to the port water depth. It must be taken into account that, in case of high depths, a lot of pollutants cannot reach the sea bed due to the high dilution in the water. Depending on the depth of marine waters (Barnes and Hughes, 1988), the recommended parameters to be monitored are indicated in table 4, which has been drawn from final report European Commission Directorate General XI (WRC Ref: CO 4150, May 1996).

4.2.2 Choice of parameters to be monitored and related methods of analysis

A sound planning of marine environment monitoring requires the identification of the most significant parameters which describe more accurately the water quality. Tables 5 to 12 show the maximum limit values of concentration recommended for parameters which are generally considered for monitoring in water, biota and sediment respectively.
Table 5 reports the standard classification for the quality of marine water proposed by the draft Economic Commission for Europe (ECE, 1992) which is divided into 5 classes and includes criteria for water and biota only. The variables list was considered to be tentative and class limits for ecotoxicological effect of harmful substances are in the USA EPA recommendations for salt water quality. Moreover, for bathing zones adjacent to the port, legislation requirements (see table 6) have already been identified.
Recommended guide values for biota (see table 7) can be those proposed by final report of the European Commission Directorate General XI (WRc Ref: CO 4150, May 1996). A good criteria to measure the concentration of a pollutant substances in the coastal zone is the sampling of mussels (see table 8). Mussels filter and stock the contaminant information about the quality of the water. They are very good indicators of industrial water pollution. A other indicative scale of sea water toxicity due to heavy metal and nutrient for invertebrate and fish is reported on table 9 anyway, to have a better analysis of the dangers of toxic elements to human health, more experiment will have to be done since all the experiments carried-out up to now are only estimations.
Tables 10, 11 and 12 report recommended limit values of concentration for dangerous substances in marine sediment.

Table 4: Recommended parameters to be monitored depending on marine water depth

QUALITY ELEMENTS	MARINE WATERS		
	Shallow	**Intermediate**	**Deep**
Dissolved oxygen	R	R	R
Toxic or harmful substances:			
- *water*	R	R	R
- *sediment*	R[1]	NR	NR
- *biota*	R[1]	NR	NR
Disease in animals and plants	NR	NR	NR
Invertebrate communities:			
- *planktonic*	NR	NR	NR
- *benthic*	R	NR	NR
Acquatic plant communities:			
- *phytoplankton*	R	R	R
- *benthic algae*	R	NR	NR
- *submerged macrophytes*	R	NR	NR
Fish populations	NR	NR	NR
Higher vertebrate population	NR	NR	NR
Sediment structure and quality	R	NR	NR
Riparian zones:			
- *costal zone*	R	NR	NR
Freshwater flow quality	NR	NR	NR

Notes:
R = recommended
R[1] = recommended where relevant (as indicated by biological measurement)
NR = non recommended

Table 5: Recommended standard classification of marine water quality

	1	2	3	4	5
Oxygen regime in marine bottom waters					
- Dissolved oxygen mg/l	>7	7 to 6	6 to 4	4 to 3	<3
Hydrogen sulphide µg/l	0	0	0 to 0.2	0.2 to 2.0	>2.0
Eutrophication in marine surface waters					
- Total P: annual mean µg/l	<10	10 to 25	25 to 50	50 to 125	>125
- Total N: annual mean µg/l	<160	160 to 400	400 to 800	800 to 2000	>2000
- Total P: winter maximum µg/l					
- Total N: winter maximum µg/l					
- Chlorophyll-a µg/l	<2.5	2.5 to 10	10 to 30	30 to 110	>110
Metals in water in µg/l					
- Arsenic III				36 to 69	>69
- Cadmium				9.3 to 43	>43
- Chromium VI				50 to 1100	>1100
- Copper				0.9 to 2.9	>2.9
- Lead				5.6 to 140	>140
- Mercury				0.025 to 2.1	>2.1
- Nickel				8.3 to 75	>75
- Zinc				86 to 95	>95
Organochlorines in water ng/l					
- Aldrin					
- alpha-benzene hexachloride (BHC)					
- beta-BHC					
- Chlordane				4 to 90	>90
- Chlorinated benzenes				129 to 160	>160
- DDT and its metabolites				1 to 130	>130
- Dieldrin				1.9 to 710	>710
- Endrin				2.3 to 37	>37
- Gamma-BHC					
- Heptachlor				3.6 to 53	>53
- Heptachlor epoxide					
- Hexachlorobenzene HCB					
- Hexachlorocyclohexane					>340
- Lindane					>160
- PCBs				30 to 10000	>10000
- Pentachlorocyclohexane				7.9 to 13	>13
- Toxaphene				0.2 to 210	>210
1.1. Other contaminants in water µg/l					
- Dinitrotoluene				370 to 590	>590
- Oil and grease				10 to 100	>100
- Polycyclic hydrocarbons					
Radioactivity					
- Caesium-137					
- Strontium-90					
- Tritium					

Note:
No value means presence not allowed.

The quality of the coastal water can be also defined by a parameter named trophic index (TRIX) (Vollenweider R.A., et al. 1998) as follow:

Trophic index = [Log_{10} (Cha • aD%O • N • P) +1,5] / 1,2

Where:

- Cha = chlorophyll “a” (mg/m^3)
- aD%O = oxygen as absolute [%] deviation from saturation: abs │100 - %O│
- P = total phosphorus (mg/ m^3)
- N = N-($NO_3^- + NO_2^- + NH_3$) (mg/m^3)

This parameter is recommended for a first classification of the ecological and chemistry state of marine waters within 3000 meters from the coasts. The first time classification is given by calculating the average value of the TRIX index over 24 mouths of water monitoring. Subsequent evaluations of this index can be carried-out over 12 mouths of monitoring.
However, in order to achieve a sound judgement of the overall state of water quality, the determination of the TRIX index should be integrated by evaluations related to the sediment and biota quality.

TROPHIC INDEX	QUALITY INDEX
2 – 4	HIGH - Good waters transparency - Absence of anomalous waters coloration - Absence of dissolved oxygen undersaturation on the benthic waters
4 – 5	GOOD - Occasional waters turbidity - Occasional anomalous waters coloration - Occasional hypoxias of benthic waters
5- 6	MEDIOCRE - Low waters transparency - Anomalous waters coloration - Hypoxias and occasional anoxias of benthic waters - Suffering states at the level of benthic ecosystem
6 – 8	BAD - High waters turbidity - Widespread and persistent anomalies in the water coloration - Widespread and persistent hypoxias/anoxias on the benthic waters - Dying off of benthic organisms - Alteration/simplification of benthic communities

Table 6: Legislation requirements for bathing waters (Directive 76/160/EEC)

	Microbiological parameters	G	I	Minimum sampling frequency
1	Total coliforms / 100 ml	500	10000	Fortnightly (1)
2	Faecal coliforms / 100 ml	100	2000	Fortnightly (1)
3	Faecal streptococci / 100 ml	100	-	(2)
4	Salmonella / litre	-	0	(2)
5	Enteroviruses PFU/10 litres	-	0	(2)
	Physico-chemical parameters			
6	pH	-	6-9 (o)	(2)
7	Colour	-	No abnormal change in colour (o)	Fortnightly (1) (2)
8	Minerals oils mg/litre	≤ 0.3	No film visible on the surface of the water and no odour	Fortnightly (1) (2)
9	Surface- active substances reacting with methylene blue mg/l (Lauryl sulphate)	≤ 0.3	No lasting foam	Fortnightly (1) (2)
10	Phenols mg/l (phenol indices) C_6H_5OH	≤ 0.005	No specific odour ≤ 0.005	Fortnightly (1) (2)
11	Transparency	2	1 (o)	Fortnightly (1)
12	Dissolved oxygen % saturation O_2	80 to 120	-	(2)
13	Tarry residues and floating materials such as wood, plastic articles, bottle, glass, plastic, rubber or any other substance. Waste or splinters	Absence	-	Fortnightly (1)
14	Ammonia mg/litre NH_4^+	-	-	(3)
15	Nitrogen Kjeldhal mg/litre N	-	-	(3)
	Other substances regarded as indications of pollution			
16	Pesticides mg/litre (parathion, HCH, dieldrin)	-	-	(2)
17	Heavy metals such as: - arsenic mg/litre As - cadmium Cd - chrome VI CrVI - lead Pb - mercury Hg	-	-	(2)
18	Cynamides mg/litre Cn	-	-	(2)
19	Nitrates mg/litre NO_3^- and phospates PO_4^-	-	-	(2)

Notes:
G = guide, I= mandatory.
(o) Provision exists for exceeding the limits in the event of exceptional geographical or meteorological conditions.
(1) When a sampling taken in previous years produced results which are appreciably better than those in this Annex and when no new factor likely to lower the quality of the water has appeared, the competent authorities may reduce the sampling frequency by a factor of 2.
(2) Concentration to be checked by the competent authorities when an inspection in the bathing area shows that the substance may be present or that the quality of the water has deteriorated.
(3) These parameters must be checked by the competent authorities when there is a tendency towards eutrophication of the water.

Table 7: Recommended operational indicators for contaminants in biota in µg/kg wet weight

EU No	Substance	Class 1: High	Class 2: Good	Class 3: Fair	Class 4: Poor	Class 5: Bad
1	Aldrin (1)	Background	< 400	> 400 to 4000	> 4000 to 40000	> 40000
12	Cadmium	Background	< 500	> 500 to 5000	> 5000 to 50000	> 50000
46	DDT (+DDE+DDD)	Background	< 50	> 50 to 500	> 500 to 5000	> 5000
71	Dieldrin	Background	< 50	> 50 to 500	> 500 to 5000	> 5000
77	Endrin	Background	< 30	> 30 to 300	> 300 to 3000	> 3000
83	Hexachlorobenzene	Background	< 150	> 150 to 1500	> 1500 to 15000	> 15000
84	Hexachorobutadiene	Background	< 200	> 200 to 2000	> 2000 to 20000	> 20000
85	Hexachlorocyclohexane Lindane	Background	< 3	> 3 to 30	> 30 to 300	> 300
92	Mercury	Background	< 50	> 50 to 500	> 500 to 5000	> 5000
101	PCB	Background	< 1	> 1 to 10	> 10 to 100	> 100
102	Pentachlorophenol	Background	< 800	> 800 to 8000	> 8000 to 80000	> 80000
115	Tributyltionide	Background	< 0.4	> 0.4 to 4	> 4 to 40	> 40
117 118	Trichlorobenzene	Background	< 50	> 50 to 500	> 500 to 5000	> 5000
124	Trifuralin	Background	< 70	> 70 to 700	> 700 to 7000	> 7000

Note:
(1) For aldrin the «safe» concentration is fixed as the same value as for endrin.

Table 8: IFREMER gives with the concentrations found in the mussels tissues, a scale of the quality of the seawater (Joanny M. and coll., 1993)

	Very good quality	Good quality	Medium quality	Bad quality
Zinc (mg/kg p.s.)	< 100	100 - 150	150 - 200	> 200
Cooper (mg/kg p.s.)	< 5	5 - 10	10 - 15	> 15
Mercury (mg/kg p.s.)	< 0.2	0.2 - 0.3	0.3 - 0.4	> 0.4
Cadmium (mg/kg p.s.)	< 1	1 - 2	2 - 4	> 4
Lead (mg/kg p.s.)	< 2	2 - 4	4 - 6	> 6
PCB (mg/kg p.s.)	< 250	250 - 800	800 - 1350	>1350
PAH (mg/kg p.s.)	< 50	50 - 125	125 - 200	> 200
Σ DDT (µg/kg p.s.)	< 2	2 - 4	4 - 6	> 6
α HCH (µg/kg p.s.)	< 5	5 - 10	10 - 15	> 15
γ HCH (µg/kg p.s.)	< 4	4 - 12	12 - 20	> 20

Table 9: Toxic value for invertebrate and fish (lethal effects CL50, 96 h for inorganic compounds and concentrations of nutrient inducing a fish death)

Heavy metal	Toxic value for invertebrate	Toxic value for fish
Arsenic (Michel P., 1993)	-	0.1 - 0.5 mg/l
Cooper (IARE, 1995)	0.15 mg/l	0.6 mg/l
Cadmium (Cossa D. and Lassus P., 1989)	1.6 mg/l (mussel)	20 - 50 mg/l (*Fundulus sp*)
Nickel (Andral B., 1994)	> 7 mg/l (mussel)	8 mg/l
Chrome (United Nations Environment Programme, 1993)	> 7.35 mg/l	0.1 mg/l
Lead (Cossa D. and coll., 1993)	2.5 – 9 mg/l	> 0.31 mg/l (*Fundulus sp*)
Mercury (Cossa and all, 1990)	0.025 mg/l (mussel)	0.3 - 2 mg/l (*Fundulus sp*)
Zinc	> 14.3 mg/l	0.14 mg/l
Ammonia (IDEE 1998)	-	0.3 mg/l (*Parus aurata*)
Nitrate (IDEE 1998)	-	200 mg/l (*Parus aurata*)
Nitrite (IDEE 1998)	-	6 g/l (*Parus aurata*)

Table 10: Recommended operational indicators and rating values for synthetic organic contaminants in marine sediments

Indicator	Class 1 High	CLASS 2 Good	Class 3 Fair	Class 4 Poor	Class 5 Bad
Synthetic organic compounds	None present	Traces	Low levels	Moderate levels	High levels
For example, weight of evidence approach/database (1)	Less than limit of detection	No observed effects level (NOEL)	> NOEL but < threshold effects level (TEL)	> TEL but < Probable effects level (PEL)	> PEL
PCBs (µg/kg DW) (1)	Less than limit of detection	< 10.8	> 10.8 < 21.6	> 21.6 < 189	> 189
PCBs (7 congeners) (mg/kg DW 1 % organic matter) (2)	Less than limit of detection	< 0.001 to 0.01	> 0.001 to 0.01	> 0.001 to 0.01	> 0.001 to 0.01
Total DDT (µg/kg DW) (1)	Less than limit of detection	< 1.95	> 1.95 < 3.89	> 3.89 < 51.7	> 51.7
Dieldrin (mg/kg DW) (1)	Less than limit of detection	< 0.36	> 0.36 < 0.72	> 0.72 < 4.3	> 4.3
Dieldrin [mg/kg DW (1 % organic matter)] (2)	Less than limit of detection	< 0.005 to 0.05	> 0.005 to 0.05	> 0.005 to 0.05	> 0.005 to 0.05
Lindane (µg/kg DW) (1)	Less than limit of detection	< 0.16	> 0.16 <0.32	> 0.32 < 0.99	> 0.99
Chlordane (µg/kg DW) (1)	Less than limit of detection	< 1.13	> 1.13 < 2.26	>2.26 < 4.79	> 4.79
PAHs (mg/kg DW 1 % organic matter)2 - naphthalene - anthracene - fluoranthene - benzo(a)pyrene	Less than the limit of detection	< 0.01 < 0.001 < 0.01 < 0.05	> 0.01 – 0.1 > 0.001 – 0.01 > 0.01 – 0.1 > 0.05 – 0.5	> 0.01 – 0.1 > 0.001 – 0.01 > 0.01 – 0.1 > 0.05 – 0.5	> 0.01 – 0.1 >0.001-0.01 > 0.01 – 0.1 > 0.05 – 0.5

Notes:

1. Weight of evidence approach using North American Biological Effects Database for Sediment (BEDS), database developed for the National for Status and Trends Programme.
2. Ecotoxicological Assessment Criteria for trace metals and organic micro contaminants in the North-East Atlantic. Oslo and Paris Commissions 1994. Ecotoxicological assessment criteria set as concentration ranges below which no harm to the marine environment is expected.

DW: dry weight.

Table 11: Some examples of sediments quality guidelines and/or standards used in Europe and North America (values in mg/kg dry weight)

Metal	AL	MRL	MTC	NIVA	NRC	NRL	PEL	TEL
Cd	2	50	15	0.25	0.15	0.50	4.21	0.676
				1				
				5				
Cr	100	--	--	70	--	--	160	52.3
				300				
				1400				
Cu	40	66	212	35	2.12	0.66	108	18.7
				160				
				700				
Zn	200	350	208	160	2.08	3.5	271	124
				650				
				3000				
Pb	40	1160	3720	30	37.2	12	112	30.2
				120				
				600				
Hg	0.4	0.015	0.28	0.15	0.003	0.00015	0.696	0.13
				0.6				
				3				
Ni	100	--	--	30	--	--	42.8	15.9
				130				
				600				
As	--	--	--	20	--	--	41.6	7.24
				80				
				400				

NIVA Proposed classification for Norway based on multiples of background values, threshold values for a 4 class system given.

PEL Probable effect level (North America)

TEL Toxic effect level (North America)

AL Action level, Ministry of Agriculture Fisheries and Food (MAFF), UK

MRL Maximum Risk Levels, based on partition equilibrium, and standard sediments, Netherlands

NRL Negligible risk levels, MRL/100

MTC Maximum Tolerable Concentration – equilibrium partitioning, standard sediment, 5% organic fraction

NRC Negligible Risk Concentration = MTC/100, NRC often below background levels, Netherlands

The international workshop (OSPARCOM 1994) undertook an overview of ecotoxicological assessment criteria for trace metals, PCBs, PAHs TBT, and some organochlorine pesticides for the purpose of assessing monitoring data from the North-East Atlantic Ocean within the framework of the Jonit Monitoring Programme of OSPARCOM. The recommendations are presented in table 12.

Table 12: Recommended rating values for contaminants in marine sediments (reproduced from OSPARCOM 1994)

	Assessment criteria mg/Kg dry weight (1% organic carbon)
Trace metals	
• Arsenic	1 to 10 (3)
• Cadmium	0.5 to 5 (1)
• Chromium	5 to 50 (3)
• Copper	5 to 50 (2)
• Mercury	0.05 to 0.5
• Nickel	FC
• Lead	5 to 50 (2)
• Zinc	10 to 100 (3)
Organochlorine pesticides	
• DDE	0.0005 to 0.005 (1)
• Dieldrin	0.005 to 0.05 (1)
• Lindane	NR
PAHs	
• Naphthalene	0.01 to 0.1 (1)
• Anthracene	0.001 to 0.01 (1)
• Fluoranthene	0.01 to 0.1 (1)
• Benzo(a)pyrene	0.05 to 0.5 (1)
• $\sum PCB_7$	0.001 to 0.01 (1)
• Tributyl Tin	0.0001 to 0.001 (1)

Notes:
1. Provisional.
2. Provisional, with lower boundary below background level.
3. Provisional, with lower and upper boundary below background level.

NR not relevant in connection with current monitoring programme.
FC future consideration (assessment criteria to be developed).

Depending on the specific situation, the reference values for monitored parameters can be found in the above tables, taking into account that a sound characterisation of port or coastal water needs a minimum monitoring period of two years. On the base of monitoring results, it will be possible to identify the most significant parameters to keep under control as well as the frequency of the sampling and related siting.
As a general approach, the monitoring of parameters listed in table 13 is recommended which also gives an indication of the number of samples to carry-out per year.

Table 13: Recommended minimum list of parameters to be monitored and related number of samples per year

PARAMETER	SAMPLES PER YEAR
Analysis of water [(d)]:	
BOD_5	12 [(a)]
COD	12 [(a)]
Total suspended solids	12 [(a)]
Total Phosphorus - Orthophosphate ($P\text{-}PO_4^{3-}$)	12 [(a)]
Total Nitrogen - $N\text{-}(NH_4^+)$ - Nitrogen as nitrate ($N\text{-}NO_3^-$) - Nitrogen as nitrite ($N\text{-}NO_2^-$)	12 [(a)]
Dissolved O_2	12 [(a)]
Temperature	12 [(a)]
pH	12 [(a)]
Transparency (Secchi disk depth)	12 [(a)]
Trophic index	12
Salinity	12 [(a)]
Faecal streptococci and Colimetric index	26 [(b)]
Chlorophyll «a» (dinoflagellates, diatoms, etc.)	26 [(b)]
Analysis of biota:	
Heavy metal bioaccumulated (Pb, Hg, Cd, etc.)	2
Halogen hydrocarbon compounds (PCB, DDT or pesticides)	2
Hydrocarbons, particularly as PAH (Polycyclic Aromatic Hydrocarbons)	2
Analysis of sediment [(c)]:	
Heavy metal bioaccumulated (Pb, Hg, Cd, etc.)	1
Organic Carbon	1
Hydrocarbons, particularly as PAH (Polycyclic Aromatic Hydrocarbons)	1
Halogen hydrocarbons compounds (PCB, DDT or pesticides)	1
Organotin	1
Granulometry (classification of Wentworth or of Shepard)	1
Tests of toxicity on some taxonomic groups (bio-luminescent bacteria, polycheliforms, amphipodous and echinoderms)	1

Notes:
(a) Every 15 day in summer. (b) Every 7 day in summer. (c) Determination of the primary most significant biotic community on the sea bed in port area by monitoring biological population every year. (d) For port or coastal zones where intense industrial or agriculture activities are carried-out, monitoring of cyanides, pesticides, arsenic and its compounds is recommended.

4.2.3 Analysis of water, biota, sediments

Before to proceed with the description of the most important method of analysis, must be pointed out that, in order to release reliable results, analytical laboratories must operate in accordance with quality standards.
General references to prepare a quality manual for the analytical laboratories are the “General Requirements for the Competence of Calibration and Testing Laboratories” (ISO IEC Guide 25, 3rd. Ed., 1990) and European standard “General Criteria for the Operation of Testing Laboratories” (EN 45001, 1989). Furthermore, a recent proposal for an European Standard “Guide to Analytical Quality Control for Water Analysis” (final draft CEN/TC 230 N223, April 1995) can be applied to the chemical and physic-chemical analysis of natural waters, including also marine waters. In order to achieve a sound reliability of analytical methods results, tests of intercomparison between different laboratories are recommended. The International Council for the Exploration of the Sea (ICES) is one of the international organisation which organises periodic workshops on these themes, as for example the one on fish disease studies (ICES, 1989), and publishes methodological guidance as for example the sampling methodology for macrofauna collecting (ICES, 1990) and trace metals (ICES, 1987a). The same organisation also supplies good laboratory practise and quality assurance (ICES, 1987b). Many quality assurance programs for analytical laboratories have been developed. An example is the QUASIMENE international program, which is a joint program established by several European marine institutes in the 1993 (Wells, 1993). The program today supports about 90 laboratory in Europe who submit data to the most important international marine monitoring programs as HELCOM, ICES, MEDPOL, OSPARCOM.

With the premises above, the definition of suggested parameters to be monitored and related recommended methods of analysis are reported below.

4.2.3.1 Analysis of water

BOD_5

BOD. (Biochemical Oxygen Demand) indicates the mass concentration of dissolved oxygen consumed under specified conditions by the biological oxidation of organic and/or inorganic matter in water.

In order to measure this parameter the methodology set out by the standard ISO 5815:1989 is recommended: Water quality - determination of biochemical oxygen demand after 5 days (BOD_5) - dilution and seeding method.

COD

COD (Chemical Oxygen Demand) indicates the mass concentration of oxygen equivalent to the amount of dichromate consumed by dissolved and suspended matter when a water sample is treated with that oxidant under defined conditions.

To measure this parameter the methodology set out by the standard ISO 6060:1989 is recommended: Water quality - determination of the chemical oxygen demand.

Total suspended solids

The suspended matter reduces the luminosity, which decreases the vegetal productivity and the development of the benthic fauna.
To determine this parameter, any of the following methods can be used:

- Filter a representative sample through a 0.45 μm filtering membrane. Dry up at 105 °C and then determine the resulting filter weight.
- Centrifugation of a representative sample for at least minutes (at 2800÷3000 revolution per minute), dry up at 105 °C and then determine the resulting weight.

Total Phosphorus and orthophosphate

The phosphorus in waste waters is contained almost exclusively as phosphate, particularly as orthophosphate, condensed phosphate and phosphate in combination with organic compounds. Several quantities of phosphate are usually associated with ionic (anionic and cationic) detergents. Anionic detergents as the SAB (Sulphunate Alkyl Benzenes) are mainly used for domestic activities; these types of ionic detergents can be biodegradable (linear chain type) or not biodegradable (branched chain type). A simple index of pollution by ionic detergents is the formation of foam in water.

To measure this parameter, the methodology set out by the standard ISO 6878-1:1986 is recommended: Water quality - determination of phosphorous - Part 1: Ammonium molybdate spectrometric method, section two: determination of orthophosphate after extraction.

Total Nitrogen

Total nitrogen is the sum of Kjeldahl-nitrogen (organic N + NH_3), nitrate (NO_3^-)-nitrogen and nitrite (NO_2^-)-nitrogen.

To measure this parameter the methodology of molecular absorption spectrophotometry is recommended. In particular, for Kjeldahl-nitrogen, the methodology set out by the standard ISO 5663:1984 is recommended: Water quality - determination of Kjeldahl nitrogen - method after mineralization with selenium.

Salinity

Saline concentration is evaluated by measuring the electrical conductivity of water solution.

To measure this parameter the methodology set out by the standard ISO 7888:1985 is recommended: Water quality - determination of electrical conductivity.

pH

pH is a parameter showing the acidity of water. A considerable difference from the typical pH sea (6-9 according to Directive 76/160/EEC) water value indicates the presence of other substances in the water.

To measure this parameter the methodology set out by the standard ISO 10523:1994 is recommended: Water quality - determination of pH.

Dissolved O_2

Dissolved O_2 indicates the oxygen concentration in the water. It can be measured by using a redox system.

To measure this parameter the methodology set out by the standard ISO 5814:1990 is recommended: Water quality - determination of dissolved oxygen - electrochemical probe method.

Transparency

This parameters can be measured by using the Secchi disc depth. The depth at which the disc becomes invisible gives a measurement of water transparency. Reference values of this parameter depend on geographcal zones. For example, a value of transparency > 20 m for the Mediterranean sea is an index of a high coastal waters quality, while a value < 10 m means fair water quality.

Temperature

The temperature represents one of the most important parameters for water quality evaluation since water density depends on it. Its value influences light transmission and therefore the life of many sea species. For this reason, it is important to measure the temperature of water at different depths from the sea bed to the surface.

Faecal streptococci and Colimetric index

One of the methods to measure the biological pollution in port waters is the evaluation of faecal streptococci and coliforms concentration. This germs are also normally present in the faecal material of the humans been and they are not dangerous for human health. However, a large concentration of these bacteria into the water is an index of a potential presence of other dangerous bacteria as for example the salmonella, which is a carrier of typhus.
Faecal streptococci (*enterococcus faecalis*) are normally characterised by a higher strength to the aquatic environmental conditions and to the action of the disinfectants than the coliforms bacteria and their presence is normally expressed by the quantity for 100 ml of analysed water.
The concentration of coliforms bacteria in the water (in particular of the faecal ones) is normally expressed by the colimetric index.
The methods of MPN (most probable number) system or MF (filtration on membrane) are normally recommended in order to determine the bacteria concentrations mentioned above.

The control of the self-depurative capability of sea water in relation to the quantity of bacteria on the liquid wastes, can be evaluated making use of the T_{90} factor (bacteria elimination factor) which shows the time necessary to reduce the bacteria content by about 90%.

Chlorophyll-a

It is an important parameter in order to indirectly evaluate the quantity of phytoplankton and the level of eutrophication of waters. The qualitative determination of phytoplankton species (dinoflagellates, diatoms, etc.) should be carried-out by the taxonomic analysis of samples. There are two main groups of phytoplankton: diatoms and flagellates (dinoflagellates). Diatoms live mainly in the surface waters and their silica skeleton is often elaborately ornamented which may be the effect of slowing down rates of sinking. Some contain a drop of oil which improves buoyancy.

They can secrete jelly like substances which can concentrate in particular situations. The whip-like flagella provide a great mobility through the water to dinoflagellates. It may happen that the population of dinoflagellates whit red pigments increase a lot, this phenomenon is called blooms, generating red tides. These dinoflagellates can be removed from the water by filter feeders such as bivalve molluscs. A great problem is the fact that shellfish concentrate the toxin produced by dinoflagellates so if they are dangerous for humans, birds or fish who eat them. The effect on local shellfish industries is disastrous.

In order to measure this parameter the methodology set out by the standard ISO 10260:1992 is recommended: Water quality - measurement of biochemical parameters - spectrometric determination of the chlorophyll-a concentration.

4.2.3.2 Analysis of pollulants on biota

Monitoring of biota is normally carried-out by checking the presence of dangerous substances on marine species (bioindicators).
The integrated analysis of data coming from water monitoring and biologic test on biota and sediments allows a better definition of chemical and ecological quality of marine water. Wherever necessary, more accurate investigations can be carried-out by particular biologic tests on selected species of different taxonomic groups. Obviously, choice of autochthonous species for these kind of investigations it is recommended. In order to give a good cartographic representation (at least 1:25000) of the biotic community situation, it is important to identify the most representative sites of the investigated area. In particular, in the Mediterranean, it is useful to monitor the presence of most precious biotic communities, such as the *Posidonia oceanica* prairies and the *coralligenous* species. This is because they represent a “biologic memory” of the studied area and provide complete information on effects induced by different anthropic impacts.

The choice of biota to carry out the monitoring program must the following criteria (Chapman, 1992): the organism must be typically immobile or just mobile in order to give a real measure of the pollution level in the monitored area; the organism must be capable to accumulate measurable quantities of polluting substances and its tissue must be easy to be analysed; the concentration of the polluting substances on the organism must correlated to concentration of the same one in the monitored water.

One of the most common species used is the *Mytilus galloprovincialis,* belonging to the family of Mytilidae (Goldberg, E.D., 1975), for which scientific data and related interpretations are easily available. Other bivalves used for monitoring activities are the Ostreoidea (Ostrea edulis, Crassostrea gigas) or, if this is not available, the Tellinoidea (Donax trunculus) and the Veneroidea (Tapes decussatus, Tapes philippinarum). Due to the lack of biological and physiological regulation mechanisms of toxic elements concentration on its tissues, the quantity of these substances accumulated on the mollusc is proportional to the quantity (concentration) of the same substances in the water. The use of a bioindicator allows the trend of toxic element concentration to be evaluated over time and to estimate the risk related to the transfer of the same elements into the food chain. In order to monitor marine waters accurately, it is suggested to use about 50-100 molluscs. These should be chosen from natural populations of different sizes and should be located in sets of 5-10 per monitoring site located within 200 meters from the coast. Once the molluscs have been fished from the sea, they must be preserved at –20 °C until the moment of analysis. For every analysed mollusc, a part from the parameters listed below, weight and shell length should be recorded.

The test of embryo-toxicity on the bivalves (oyster larvae, mussels, sea urchin) gives a good indication of the quality of the habitats. Routine ecotoxicological monitoring requires simple, rapid and inexpensive methods. Determining the percentage of abnormalities in D-larvae after 18 hours assesses water quality. If the percent of D-larvae abnormalities is above 50% the toxicity of the sample is very high.

Lead and Cadmium and Mercury

Many metals can be analysed by the atomic absorption spectrophotometer. Cadmium content can be determined by atomic absorption spectroscopy with the graphite atomiser (GFAAS). Soft tissues must be analysed on the same day of sampling or must be frozen at –30 °C until the analysis. The preparation of sample to be analysed must be carried-out by treating the wet-ashed with nitric acid and hydrogen peroxide (Goldberg, E.D., et al. 1983). Such solution is then analysed by the atomic absorption in order to determine Cd and Pb. Mercury is determined by the could-vapour atomic absorption spectrometry (CVAAS) technique, using stannous chloride as a reducing agent. The determination of metals in other biotic species, as fishes and algaes, can to be carried-out by inductively coupled plasma-atomic emission spectrometry (ICP-AES) (Rainbow, 1990). For methods of analysis see also indication in table 9.

Halogen hydrocarbon compounds (PCB, DDT or pesticides)

Pesticides are chlorinated substances often found between the polluting substances of marine water (Sànchez, J., et al, 1993).
PCB (Poly Chlorine Biphenyls) were synthesised for the first time in 1930. They are mainly employed as fluids for cooling electrical transformers and as hydraulic fluids in mining equipment. In the 1960s, it was discovered that they are particularly dangerous for living organisms.
The muscle tissues is separated from the valves and is cold frozen-dried, so the water content is removed without loss of volatile components. The measure of this parameter is carried-out by single and multidimensional capillary gas chromatogratograph, using electron-capture detection (GC-ECD). The sample to be analysed must be prepared by extraction (Soxhlet) with n-hexane, clean-up with alumina and HPLC. (Farrington; J.W., 1983; Jenerlov, A. 1996; LAW, R.J., 1995).

Hydrocarbons

Hydrocarbon compounds form an insulating film on the sea surface, This obstructs the regular exchange of oxygen from the atmosphere to the water. For a first quantitative screening of these substances, the measuring of the total concentration on water of polycyclic aromatic hydrocarbons (PAH) is recommended (Farrington, J.W. et al. 1994). In the water, The water pollution with hydrophobic PAHs is normally associated with the transport of organic particulate which remains suspended on the water column or deposits on the bottom sediments. It is know that PHAs may enter food chains eating mussels, crustacean and fish. Only the mussel is confirmed as a biomonitoring of PAHs in the marine environment because of its ability to accumulate, whereas fish and crustacea are capable of surviving in polluted environment based on an active oxidative enzymatic system.

To measure this parameter the gas chromatography-mass spectophotometry (GC-MS) is recommended. Beside the methodology for the PHA determination, the Pressurized Fluid Extraction (PFE) (Richter, B.E. et al., 1996; Schantz, M.M, et al., 1997) is one of the recent . This method is applied to determine the same components on sediment.

4.2.3.3 Analysis of sediments

The analysis of sediments is important as deposits contain the majority of polluting substances such as heavy metals produced by industries or held in alluvial material transported by rivers.

In particular, heavy metals are usually used by chemical industries due to their high complexing capability, but they have some extremely negative implications on the environment. In this context, sampling should be carried-out by taking a core sample of 1-2 centimetres from the sea bed, also if this choice varies in function of the sedimentological characteristics of investigated area. Sampling must be carried-out on identical periods of the year, possibly in summer when meteorological and marine events are more limited. General guides to estimate the marine sediment quality have been developed in many countries (van de Meent et al. 1990; MacDonald et al., 1992; EPA, 1992; MAFF, 1993) such as the recent report of van Helmond (1995) on this matter.
A first screening of bio accumulation should be carried-out on the following heavy metals: As, Cd, Cr, Cu, Hg, Mn, Ni, Pb, Zn. Then, on the basis of these first results, monitoring will be restricted to a minimum number of the above mentioned elements. However, a good monitoring plan should consider at least the determination of Hg, Pb and Cd. In fact, in particular, the presence of mercury on the sea bed (normally due to low efficiency depuration systems) results in the formation of some derivatives of this metal, such as mercury which affects the human central nervous system. Moreover, the monitoring of lead is important since this metal is a typical anthropic marker. Other dangerous substances to be monitored on the sediment are: organotin chemicals, halogen hydrocarbon compounds, hydrocarbons and some taxonomic group.

Mercury, Lead, Cadmium

Monitoring of metals in sediment poses some problems, as the organic content of the sediment, its particle size and the redox potential level of metals. It is very difficult to account for these factor and so to standardise the methods of analysis (Luoma, S.N., 1990).

The sample preparation for the analysis is carried-out by acid mineralization in microwave oven. The quantitative determination of lead and cadmium can be carried-out by atomic absorption spectrophotometry (Giani et al., 1994). Mercury is determined by the could-vapour atomic absorption spectrometry (CVAAS) technique.

Organotin chemicals

Paint antifouling are particularly used on dry docks. These products contain tributyl, dibutyl and monobutyltin which are dangerous for the reproduction of marine organisms (Axiak, V., 1995).

To measure this parameter, the Waldock et al.(Waldock, 1989) method refers.

Halogen hydrocarbon compounds (PCB, DDT or pesticides)

PCB are extracted from sediment by the following process: treatment with a solution 1:1 of acetone and petroleum ether (40°-60°). The solution obtained is then treated with concentrated sulphuric acid for sulphur removal and solution purification (Di Muccio et al., 1990). After a further purification by chromatography on Florisil column, the solution is analysed by gas chromatography at electron-capture detection for the quantitative determination.

Hydrocarbons

The determination of sixteen main toxic PAH indicated by EPA is recommended (U.S.E.P.A., 1986).

After freeze drying, the treatment of sample (Soxhlet extraction, sulphur removal, partition of hydrocarbons by column chromatography) according to the UNEP procedure (UNEP/IOC/IAEA, 1992) is recommended. The content of hydrocarbons is then determined by gas chromatography. Other analytic methods use HPLC chromatography with fluorescence detection.

Granulometry

Measurement of sediment grain sizes.
To measure this parameter, the classification methods set out by Wentworth or Shepard is recommended.

Organic carbon

The organic carbon can be determined by gravimetry method, calculating the difference between the initial weight of the sample and its weight after calcification on muffle furnace at 450 °C for six hours (Byers et al, 1978).

Toxicity tests

This test is recommended in order to check the presence of pollution (heavy metals, aromatic polycyclic hydrocarbons, etc.) on sediments. Some scientific works (Lourens et al, 1995; Tay et al. 1992) and guide-lines (EPA/USACE, 1991; 1994), suggest biologic tests to determine the toxicity of port sediments. Biological tests are however very unusual respect to the chemical ones and this is mainly due to the difficult of separation and identification of varies biologic species which normally live on the sediment. Methods development, training and standards harmonisation by international organizations (such for example the ones promoted by the ICES) is very important.
Generally, a toxicity test checks the resistance of some taxonomic groups, such as the bio-luminescent bacteria vibrio fischeri (Microbics Corporation, 1994), polycheliforms, amphipodous (Ciarelli S., 1994) and echinoderms, to polluting substances (Pellegrini, 1998).

4.3 Multi-parameter tools for «on-site» sampling

Most of the analyses based on manual sampling processed in laboratories could be carried-out by using instruments for continuous and on-site analysis. This instrumentation, equipped with emergency systems could be the environmental safeguard for port and surrounding areas. The prompt measurement of environmental indicators requires the use of complex instruments. These instruments assemble the main sounding leads necessary for measurements. Possible tools are oceanographic buoys and multi-parameter probes.

Oceanographic buoys

These buoys are stations of continuous remote sensing and are capable of containing many measurement instruments. They are positioned in the sea at a depth which can vary from 40 to 3000 meters.
Special accumulators recharged by sea solar panels installed on the buoy provide the system with the necessary energy. The solar energy allows the systems to carry out chemical and physical analyses such as: acidity, chlorophyll, dissolved oxygen, redox potential, salinity, turbidity, conductivity, nitrates, nitrites, phosphates and NH_3. Oceanographic buoys are also equipped with other important sounding leads to measure physical parameters which can be used to monitor many problems arising in port areas. Oceanographic buoys include sounding leads such as: underwater thermometers, barometers, solar irradiation detectors, inertial wave-meters, electronic compasses, positioning sensors, anemometers and hygrometers, radar sensors and day and night sonar cameras . By using these instruments it is a continuous remote supervision is possible. Acoustic microphones, for instance, allow surface or air transportation means to be identified. Hydrophones and sonars allow the presence of boats, the study of cetaceans and fish or submarine vehicles to be identified.

Advantages

The use of oceanographic buoys permits continuous monitoring of waters also during bad weather conditions when manual samplings are more difficult. Oceanographic buoys are, therefore, a very useful instrument in monitoring, not only for their precise measurements of the relevant parameters but also for all general management issues and for security in port areas. Data are transmitted by radio and the system guarantees complete and precise transmission. The receiving station processes and controls the data received by many buoys simultaneously, therefore enabling the evaluation of the quality of port waters. In many cases it is possible to interface the database of the central unit by using a simple telephone line. In this way, it is possible to receive information from all over the world without intrusion, since the system is protected with a security device Compact receiving meteorological stations are on the market. They are very small in size and can be installed, therefore, on small boats too. They are useful for unforeseen situations which require prompt and on-site interventions.

Equipment

The disposition and number of oceanographic buoys depends on port area conformation and marine currents. Generally it is recommendable to install 1 buoy every 10 km of coast.

Multi-parameter probes

This type of equipment is used for rapid and discontinuous measurements. They measure in real time parameters such as temperature, pH, conductivity, salinity, dissolved oxygen and redox systems until 100 meters of water depth.
The monitored parameters can be recorded on a data base and than, eventually processed.

5 MONITORING COSTS

Table 14 shows the indicative costs to monitor, by sampling, the parameters indicated in table 13. it is important to note that these costs are composed as follows:

- *manpower costs*
- *instrumentation mortgage costs*
- *reagents costs*
- *indirect costs.*

Table 14: Indicative costs for environmental monitoring

ACTIVITY	COST IN EURO/YEAR
Sampling (4 sites)	2450
Pollutants analysis (4 sites)	1120
Estimated cost of a complete monitoring plan	17000

Table 15 shows the indicative costs for continuous (oceanographic buoys) and discontinuous (multi-parameter probes) sea water monitoring without sampling. It is important to note that these costs are related to a single oceanographic buoy and do not comprise manpower maintenance costs and VAT.

Table 15: Indicative monitoring costs for a single oceanographic buoy and for multi parameter probes

EQUIPMENT TYPOLOGY	COST OF INSTRUMENTS (Euro)	OPERATING COSTS (Euro)
Oceanographic buoy:		
Standard	43000	3000
Package for acoustic reliefs	13000	5000
Package of elements for analysis	22000	6000
Weather station	13000	1400
Receiving station on land	15000	1400
Multi-parameter probe (temperature conductivit salinity, element for redox for dissolved oxygen)	10000	

6 DEFINITION OF INDICATORS AND CRITERIA: ASSESSMENT / EVALUATION OF MONITORING RESULTS

The assessment of monitoring activities can by carried-out by comparing the results with the reference indicators and/or criteria indicated in the above section on ‘Monitoring’ with particular emphasis on:

- **Concentration of dissolved oxygen in the water**

Low oxygen concentration affects the life of fish and benthic communities. In this respect, a valid classification of water quality could be the one proposed by the Economic Commission for Europe (ECE, 1982) standard statistical classification of marine water quality:

a) High quality (dissolved oxygen more than 7 mg/l and % of saturation more than 80);
b) Good quality (dissolved oxygen 6 ÷ 7 mg/l and % of saturation more than 60);
c) Fair quality (dissolved oxygen 6 ÷ 4 mg/l and % of saturation more than 40);
d) Poor quality (dissolved oxygen 4 ÷ 3 mg/l and % of saturation more than 20);
e) Bad quality (dissolved oxygen less than 3 mg/l and % of saturation less than 20).

- **Faecal streptococci and Colimetric index**

These parameters indicate the status of water in tourist areas.
As a term of reference, the maximum limit value of these parameters for bathing waters in port areas should not exceed 100 faecal streptococci / 100 ml and 100 faecal coliforms / 100 ml.

- **Benthic communities**

A careful examination of benthic communities, at least once per year, is recommended in order to identify quality modifications in the marine environment.

Moreover, general criteria to reach and maintain a good quality of marine water are:

- Avoid bio-accumulation of dangerous substances on biota and, through the food chain and trophic web, to human beings;
- Avoid that marine species abandon their natural environment;
- Allow all development phases of aquatic organisms.

7 PRINCIPLES AND GUIDELINES FOR IMPROVEMENT / NEEDS FOR TECNOLOGICAL INNOVATION

The analysis of considerations done on the previous sections suggests the following principles and needs to improve marine quality and the activities of environmental monitoring on port areas.

1. Environmental impact of human activities carried-out in port areas must be assessed by taking account of the global effect produced from the single source of pollution.
2. Planning of investments.
3. Actions evaluation and follow up.
4. Have objective information to incite the ports managers to research good solutions permitting to eliminate the pollution at its sources.
5. Plan the environmental littoral development, globally and locally, improve the knowledge about the area and protect the area, with quality objectives.
6. Sensitize and communicate.
7. Need for research improvement, starting from a careful analysis of ports and their surrounding infrastructures.
8. Consistency in monitoring the parameters and indexes specified in previous sections.
9. Need to constitute territorial branches specialised in marine environment protection and related emergency management.
10. Need for continuous monitoring networks of port waters by installing appropriate equipment and related systems of remote sensing; these systems should be directly managed by competent territorial authorities (port authorities, etc.) and specialised branches.
11. Need for continuous monitoring discharge deballasting water.
12. Need for more appropriate equipment for emergency operations in case of environmental disasters.
13. A careful examination of benthic communities, at least once per year, is recommended to identify quality modifications in marine environment.
14. Need for continuous monitoring of toxic heavy metals concentration on sea bed.
15. Use of biological tracers. These are biochemical or cellular responses which indicate that an organism has been subjected to chemical or an anthropogenic stress.
16. The control of the littoral environment has to be made according to the nature and each type of pollution. The three compartments must be considered: water, sediment and biota. The categories of pollutants to fight in priority are:
    - the nutrients (nitrogen and phosphorus);
    - the micropollutants including radio-elements;
    - the bacterial pollution.
17. Determination of a target species according to different criteria such as wide distribution, limited migration and contact with pollutant-rich sediments and selection of suitable parameters (a good example is the choice of Posidonia).
18. Need to keep under control the concentration of dissolved oxygen in port waters; it is recommended that this value never fall below 5 mg/l.
19. Need for keeping under control the auto-purification capability of port waters by a continuous monitoring of the T_{90} factor (bacteria elimination factor) which indicates the time required to reduce the initial bacteria charge by 90%.
20. Need to increase the auto-purification capability of marine waters. For this, appropriate piping systems (1000 to 3000 meters off-shore, 30 meters deep) for the discharge of treated waste waters are recommended.

8 ANALYSIS OF TRAINING NEEDS

Increasing concerns for environmental pollution, including marine or port water pollution, implies providing enterprises (in particular small and medium ones) with standardised systems and tools to bring personnel up-to-date on environmental technologies, standards and laws and monitoring the compliance of production sites with these. To this end, table 16 gives some suggestions (and related estimated costs) of the above mentioned tools.

Table 16: Recommended systems and tools to check environmental sites compliance and for personnel training

SYSTEM / TOOL	IMPLEMENTATION COST (INTERNAL AND EXTERNAL) (EURO)	REGISTRATION CERTIFICATION COSTS (EURO)
Integrated auditing systems for environmental managing of production sites:		
• EMAS	from 15000 to 25000 for instruction	from 5000 to 15000 for verification 250 for registration (1)
• ISO 14001	15000 to 25000 for instruction	10,000 for certification

Data banks on environmental standards and laws	5000 (initial cost)	1500 (operating cost)

Note:
(1) Reference is made to the Italian regulation (ANPA).

9 PUBLIC COMMUNICATION

The way in which the public is informed on the status of environmental health is a very critical topic. The quality of information and the way it is communicated determines the type and level of impact on the public and hence its positive or negative effect. Communication to the public should neither be too technical nor detailed but clear enough and complete to portray the true situation. Before being issued to the public, data should be checked and validated by the official competent authorities. Tools of communication can be television, newspapers, some free-phone telephone lines, illustrations, etc.

In particular the realisation of an Internet site (World Wide Web) could be useful where, once validated, all information and data could be put at the disposition of the public. As a general reference, table 17 shows some estimated costs of communication tools.

Table 17: Estimated costs of some tools of communication

COMMUNICATION TOOL	ESTIMATED COSTS (Euro)
• **Internet site**	25000 (operating cost per year)
• **Newspaper**	2000 (cost for one day/half page)
• **Illustrations**	1000 (cost to print about 10000 illustrations)
• **Television site**	45000 (cost of space for one year)
• **Congresses**	75 (cost per person all inclusive)
• **Free-phone telephone lines**	750 (installation cost per year)

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OIL STORAGE

OIL STORAGE WORKSHEET

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1 DESCRIPTION OF THE ACTIVITY

1.1 Oil storage activity

1.1.1 Generalities

The common origin of all the combustibles are the organic matters synthesised by the vegetal. The non-destructible organic matter (0.1% to 4%) will give the organic residues under the ground. The residues are insoluble.

The organic fossil matter is composed with polyaromatic nucleus and aliphatic chains. For more than one hundred million year the organic matter was deeply buried, and so the increase of the temperature started up a “thermo-cracking”. This phenomenon causes the destruction of the aliphatic chains, delivering liquid oil.

Crude oil is a complex mixture of aliphatic compounds, aromatic compounds, sulphur compounds, oxygenated substances, nitrogenous compounds, asphalt compounds and metal compounds. In asphalt, the high molecular weight compounds are composed with hetero-atoms as nitrogen, oxygen, sulphur, nickel and vanadium. Crude oils are always composed with the same families and then differ depending on their oilfield.

The common crude oil is defined by its physical-chemical characteristics : specific gravity, viscosity, boiling point, pour point, and level of trace elements (vanadium, nickel, sulphur and nitrogen).

The main physical properties, which affect the behaviour of oil spilled at the sea, are specific gravity, distillation, characteristics, viscosity and pour point.
The specific gravity of oil is its density in relation to pure water. Most oils are lighter than water and have a specific gravity below 1. The density of crude oils and petroleum products is usually expressed in terms of API gravity in accordance with the following formula:

$$API = (141.5 / \text{Specific Gravity}) - 131.5$$

In addition to determining whether or not the oil will float, its density can also give a general indication of other properties of the oil. For example, oil with a low specific gravity (high API) tends to be rich in volatile components and highly fluid.

The distillation characteristics of oil describe its volatility. As the temperature of oil is raised, different components reach their boiling point in turn and are distilled.

The viscosity of an oil is its resistance to flow. High viscosity oils flow with difficulty whilst oil with low viscosity are highly fluid. Viscosity decreases at higher temperatures and so the seawater temperature and the extent to which the oil can absorb heat from the sun are important considerations.

The pour point is the temperature below which oil will not flow. If the ambient temperature is below the pour point, the oil will essentially behave as a solid.

The toxicity of pollutants increase with increasing temperature. Slightly soluble pollutants such as oil are more soluble and may reach higher concentration in warm water than in cold water.

1.1.2 The storage activity

This activity is divided in four stages:

- Receipt the crude oil coming by sea;
- Store the crude oil in tanks;
- Can realised blending (melt some products to obtain a particular mixture);
- Supply the products to the clients by road, railway, sea or pipelines.

The storage activity is operated continuously (3x8 hours shifts for the quarter chief and the operator).

1.2 Laws

1.2.1 International laws

- The 1954 OILPOL convention, in London, is about the fight against the pollution of the sea by hydrocarbons.

- The 1969 Brussels convention concerns the harms caused by the pollution by hydrocarbons.

- The International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 (better known as MARPOL 73/78) is one of the must important international agreements on the subject of marine pollution. It concerns construction norms, like separated ballasts and double hull, and controls the activity of the oil tankers in special zones.
  Detailed regulations covering the various sources of ship-generated pollution are contained in five Annexes of the Convention.

  - Annexe I : regulations for the prevention of pollution by oil;
  - Annexe II : regulations for the control of pollution by noxious liquid substances in bulk;
  - Annexe III : regulations for the prevention of pollution by harmful substances in packaged form;
  - Annexe IV : regulations for the prevention of pollution by sewage from ships;
  - Annexe V : regulations for the prevention of pollution by garbage from ships.

The annexes I and V must be applied by all the States.

- The1974 Solas convention concerns the safety at sea and the maritime pollution.

- The Barcelona convention in 1976, is about the interdiction of spilling oils in the sea. This convention is related to the co-operation concerning the fight against oil pollution in the Mediterranean sea.

- The Paris memorandum in 1982 is about the control of the ships in ports, to see if they respect the Marpol construction norms.

- The accidental spilling of oil in the sea is covered by an international law. So the polluter has to pay for the damage done by oil. This convention was done in London November 27th, 1992.

1.2.2 European laws

- Directive 61/96/EEC is about prevention and reduction of pollution.

- Directive 76/464/EEC concerns the pollution caused by harmful substances discharged in aquatic environment. It defines two categories of pollutants in function of their toxicity, persistence and bio-accumulation.

- Directive 77/585/EEC is relative to the conclusion of the convention to the protection of the Mediterranean sea against pollution.

- Decision 81/420/EEC dated May 19th, 1981 concerns the treaty conclusion relative to the co-operation in matter of fight against Mediterranean Sea pollution by hydrocarbons and other harmful substances.

- Directive SEVESO dated June 24th, 1982 is relative to accident risks in classified installations in matter of environment protection.

- Decision 84/358/EEC dated June 28th, 1984 concerns the treaty conclusion relative to the co-operation in matter of fight against North Sea pollution by hydrocarbons and other harmful substances.

- Decision 86/85/EEC dated March 6th, 1986 institutes an information community system to control and to reduce the pollution caused by discharge of oils and other harmful substances. It is modified by the decision 88/346/EEC dated June 16th, 1988.

- Regulation 1973/92/EEC dated May 21st, 1992 is relative to the creation of a financial instrument for environment (LIFE). Its aim is to develop and to apply the politics and the community legislation about environment. It modifies the regulation 563/91/EEC MEDSPA and the regulation 3908/91/EEC NORSPA, programs of fight against pollution in Mediterranean Sea and in North Sea.

1.2.3 Uniform protection areas

The decision 84/132/EEC dated March 1st, 1984 concerns the conclusion of the draft treaty relative to the special protected areas in the Mediterranean Sea.

The ZNIEFF are areas itemised for the national inventory of the natural patrimony, presenting an ecological interest. It is a tool for knowledge, and have a juridical value.

2 POLLUTION SOURCES (CONCERNED SUBSTANCES AND BY - PRODUCTS)

2.1 Land pollution sources

The essential risk of pollution is created by the leak of the storage area, which induces the percolation of the oil in the ground. The oil pollutes the soil and the ground water. The pollution is created by:

- Escape of the material (corrosion, leakage, etc.);
- Human error;
- Exterior attack (thunder, human attack, etc.).

The potential risks emphasised the importance of having continuous monitoring of the area. The monitoring reduces the risk of pollution of the marine environment. The security provisions are regularly evaluated, but the "coincidence" of different events can produce an accident.

The evaluation of the risks is made possible by "Failure Modes Effects and Consequences Analysis" (FMCEA) method. This method works with a database examining the reliability of system components (table 1). This method determines a failure probability.

The failure of material can have dangerous effects for the environment. The level of risk is different depending upon the equipment.

Table 1: Database evaluation of the reliability

Frequency by hours	
A > 10^{-3}	Very unreliable, occurs frequently
B > 10^{-4}	Very unreliable, occurs frequently
10^{-4} > C >10^{-6}	Once every ten year, rare probability but possible
10^{-6} > D > 10^{-8}	Never happened, but possible
E < 10-8	Improbable, but possible
F ~ 0	Impossible

Pollution occurs essentially when oil is loaded and unloaded from the tanks. Pollution can also be caused by the leakage of valves or pipes.

Coating the sediment, the spilled oil will slowly progress with the infiltrated water. This percolation brings the oil up to the ground water, later on the oil mix with the ground water will percolate to the sea.

In fact, soil can be polluted by direct infiltration of oil in waterproof ground or by infiltration of polluted rainwater in the waterproof ground.

The pollution of the ground by the oils depends on the percentage of organic matter in the ground, the nature of the sediment, its granulometry and the quantity of oil spilled. In fact, clay soils adsorb more easily the organic compounds than chalky soils.

2.2 Sea pollution sources

2.2.1 Natural sea pollution sources

Some natural oozing exist in the continental surface and pollute naturally the marine environment. The marine organisms elaborate hydrocarbons or precursor of hydrocarbons. These oils will accumulate in the sediment.

2.2.2 Anthropic sea pollution sources

By the atmospheric way, industrial smoke and exhaust gas bring hydrocarbons in seawater.
There are a lot of direct discharges which are one of the main sources for the pelagic pollution. They are systematic or accidental.

The systematic discharges take place during the cleaning of petroleum tanks (in case of storm), the off-shore exploitation, the discharges of oil refinery and the urban discharges. The accidental discharges happen during the petroleum shipping.
During the operation of storage, an accidental oil spill can reach the sea by river or after a percolation in the ground. In such a case the oils contact with the sea will create a thin cover, intercepting a part of the sun and limiting the photosynthesis processes. Then the gas exchange is disturbed, which affects the re-oxygenation process and as a consequence the auto-purification process.

2.2.3 Oils evolution

The hydrocarbons evolution depends on several parameters : mechanic and physical-chemical parameters, and biological parameters.
The first induce the moving of the oil slick, in accordance with the currents, waves and tide, the mixing, the degradation and the sedimentation.
The second consist of a bacterial degradation and a passage in the food chain by zooplankton and filter organisms.
Oil spilled into the sea undergoes a number of physical and chemical changes, some of which lead to its disappearance from the sea surface whilst others cause it to persist. The time taken depends primarily upon the physical and chemical characteristics of the oil, as well as the quantity involved, the prevailing climatic and sea conditions and whether the oil remains at sea or is washed ashore.
In considering the fate of spilled oil at sea, a difference is frequently made between non-persistent oils, which tend to disappear rapidly from the sea surface, and persistent oils, which disappear more slowly and usually require a clean-up response.
Non-persistent oils include gasoline, naphtha, kerosene and diesel. Most crude oils and refined residual oils have varying degrees of persistence depending on their physical properties and the flow of the spill.

2.2.3.1 Mechanic and physical-chemical parameters

During the mixing, two types of emulsion can appear: the emulsion water-in-oil and the emulsion oil-in-water.

The emulsion water-in-oil makes up a gelatinous mousse called “chocolate mousse”. This film of 1 mm thickness is very stable and stays fair seawater surface. These mousses are above all produced by heavy fuels. Their chemical and biological degradations are very slow.

The emulsion oil-in-water takes up droplets in rough sea conditions. These droplets can be degraded more rapidly by biological and photochemical processes. In this case, the oil can be ingested by filter organisms or can stick to plants. Also, they will be dispersed in all the ecosystem.

With these two types of emulsions, when the volatile fraction is evaporated, some tar balls are formed and deposited in the sediment.

2.2.3.2 Role of marine organisms

Zooplankton and Copepodes (Crustaceans) ingest a lot of oil which they will excrete in their faeces without modification. Under this form, oil is more easily used by organisms and it deposits in sediment more rapidly. Also, 3 T/Km^2/day of petroleum disappear.

The filter Bivalves reduce oil in suspension and reject it in their faeces. For example, one mussel can keep up to 20 ml of oil by litre of filtered water.

The bacterial biodegradation is a natural process. Some bacteria use hydrocarbons as carbon sources. A pollution induces an increase of these population in one or two weeks, and the increase of the predator populations. After the pollution, the rate of bacteria becomes normally.
These processes are very slow. The oils effects persist during several years in sediment.

3 CONSEQUENCES

3.1 Effects on the environment

3.1.1 Effects of the weathering processes of the oil

The physical and chemical changes spilled oil undergo. The various processes are shown schematically in figure 1.

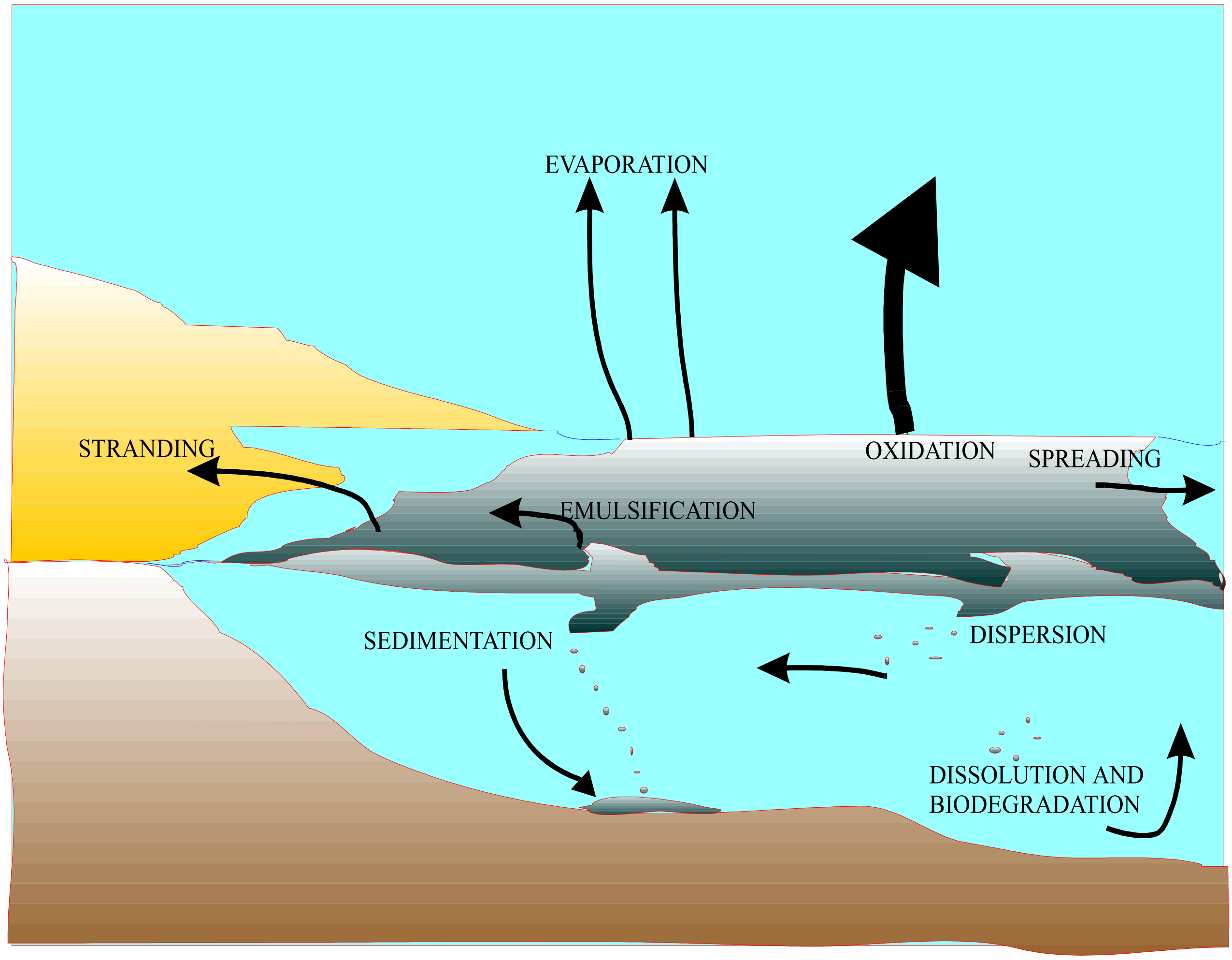

Figure 1. Fate of spilt oil including the main weathering processes

Knowledge of these processes and how they interact to alter the nature and composition of the oil with time is valuable in preparing and implementing contingency plans for oil spill response.

3.1.1.1 Spreading

It is one of the most significant processes during the early stage of spill. A large instantaneous spill will spread more rapidly than a slow discharge. High viscose oils spread slowly and those spilled at a temperature below the pour point hardly spread at all. After a few hours the slick begins to break up and form narrow bands parallel to the wind direction. Variations in spreading rate are due to difference in the prevailing hydrodynamic conditions such as current, tidal streams and wind speeds.

Spreading is not uniform (except in the case of small spill of low viscosity oil) and large variation of thickness occur within the slick.

3.1.1.2 Evaporation

The rate is determined primarily by the volatility of the oil. Greater are the proportions of components with low boiling points, greater are the evaporation. The initial spreading rate of oil also affects evaporation, since the place where the surface area is larger, the faster light components will evaporate.
Rough seas, high wind speeds and warm temperatures will further increase the rate of evaporation. In broad terms, the oil components with a boiling point below 200°C will evaporate within a period of 24 hours in temperate conditions.

Spills of refined products, such as kerosene and gasoline, may evaporate completely within a few hours and light crude can lose up to 40% during the first day. In contrast, heavy curds and fuel oils undergo little, if any evaporation.

When extremely volatile oils are spilled in confined areas, there may be a risk of fire and explosion. The flammability of oil has often led to the idea of burning slicks on the sea surface. Although it is often possible to ignite slicks, particularly of fresh oil, it is difficult to maintain combustion even when wicking agents are employed due to residues remaining after partial combustion being usually more troublesome and difficult to deal with than naturally weathered oil.

3.1.1.3 Dispersion

Waves and turbulence at the sea surface act on the slick and produce oil droplets with a range of sizes. Small droplets remain in suspension while the larger ones rise back to the surface, behind the advancing slick, where they may either coalesce with other droplets to reform a slick, or spread out in a very thin film. Droplets small enough to remain in suspension become mixed into the water column and the increased surface area presented by this dispersed oil can enhance other processes such as biodegradation and sedimentation.

The rate of natural dispersion is largely dependent upon the nature of the oil and the sea state, proceeding most quickly in the presence of breaking waves. Slick thickness, which is related to the amount spilled and the degree of spreading, is an important factor in the rate of dispersion since smaller droplets are produced from thin films.

Oils which remain fluid and can spread unhindered by other weathering processes may disperse completely in moderate sea conditions within a few days. Conversely, viscous oils or stable water-in-oil emulsions tend to form thick lenses on the water surface, and will show little tendency to disperse. Such oils can persist for several weeks.

3.1.1.4 Emulsification

Many oils tend to absorb water to form water-in-oil emulsion, which can increase the volume of pollutant by a factor between three and four. Such emulsions are often extremely viscous and so the other processes that would dissipate the oil are retarded. This is the main reason for the persistence of light and medium crude oils on the sea surface. Emulsion may separate out into oil and water again if heated by sunlight under calm conditions or when stranded on shorelines.

In wind strengths greater than about 7 to 10 knots, some low viscosity oils can incorporate between 60% and 80% water by volume within about 2-3 hours. In contrast, very viscous oils may take 10 hours or more to absorb 10% water under the same conditions and even after several days the water content seldom exceeds 40%.

Absorption of water usually results in black oil changing colour to brown, orange or yellow. As the emulsion develops, the movement of the oil in the waves causes the droplets of water taken up in the oil to become smaller and smaller making the emulsion progressively more viscous. As the amount of water absorbs increases, the density of the emulsion approaches that of sea water.

3.1.1.5 Dissolution

The rate and extent to which an oil dissolves depends upon its composition, extent of spreading, water temperature, turbulence and degree of dispersion. The heavy components of crude oil are virtually insoluble in sea water whereas lighter compounds, particularly components are also the most volatile and so are lost very quickly by evaporation, typically 10-1000 times faster than by dissolution. Concentrations of dissolved hydrocarbons rarely exceed one part per million and dissolution does not make a significant contribution to the removal of oil from the sea surface.

3.1.1.6 Oxidation

Hydrocarbon molecules react with oxygen and either break down into soluble products or combine to form persistent tars. Many of these oxidation reactions are promoted by sunlight and although they occur throughout the lifetime of a slick, the effect on the overall dissipation is minor in relation to other weathering processes. Under strong sunlight, thin films break down at rates of no more than 0.1% per day.

Oxidation of thick layers of high viscosity oils or water-in-oil emulsions is more likely to lead to their persistence than to their degradation. This is due to the formation of higher molecular weight compounds, which form a protective outer skin. For example, the tarry deposits, which are sometimes stranded on shorelines as tar balls, usually consist of a solid outer crust combined with sediment particles surrounding a softer, less weathered interior.

3.1.1.7 Sedimentation

Some heavy residual oils have specific gravity greater than 1, and so will sink in fresh or brackish water. However, very few crude oils are sufficiently dense, or weather to such an extent that the residues alone will sink in sea water. Sinking is usually brought about by adhesion of particles of sediments or organic matter to the oil.

Temperature can also be expected to affect the behaviour of neutrally buoyant oil. Over a 10°C temperature range the density of the sea water will only changes by 0.5%.
Oil, which barely floats during the day, may submerge as the temperature falls at night due to its greater relative increase in density but may resurface later in warmer water.

Shallow waters are often laden with suspended solids providing favourable conditions for sedimentation. It is less likely in the open sea, but zooplankton may inadvertently take in particles of oil during feeding which become incorporated into faecal pellets, which fall to the seabed.

Oil stranded on sandy shorelines often becomes mixed with sediments and if the mixture is subsequently washed off the beach it may sink. Sheltered shorelines tend to be made up of fine-grained sediments and if oil becomes incorporated in these, it is likely to remain there for a considerable time.

3.1.1.8 Biodegradation

Seawater contains a range of marine bacteria, moulds and yeast, which can utilise oil as a source of carbon and energy. Such micro-organisms are widely distributed in the sea although they tend to be more abundant in chronically polluted water, such as those receive industrial discharge and untreated sewage.

The main factors affecting the rate of biodegradation are temperature and the availability of oxygen and nutrients, principally compounds of nitrogen and phosphorous. Each type of micro-organism is not always present in sufficient numbers in the open sea, but with the right conditions they multiply rapidly until the process becomes limited by nutrient or oxygen deficiency.

Because micro-organism live in seawater, biodegradation can only take place at an oil/water interface. Oil stranded on shorelines above high water mark will therefore break down extremely slowly and may persist for many years. Once oils become incorporated into sediments, however, degradation rates are very much reduced due to a lack of oxygen and nutrients.

3.1.1.9 Combined processes

The processes of spreading, evaporation, dispersion, emulsification and dissolution are most important during the early stage of a spill, whilst oxidation, sedimentation and biodegradation are long term processes which determine the ultimate fate of oil.

Since the mechanisms of interaction between the various weathering processes are not well understood, reliance is often placed on empirical models based upon oil type.

For this purpose it is convenient to classify the most commonly transported oils into four main groups roughly according to their specific gravity. As a general rule, the lower the specific gravity of the oil, the less persistent it will be.

Having classified the oils, one way in which their persistence can be described is in terms of a half-life for each group. This is the time taken for the removal of 50% of the oil from the sea surface. After six half-lives, little more than 1% of the removal will remain. Weather and climatic conditions will also influence the half-life of a slick.
For example, in a very rough weather, an oil in Group 3 may dissipate within a time scale more typical of a Group 2 oil. Conversely, in cold calm conditions it may approach the persistence of Group 4 oil.

3.1.1.10 Forecasting slick movement

It is equally important to be able to forecast the probable movement of the slick as well as the likely changes in the properties of oil after it has been spilled.

This allows sensitive resources in the path of the slick to be identified and, if appropriate, response measures to be put into effects. The task of forecasting the position of the oil can only be accomplished if data on winds and currents are available, since both contribute to the movement of floating oil from a known position. The movements of the slick correspond to 3% of the wind speed.

3.1.2 The effects of oil on marine organisms

The paraffin compound perturbs some biological mechanisms, and aromatics are a violent poison for all organisms. The distillation products of the oil act on the nervous system of the marine organisms. The toxicity of the refined products is more important than the crude oils. Essence is the most toxic product. The dispersants used to make the oil soluble in the water can be dangerous for some marine organisms. The neritic province is the place the most disturbed by oil pollution.
The effects of oil on marine life can be considered as being caused by either its physical nature (physical contamination and smothering) or by the chemical components of the oil (toxic effects and accumulation leading to tainting). Marine life may also be affected by cleaning up operation or indirectly through physical damage to the habitats in which they live.

Population of plants and animals in the sea are subject to considerable natural fluctuations in numbers brought about, for example, by changes in climatic and hydrographic conditions and the availability of food. Thus the species composition and age structure of the various populations within a particular marine habitat are far from constant but instead are in a state of dynamic balance. It is usually extremely difficult to assess the effects of an oil spill and to distinguish changes caused by the oil from those due to natural variability.

The different life stages of a species may show widely different tolerances and reactions to oil pollution. Usually the eggs, larval and juvenile stages will be more susceptible than the adults. However, many marine species produce very large numbers of eggs and larval stages to overcome natural looses. This will normally result in less than 1 in 100,000 eggs or larvae surviving to maturity but the excess production provides a reservoir to compensate for any extreme losses due to adverse local conditions. These facts make it unlikely that any localised losses of eggs or larvae caused by an oil spill will have a discernible effect on the size or health of future adult populations.

The ability of animal and plant populations to recover from an oil spill and the time taken for a normal balance in the habitat to be re-established depends upon the severity and duration of the disturbance and the recovery potential of the individual species. Abundant organisms with highly mobile young produced regularly in large numbers may repopulate an area rapidly when pre-spill conditions are restored, whereas populations of long lived, slowly maturing species with low reproductive rates may take many years to recover their numbers and age structure.

Whilst it may be possible to restore the physical characteristics of an oiled habitat to near its pre-spill condition, the extent to which its biological recovery can be enhanced is severely limited. Although the cleaning of salt marshes, and replanting with seedlings, may be feasible in some situations, care needs to be exercised to ensure that the area is not physically damaged since this may be more destructive in the longer term than the loss of vegetation.

The replacement of animals is virtually impossible and although some species can be bred and released or be moved from undamaged areas (e.g. certain birds, fishes) it is highly improbable that such programmes will accelerate the natural recovery of a complex marine habitat.

3.1.3 Effects of oil on humans

Between the oil products the most dangerous for the humans are :

- Essence and volatile compounds;
- Kerosene, gas-oil and fuels;
- Mineral oil and crude.

A inhalation smell of oil products can kill (from 30 g of oil per litre of air). It brings an immediate loss of memory, followed by convulsions and death. Lower concentrations are characterised by deep sleep with loss of memory upon awakening.
Intoxication by ingestion depends to the quantity absorbed. The first signs start with a sore throat and sickness. Then appear nervous signs as if drunk. It can be dangerous if therapy is not quickly given.

Oil products have a lot of effects, their action depend upon the composition of the pollutant, their toxicity and the environment touched.

Combustion of oil is due to the presence of inflammable gas. Fire happens only if the mixing is at the interval oxygen / hydrogen.

3.1.4 Effects of the oil on coastal activities

Oil spills can have a serious economic impact on coastal activities and on those who exploit the resources of the sea. In most cases, such damage is temporary and is caused primarily by the physical properties of oil creating nuisance and hazardous conditions. The impact on marine life is compounded by toxicity and tainting effects resulting from the chemical composition of oil, as well as by the diversity and the variability of biological systems and their sensitivity to oil pollution.

The extent of the damage caused by a spill does not always reflect the quantity of oil spilled. A little oil in a sensitive area can do considerably more effects than a large quantity on a desolate rocky shore.

3.2 Impact on the environment and the users

3.2.1 Impact of oil on marine organisms

On marine organisms, oils can occur different types of effects:

- Lethal effects due to chemical toxicity and mechanical toxicity;
- Differed and sub-lethal effects which act in long term in the physiology or comportment. The mortality is differed after ingestion of contaminated animals;
- Mechanical effects are the liming of the organisms which induce a mortality in a long term. The liming can be acute or chronic.

On the coastline, the acute liming induce the disappearance of plants and algae, sessile animals and grazers. The seabirds and the sea-mammals are very vulnerable.

The chronic liming induce a rapid imbalance for the coastal communities and effects in long term by ingestion of oil. In preening their feathers, 90% to 95% of seabirds dead.

This impact is very important for mammals and seabirds which can be endangered yet. For other species, the recolonisation is always possible.

The oils can have a positive action for some organisms. A weak concentration in oils increase the respiration of vegetal cells. They cause the proliferation of bacteria and inferior mushrooms (Bellan and Pérès, 1994).

The major actions of oils are negative. They induce important lesions in the reproduction organs of the crab *Carcinus maenas* and in the Turbot larvae (fish). Oils have a narcotic action for mussels, induce the escape of prawns *Crangon* and alter the Salmonides migration (Bellan and Pérès, 1994).

3.2.2 Impact of oil on specific marine habitats

In the receiving environment, the oils form a surface film which induces several consequences:

- Desoxigenation of water. There is not exchange between water and air, the water becomes anoxic and the living organisms dead. This phenomenon induces a putrid fermentation because of the auto-purification processes are altered;

- The light cannot penetrate in water column and the primary production will decrease. The smooth running of all the food chain is concerned.

The following summarises the impact oil spills can have on selected marine habitats. Within each habitat a wide range of environmental conditions prevail and often there is no clear division between one habitat and another.

Plankton is a term applied to floating plants and animals carried passively by water currents in the upper layers of the sea. They form the base of the marine food web and include the eggs and young stages of fish, shellfish and many bottom-living animals. Their sensitivity to oil pollution has been demonstrated experimentally. In the open sea, the rapid dilution of naturally dispersed oil and its soluble components, as well as the high natural mortality and patchy, irregular distribution of plankton, make significant effects unlikely.

Plants and animals living on the sea bed (benthos) also form an important part of the food web and in nearshore waters many of the animals (“shellfish”) and some seaweed, such as kelp, are exploited commercially. The risk of surface oil slicks affecting the sea bed in offshore waters are minimal, but in shallow waters oil droplets may reach the bottom, particularly during periods of rough weather. Fresh crude oils and light refined products with a high proportion of toxic components can cause local damage to seagrass beds, and to various animals such as clams, sea urchins and worms.

The incorporation of oil into sediments can lead to their residence in localised areas of several years, with the possibility of sub-lethal effects and tainting of commercial species. Weathered oil may accumulate sediment particles and sink, especially after temporary stranding, possibly causing damage to benthic species.

Shorelines, more than any other part of marine environment, are exposed to the effects of floating oil. The impact may be particularly great where large areas of rock, sand and mud are uncovered at low tide. Whilst intertidal animals and plants are able to withstand short-term exposure to adverse condition, they may be killed by toxic oil components or physically smothered by viscous and weathered oils and emulsions. Animals may also become narcotised by the oil such that they become detached from the rock surfaces or emerge from burrows.

They are then susceptible to predator or to being washed into an area where they cannot survive.

Recolonisation of a shoreline by the dominant plant and animal species can be rapid : on rocks the initial stage is usually the settlement of seaweed followed by the slower return of grazing animals. However, the complete re-establishment of a normal balance may, in extreme situations, take many years.

3.2.3 Impact of oil on the coastal activities

Contamination of coastal amenity areas is a common feature of many oils spills leading to public disquiet and interference with recreational activities such as bathing, shipping, angling and diving. Hotel and restaurant owners and others who gain their livelihood from the tourist trade can also be affected.
Persistent oils and their residues because of their visual impact, cause the most nuisance and concern, with the greatest effect likely to be just before or during the main tourist season. The disturbance to coastal areas and to recreational pursuits from a single oil spill is comparatively short-lived and any impact on tourism is largely a question of restoring public confidence once clean up is completed.

Interference with shipping may results from oil spills and clean up operations, taking place in harbours and port approaches. The installation of booms or closure of lock gates to contain oil may cause delays. Direct contamination of jetties as well as mooring lines and hulls of ships is a common occurrence.

Other routine harbour activities such as ferry services and lock operations can be disrupted, particularly after a spill of light crude oil, gasoline or other flammable material. Welding and the use of spark-generating machinery may have to be suspended as long as fire hazard persists. In this way even small spills in a busy port can have considerable repercussions.

3.2.4 Impact of oil on fisheries and marine cultures

There are two types of impact for fisheries:

- The direct impact: stocks decrease by adults mortality, alteration of shipping ways, destroying of nurseries, physical degradation of environment;
- The indirect impact: accumulation and storage of pollutants in greases, danger for consummation (Bellan and Pérès, 1994).

The degradation of the ecosystems induces economic nuisances destroying fisheries which take seven or eight years to restore them. The surface film can destroy eggs and larvae in one stock with commercial interest.
There is a transfer of pollution in the food chain up to grease of comestible fishes. The organisms cannot be consummated and the more sensible species disappear (Bellan and Pérès, 1994).
An oil spill can directly damage the ships and gear used for catching or cultivating marine species. Floating equipment and fixed traps extending above the sea surface are more likely to become contaminated by floating oil.
Reducing catches of fish, shellfish and other marine organisms are occasionally reported after an oil spill. Most often this is due to the reduction in fishing effort. Rare physical occasion of contamination or close contact can cause moralities with freshly spilled oil in shallow water with poor water exchange.
It is sometimes suggested that fish and shellfish stocks will be depleted for a number of years after a spill as a result of damage to eggs and larvae. However, experience from major oil spills has shown that the possibility of such long-term effects is remote because the normal over-production of eggs provides a reservoir to compensate for any localised losses.
Cultivated stocks are more at risk from an oil spill : natural avoidance mechanisms may be prevented, and the oiling of cultivation equipment may provide a source for prolonged input of oil components and contamination of the organisms.
Reduced catches of fish, shellfish and other marine organisms are occasionally reported after oil spill. More often this is due to reduction in fishing effort and natural fluctuations in size of the stock.
It is comparatively easy to determine oil spill death rates in a cultivated stock of known size. Losses can be quantified by comparing post-spill production with yields and market values in previous years or in adjacent unaffected areas. The situation in the case of naturally occurring species is frequently more difficult since accurate stock assessment is impossible and any dead individuals are likely to be consumed by scavengers. Catch statistics are not sufficiently detailed to enable any decline due to an oil spill.

4 MONITORING

4.1 How to plan environmental controls on the activities

The ports should have their own special risk prevention plans. Every quay should have a dedicated fire fighting system providing a screen of water to protect staff and a video camera system covering the entire area.

In windy conditions, the guards should be at high alert because if pollution occurs it can be dangerous for the marine environment.

In the case of a serious alert the ports should call a special group which could be set up by one representative person of the following services:

- Port harbour master office;
- Management of the Oil and Chemical installation;
- Navy Fireman;
- Naval reparation and heavy packages;
- Service of the workers;
- Lighthouse and Beacon service;
- Maritime Service (Water Police);
- Communication and public relations.

Pollution response operation involve three phases:

- Research of products and methods used, depending on the type of pollution involved;
- On-site implementation;
- Calling on specialised services to provide operational support.

Also sea environmental controls could regularly be done by a special plan. This plan could deal all the oil pollution. This plan should have several miles of high sea boom, more than 200 karcher washing units, pillow tanks and a number of ships for skimming oil slicks.

This plan has to control the coast where oil pollution can occur. Special aircraft equipped to detect pollution implement the control. If a pollution incident occurs the plan is executed.

Anti-pollution barrages are very useful for the collection of oil pollution spilled on the sea. Three type of barrage exist :

1. The first type called “fence” is held in vertical position by lateral floaters, filled with air.

2. The second type is called “curtain” and have cylindrical floaters held by ballast beneath.

For both of these barrages, water current plays an important part in the success of the technique. If the water speed is above 0.7 to 1 knot, the barrage will not be effective.

Wind is also a cause of overflowing leakage. An adequate solution is to use several barrages, backing each other. This technique permits the leakage recapture from the preceding barrages.

3. The third type of barrage is made up of a floating tube, which absorbs oils. They are used to get rid of the last traces of oil or to clean inaccessible places. Their absorbing power can reach 3 to 6 times their initial weight.

The waves action on oil slicks can promote the natural dispersion of oil into small droplets. Then the oil becomes more readily available for eventual degradation by micro-organisms. In order to accelerate this process it is sometimes better to use a chemical dispersing. The removal of oil from the sea surface prevents the formation of persistent water-in-oil emulsions and residues.

Much oil spills results in the pollution of shorelines, despite efforts to fight the oil at sea and to protect the coastline. Shoreline clean-up is usually straightforward and does not normally require specialised equipment. However, the use of inappropriate techniques and inadequate organisation can increase the damage caused by the oil itself.

4.2 How to plan environmental controls in the environment

There has been numerous authors who showed interesting methods to identify oil pollution in the environment like:

- The chemical measuring of sulphur, nickel, and vanadium;

- The infrared spectrophometry. The detection limit of oil is up to 20 µg/l. it is a quantitative approach;

- The gas chromatography at high resolution (capillary columns). It is a quantitative and qualitative approach;

- The test of biological effects or EROD test. It allows to detect hydrocarbons pollution using organisms like indicators. The measure of the EROD enzyme ratio in the organisms indicates the chronic pollution ratio in the environment;

- The test of embryo-toxicity on the bivalves (oyster larvae, mussels, sea urchin…) gives a good indication of the quality of the habitats (see § 4.2.3.2, worksheet “Port waters”).

The objectives to plan an environmental control could be to:

- Plan the environmental littoral development, globally and locallyl;
- Help for planning and investment;
- Protect the immediate area, with quality objectives;
- Follow and evaluate the actions;
- Improve the knowledge about the area;
- Sensitize and communicate.

Coastal zone is divided into “homogeneous” areas. Three levels of impact could be studied:

1. The first area is the zone nearest to the coast. It corresponds to the area where there is a dilution of the rejects.
2. The intermediate area starts at the bathymeter 50 and goes up to 100 m. In this area the pollutant concentrations are mixed up.
3. The last area starts at the bathymeter 100 m, and is related to the background noise.

Measures should be done to analyse the quality of:

- The water column every trimester;
- The sediments once a year and every time the dredging activity is done;
- The living matter every semester;
- The phytoplanktonic and microbiological quality of the water every trimester and once a month in summer times;
- The area using the vitality of vegetal plantation as a biological indicator, twice a year.

These measures are done more often when there has been an oil spill: just after the accident, and all the weeks during the following month.

5 MONITORING COSTS

The monitoring cost to analyse the water discharge should be paid by the port (see table 14 of work sheet “Port waters”).

As an example, for the Port of Marseilles Authority, the total cost for the year 1997 was around 3,550 EURO. This is to analyse on four sites the quality of the water in the port.

6 DEFINITION OF INDICATORS AND CRITERIA: ASSESSMENT / EVALUATION OF MONITORING RESULTS

Water containing oil is reject in the sea after treatment. The reject norms admissible should be under 20 mg/l of oil per litre of marine water.

Two types of toxicity tests exist:

Tests of acute toxicity. The phenomena of photochemical oxidation induce the formation of acids and then the harmfulness increase. The aromatic compounds with a boiling point minus than 149°C are the most harmful. In this case, the pollutant concentrations are able to kill the organisms. The variations of temperature and salinity increase the species sensibility against pollutants.

Tests of sub-acute toxicity. In this case, the pollutant concentrations are unable to kill them but are able to affect the vital functions in the long term period (Bellan and Pérès, 1994).

Some biologic indicators can be used to calculate an index of pollution and to monitor the alteration of the environment. Some species are used yet: Bryozoaires, Echinodermes, Polychetes, Crustaceans (IFREMER, 1985). The benthic population is a good indicator of the evolution of the environment because it only lives in the same place.

There are some guidelines proposed for evaluating threshold values for tainting of seafood by chemical substances. These guidelines propose a procedure for measuring the ability of a chemical substance to taint seafood when the substance is present in the water to which the seafood is exposed.

Measurement of the capacity of a chemical to taint seafood is conducted in two stages : exposure of the organism to the chemical, and evaluation of the exposed organism for taint.

7 PRINCIPLES AND GUIDELINES FOR IMPROVEMENT / NEEDS FOR TECHNOLOGICAL INNOVATION

The first essential need for improvement concerns the watertightness of the retention basin of the storage oil. In fact those basin are made of ground to protect the area in case of an accidental spill. They are reputable watertightness, but are only composed with normal ground. They should have a fine cover of clay or a plastic membrane to protect at least the ground water if pollution occurs.

An other principle for improvement is the necessity to have experienced and trained personnel for anti-oil pollution activities. Also it is very important to remember four essential operations for fighting oil pollution at sea or on land.

Identification of the pollutant
⇩
Immediate stopping of the pollution
⇩
Confining of the pollutant
⇩
Elimination and treatment of the pollutant

The concept of “biological indicators” (and biological clues) is applied to all levels of integration, from sub-cellular to ecosystem.
From simple data, of synthetic value (taxon, reduce groups of taxons, function, metabolite, etc.) a global holistic approach is made possible, which leads to an accurate interpretation of a phenomenon as well as to the prediction of its evolution.
Nevertheless, their choice, their use, their interpretation indeed their validity necessitate more than precautions: they require abilities (Bellan, 1992).

The establishment of a network to assess pollutant effects is a current concern of international organisations such as the North Sea Task Force, the International Council for the Exploitation of the Sea and the Intergovernmental Oceanographic Commission. Three major considerations have been defined : the choice of monitoring areas; the determination of a target species according to different criteria such as wide distribution, limited migration and contact with pollutant-rich sediments; and the selection of suitable parameters (Galgani *and al*., 1992).

8 ANALYSIS OF TRAINING NEEDS

Because of the difficult decisions required during a ballast spill, in order to mitigate damage and to resolve conflicts of interest, much can be done at the contingency planning stage to identify sensitive areas and to determine priorities for protection. The mapping of sensitive areas can be a useful starting point.

Detailed consideration should be given to the likely impact that a spill would have on each habitat or activity, taking into account any seasonal variability. Also attention should be given to identifying areas to be protected and their order of priority. This will never be easy since value of each resource to the community will depend upon the weight given to environmental recreational, economic and political considerations.

Having determined priorities for protection, attention can be given to designating appropriate clean-up measures. It is necessary to make realistic assessment of feasibility of employing various techniques since the recommendations to avoid the more ecologically damaging response options may result in the no-adaptation of techniques.

Absorbent, dispersing and biodegradable products have to be used only in great needs. In fact those products are harmful to the environment (except for the biodegradable products of the latest generation). They have a toxic action on the maritime organisms.

The article 8 of the Directive “SEVESO” mentions that the Members States have to see to : the persons who can be affected by a major accident are being informed about the comportment to adopt in that case. So, workers and public have to be informed to improve prevention and to prepare intervention.

The control of the littoral environment has to be made in accordance with the nature and each type of pollution.

Three types of criteria are used:
- Subjective (smell, colour, appearance)
- Link with the hydrobiological factors (temperature, pH, turbidity, salinity, nutritive salts…)
- Toxic factors (origin, nature, toxicity threshold).

The three compartments must be considered : water, sediment and organisms (Arnoux, 1992).

The biological tracers could be used too. They are biochemical or cellular responses which indicate that an organism has been subjected to a chemical or an anthropogenic stress (Galgani *and al*., 1992).

The impacts of anthropic activities in the environment are a growing worry for the concerned firms. The environmental management is a tool for the help of the regulation.
It is in this objective that the norm ISO 14,001 about the Systems of Environmental Management (SEM) was published in October, 1996 by the AFNOR (French Association for the Normalisation) and considered like European norm by the European Commission. It belongs to the international norms of the series ISO 14,000; The ISO 14,001 norm describes the requirements of the SEM.

The ISO 14,001 is a dynamic method to simplify and to elaborate the development of an adapted environmental politics. It permits to:

- Measure the effects of the activity which have some significant effects in the environment;
- Define the environmental objectives and aims;
- Elaborate some prevention and amelioration measures for a best control of the impacts of the activity in the environment.

The ISO 14,001 norm is based on five principles:

1. Adaptability: the norm is adapted for all the firms whatever their activities;
2. Complementarity: the ISO 14,001 completes the quality systems elaborated yet;
3. Prevention: it insists on the prevention and the capacity of the firm to react in case of accidents, and so to reduce the impact in the environment;
4. Engagement: the certification ISO 14,001 demonstrates the engagement for the constant progress of the environmental performance of the firm;
5. Universality: the ISO 14,001 is valuable at the international rank.

In port management, it appears necessary to get a sound perspective of the role of Environmental Audits (Ruling 1836/93) and of similar tools for environmental management in ports (ISO 14,000). It becomes necessary to prepare and deliver courses and seminars like:

- “Seminar on the European System of Environmental Management and Auditing and its application in the fields of ports”;
- “Designing Environmental Management and Auditing Systems adapted to port sector requirements”;
- “Training for Environmental Auditors specialising in the field of ports”.

9 PUBLIC COMMUNICATION

The decision 86/85/EEC dated March 6th, 1986 institutes a community system of information to control and to reduce the pollution caused by discharge of hydrocarbons and other dangerous substances in seawater or in internal waters. The first decision is modified by the decision 88/346/EEC dated June 16th, 1988.

The law n° 78-17 dated January 6th, 1978 gives law to every one to contest information and reasoning used in automated data treatments. The law n° 78-753 dated July 17th, 1978, modified by the law of 11th July 1979, is relative to the amelioration of the relations between administrations and public.

The directive 90/313/EEC dated June 7th, 1990 is relative to access liberty to information in matter of environment.

According to the Directive “SEVESO”, the Members States have to collaborate and to exchange information. The public has to be informed too about the comportment to adopt in accident case.

In the classified installations, a public enquiry must be done during one month to have the authorisation to exercise the activity or to develop the port area. This enquiry permits a good information of the public and the workers.

The decrees of the public inquiries (decree n° 85-453 dated February 1985) and the impact studies (decree n° 77-1141 dated October 1977) where modified by the decree n° 93-245 dated February 1993. It invites the public to give his appreciation on the projects.
The law n° 83-630 of the 12th July 1983 is relative to the democratisation of the public inquiry and to the protection of the environment.

Public communications should be carried out to raise awareness of pollution detection. In fact a brochure should exist.

This brochure should be given to shipping agents, port company workers, sailors, health and safety staff, refinery and depot personnel, immigration officials, pilot personnel, customs officials, tug crews, coast guards, ship crews, visitors… Reaching zero pollution and avoiding pollution from oil terminals concerns everyone.

If pollution is detected by somebody, they should dial the emergency channel to alert the port. This person will have to use the special map and special messages explained in the brochure to advise of the oil pollution.

The brochure should also specifies the risk depending on the port location : wind force on the Beaufort scale, the wind speed, wind direction, as well as the direction and the movement of hydrocarbon layers.

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Deballasting treatment

DEBALLASTING TREATMENT WORKSHEET

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1 DESCRIPTION OF THE ACTIVITY

1.1 Deballasting treatment activity

1.1.1 Generalities

When an oil tanker has discharged the oil in a port, it can not go away without loading a certain amount of water (10 to 15% of the total tank capacity, even up to 50%). This water ballast allows to the tanker to be navigable and cleans their tanks.

The ballast water can be cleaned in the ship by a process of “load on top”. Up to 80% of the oil tankers have the process “load on top” (only 20% are not equipped for cost reasons). The process allows the cleaning of oil from the tanks by pressurising the water in it.

The mixture of oil and water will settle in special tanks and will make slops. An emulsion separator can facilitate the settling. Then the deballasting station will treat the slops. The water phase containing little oil will be discharged into the sea.

The water ballast must be discharged into the port’s deballasting tanks. Those waters are inspected by a certified chemist. He will give the authorisation for its discharge into the deballasting station. Only clean ballasts are accepted as stated by the 1978 London Convention.

The ship have to respect the flow driving back order by the service of the petroleum installation or the operator of the deballasting treatment plant. The sea gate must be closed and fixed until the end of the deballasting operation.
The scuppers and deck of the floating bridge must be kept closed throughout the period of ballasting. Save-all must be placed in appropriate locations as necessary in order to collect spillage.

The cargo handling and the galley fires are forbidden during deballasting. The doors of the decks must be all closed, as are the tank covers and gauge caps. The deballasting operation is stopped if there is a fire in the port installation or on a ship, or if there is a bad weather conditions.

Before ballasting and before opening the seawater valves, the discharge lines must be cleared into an empty tank. The seawater suction pumps and all pipes must be cleaned. The pumps should be started slowly before opening the sea valves.
Deballasting are forbidden when the wind speed is less than four knots. In case of spillage, the port service must immediately be informed by the captain of the ship or by the guard officer. The responsible party will pay any pollution clearing. The oil terminal must be equipped with quick closing gates on the quay.

1.1.2 The ballast chain treatment

It is constituted by:

- A reception capacity of 60,000 m^3. Oil is separated from water via the primary separator with 5,000 m^3/hour flow (flow of the ship pump). At this level natural settling only creates a separation between oil and water.

- A storage lagoon of 80,000 m^3 in a retention basin with an adequate waterproofing. The lagoon receives water already treated by the primary separator. The maximum flow is 3,000 m^3/hour. Thebottom of the lagoon has 5 to 10 cm (or 3.94 inches) of waste. These wastes can be used without any treatment if they are mixed up with sand, chalk.

- A secondary separator insures the terminal treatment with a flow of 250 m^3/hour across filters with automatic washing.

- A discharge lagoon of 3,000 m^3, with continuous analysis of the oil values in the effluents. An infra red oil meter is used to measure the ppm (mg/litre) content. It has to be less than 15 mg/l as stated by the MARPOL legislation.

A ship of 200,000 tonnes has around 60,000 m^3 of ballast. It takes 20 hours to the pumps to deballast the ship. The second treatment takes 10 days.

The deballasting plant is completely fenced in. It is forbidden to smoke or to make fire 15 m around lagoon and around the secondary separator. The lagoon is waterproofed by a plastic film resistant to oil. All precautions have to be taken to limit the undermining of the ground due to the water pressure. Drains under the lagoon permit the detection of leaks. The recovery of oil is done in the 4 corners of the lagoon.

1.1.3 Valorisation of the slops

Oil residues (slops) from oil terminals can be recycled and valorised by a special installation that can treat up to 38,000 m^3 of oil per year. The role of this special installation is to transfer the slops (with 30% of water) in 3 heated up tanks (300 m^3 each), to obtain a mixture with 5 to 10% of water. The slops are then transferred in other tanks.

The final mixture contains 2% of water. The wastes from the bottom of the tanks are sent to the incinerator.

For 100 Kg of waste input there are two final products valorised:

- 15 Kg White Distillate Residue (WDR);
- 85 Kg Black Distillate Residue (BDR).

Those products are 100% low tenor in Sulphur.

In fact, this installation has an ECOIL (Economy-Ecology-Petroleum) plant where the technical choice is focussed on a solution using low pressure and low temperature in order to reduce investment and to facilitate the running of the process.

The unit yields a black distillate residue (BDR) which is equivalent to a low viscosity fuel oil with high calorific value (used for boilers, furnaces,…) and a white distillate residue (WDR) comparable to naphtha (used in the gasoline pool or in petrochemical industry).

This unit has been conceived and developed in order to meet the strict standards of large European Harbours. It is now totally operational and profits making, destined to solve nearly all pollution and recycling problems for ports.

The treatment plant consist of:

- Storage tanks of unfinished and finished products;
- ECOIL unit;
- Transfer pumps;

- Boiler room;
- Truck loading rack;
- Weighing scale;
- Laboratory;
- Office buildings.

The ECOIL unit is made up of:

- A rectification flash point column;
- Unfinished/finished products heat exchanger (black distillate residue);
- Unfinished/vapour product exchanger;
- 3 pumps : unfinished products – BDR – WDR;
- 1 water/distillate separator;
- Phase gas condensation material;
- 2 tanks : BDR and WDR;
- 1 fresh water cooling reservoir (lagoon);
- 1 fresh water air-cooled;
- Safety systems.

The retention tanks are waterproof, as all the areas susceptible to be polluted by oils. All the installation have to be easily accessible by the emergency services. A detector can stop the oil treatment in case of leak.

1.2 Laws

1.2.1 International laws

- The first international convention, the 1954 OILPOL convention, in London, is about the prevention of pollution in the sea.

- The Brussels convention dated November 29th, 1969 concerns the intervention in seawater in case of pollution caused by hydrocarbons and other substances.

- The international laws concerning the deballasting activity are under the MARPOL convention 1973-1978. These conventions entered into French law by the decree n°83-874 dated September 1983.

For a petroleum tanker the discharge into the sea are totally forbidden except in certain strict condition (more than 50 nautical miles from the nearest land, the tanker is not within a special area, the instantaneous rate of discharge of oil content does not exceed 30 litres per nautical mile…).

The administration shall ensure the ship is equipped as far as practicable and reasonable with an installation storing oil residues on board and discharging them to reception facilities.
Every new crude oil tanker of 20,000 tons dead-weight and above and every new product carrier of 30,000 tons dead-weight and above shall be provided with segregated ballast tanks. The ballast water is processed and discharged in compliance with regulation 9 ("Control of discharge oil"), referred to the regulation 20 ("Oil Record Book") of the MARPOL Annex I ("Regulation for the Prevention of Pollution by Oil").

As an example, the items recorded on the oil record book are:

1. Ballasting or cleaning of oil fuel tanks:

   - Identification mark of tanks ballasted;

   - Whether cleaned since they last contained oil and, if not, type of oil previously carried;

   - Cleaning process:
     - Position of the ship and time at start and completion of cleaning;
     - Identify tanks in which one or another method has been employed (rinsing through, steaming, cleaning with chemicals, type and quantity of chemicals used);
     - Identification of tank(s) into which cleaning water was transferred.

   - Ballasting:
     - Position of the ship and time at start and end of ballasting;
     - Quantity of ballast if tanks are not cleaned.

2. Discharge of dirty ballast or cleaning water from oil fuel tanks referred:

   - Identification of tanks;

   - Position of ship at start of discharge;

   - Position of ship on completion of discharge;

   - Method of discharge:
     - Through 100 ppm (mg/l) equipment;
     - Through 15 ppm (mg/l) equipment;
     - To reception facilities.

   - Quantity discharge.

- The1974 Solas convention concerns the safety at sea and the maritime pollution.

- Barcelona convention in 1976, is about the prohibiting of spilling oils into the sea. This convention is related to the co-operation concerning the fight against oil pollution in the Mediterranean sea.

- The Paris memorandum in 1982 is about the control of the ships in ports, to see if they respect the Marpol construction norms.

- The La Haye conference in 1990 has the objective to reduce the discharges in seawater.

- International convention help covers the accidental spilling of oil into the sea. This help reaper the damaged done by the oils pollution. This convention was agreed in London on November 27th 1992, and signed by France in 1993. Then it entered into used on May the 30th, 1996 (Decree n° 96-719).

- The 1992 Paris convention is about the protection of the north-east Atlantic. One of its objectives is the reduction of the discharges in seawater.

1.2.2 European laws

- Directive 61/96/EEC is about prevention and reduction of pollution.

- Directive 75/439/EEC dated June 16th, 1975 concerns the elimination of used oils; it was modified by the directive 87/101/EEC dated December 22nd, 1986.

- Directive 76/464/EEC dated May 4th, 1976 concerns the pollution caused by harmful substances discharged in aquatic environment. It defines two categories of pollutants in function of their toxicity, persistence and bio-accumulation.

- Directive 77/585/EEC dated July 25th, 1977 is relative to the conclusion of the convention to the protection of the Mediterranean sea against pollution.

- Decision 81/420/EEC dated May 19th, 1981 concerns the treaty conclusion relative to the co-operation in matter of fight against Mediterranean Sea pollution by hydrocarbons and other harmful substances.
- Directive SEVESO dated June 24th, 1982 is relative to accident risks in classified installations in matter of environment protection.

- Decision 84/358/EEC dated June 28th, 1984 concerns the treaty conclusion relative to the co-operation in matter of fight against North Sea pollution by hydrocarbons and other harmful substances.

- Decision 86/85/EEC dated March 6th, 1986 institutes an information community system to control and to reduce the pollution caused by discharge of oils and other harmful substances. It is modified by the decision 88/346/EEC dated June 16th, 1988.

- The modalities of importation of slop are in accordance with the law n° 93/259/EEC dated February 1993.

- Since July 6th, 1993 new petroleum tankers have to be built with a double hull or with a intermediary bridge, Directive 93/93/EEC.

- Directive 96/61/EEC is about the integrated prevention and the reduction of pollution.

- The norm ISO 14,001, dated October 1996, is about the System of Environmental Management (SEM). It belongs to the international norms of the series ISO 14,000. The ISO 14,001 norm describes the requirements of the SEM.

2 POLLUTION SOURCES (CONCERNED SUBSTANCES AND BY - PRODUCTS)

2.1 Land pollution sources

The essential risks of pollution are:

- Blackout of the material (corrosion, leak, etc.);
- Human error;
- Exterior attack (thunder, human attack, etc.).

A continuous survey of the area is important. The emergency procedures are regularly evaluated.

The assessment of the risks is possible by the method "Failure Modes Effects and Consequences Analysis" (FMECA). The method works with a database concerning the accuracy of the material, and determines the level of failure risk (table 1).

The failure of divers material can have dangerous effects for the environment. The level of risk is different depending on the equipment.

Table 1: Base of appreciation for a database of accuracy

Frequency by hours	
A > 10^{-3}	Very common happened a lot.
B > 10^{-4}	Very common happened a lot.
C $10^{-4} > 10^{-6}$	Once every ten year, rare probability but possible.
D $10^{-6} > 10^{-8}$	Never happened, but possible.
E < 10^{-8}	Improbable, but possible.
F ~ 0	Impossible.

2.2 Sea pollution sources

Pollution can be caused by bad treatment of slops. In that case, the water discharged into the sea is harmful to the marine environment.

If the deballasting station leaks, then the pollutant can reach the sea. The oil with the sea contact will create a thin cover, it intercepts a part of the sunlight and limits the photosynthesis processes. So it disturbs the gas exchange, affects the re-oxygenation process, and by consequences the auto-purification process.

If a fire takes place in the deballasting station, the oil products burning will be put out by water. This water is composed with oil and aromatics products. If this water reaches the sea it will be harmful for the marine environment. Poly-condensed nucleuses created in fires are very dangerous for the marine flora and fauna.

Oil spilled into the sea undergoes a number of physical and chemical changes, some of which lead to its disappearance from the sea surface whilst others cause it to persist.

The time taken depends primarily upon the physical and chemical characteristics of the oil, as well as the quantity involved, the prevailing climatic, and sea conditions.

3 CONSEQUENCES

3.1 Effects on the environment

Water ballast spills can have a serious economic impact on coastal activities and on those who exploit the resources of the sea. In most cases, such damage is temporary and is caused primarily by the physical properties of oil creating nuisance and hazardous conditions. The toxicity of oil and tainting effects on marine life result from the chemical composition of oil, as well as by the diversity and the variability of biological systems and their sensitivity to oil pollution.

The extent of the damage caused by a spill does not always reflect the quantity of water ballast spilled. A little oil in a sensitive area can do considerably more effects than a large quantity on a desolate rocky shore!

3.1.1 Effects for the living organisms

The effects of oil on marine life can be considered as being caused by either its physical nature (physical contamination and smothering) or by the chemical components of oil (toxic effects and accumulation leading to tainting). Marine life may also be affected by the cleaning up operation or indirectly through physical damage to the habitats in which they live.

Marine population of plants and animals are subject to considerable natural fluctuations : the species composition and the age structure of the various populations within a particular marine habitat. It is usually difficult to assess the effects of an oil spill and to distinguish changes caused by the oil from those due to natural variability.

The different life stages of the species may show widely differing tolerances and reactions to oil pollution. Usually the eggs, larval and juvenile stages will be more fragile than adults. However, many marine species produce large numbers of eggs and larval stages to overcome natural looses. This will normally result in less than 1 in 100,000 eggs or larvae surviving to maturity but the excess production provides a reservoir to compensate for any extreme losses due to adverse local conditions.
These facts make it unlikely that any localised losses of eggs or larvae caused by an oil spill will have a discernible effect on the size or health of adult populations.

3.1.2 Effects for the diversity

The ability of animal and plant populations to recover from an oil spill and the time taken for a normal balance in the habitat to be re-established depends upon the severity and duration of the disturbance and the recovery potential of the individual species.

Abundant organisms with highly mobile young stage produced regularly in large numbers may repopulate an area rapidly when pre-spill conditions are restored, whereas populations of long lived, slowly maturing species with low reproductive rates may take many years to recover their numbers and age structures.

The replacement of animals is impossible and although some species can be bred and released or be moved from undamaged areas (e.g. certain birds, mammals, reptiles and fish). It is highly improbable that such programmes will accelerate the natural recovery of a complex marine habitat.

3.2 Impact on the environment and the users

3.2.1 Impact of ballast water on the coastal activities

Contamination of coastal amenity areas is a common feature of to much discharged ballast water, leading to public disquiet and interference with recreational activities such as bathing, shipping, and diving. Hotel and restaurant owners and others who gain their livelihood from the tourist trade can also be affected.

Oil residues because of their visual impact, cause the most nuisance and concern, with the greatest effect likely to be just before or during the main tourist season.

Interference with shipping may result from ballast water and clean up operations, taking place in harbours. The installation of booms or closure of lock gates to contain oil may cause delays. Direct contamination of jetties as well as mooring lines and ships' hulls is a common occurrence.

3.2.2 Impact of ballast water on specific marine habitats

Plankton is the floating base of the marine food chain. It includes microscopic plants and animals, and the eggs and young stages of fish, shellfish and many bottom-living animals. Their sensitivity to oil pollution has been demonstrated experimentally. In the open sea, the rapid dilution of naturally dispersed oil and its soluble components, as well as the high natural mortality and patchy, irregular distribution of plankton, make significant effects unlikely.

Plants and animals living on the sea bed (benthos) also form an important part of the food chain. In onshore waters many of the animals ("shellfish") and some algae, such as kelp, are exploited commercially.

In shallow waters oil droplets may reach the bottom, particularly during periods of rough weather. Fresh crude oils and light refined products with a high proportion of toxic components can cause local damage to sea-grass beds and to animals such as clams, sea urchins and worms.

The incorporation of oil into sediments can lead to residence times of several years in localised areas, with the possibility of sub-lethal effects and tainting of commercial species. Weathered oil may accumulate sediment particles and sink, especially after temporary stranding, possibly causing damage to benthic species.

Shorelines, more than any other part of marine environment, are exposed to the effects of floating oil. Whilst intertidal animals and plants are able to withstand short-term exposure to adverse condition, they may be killed by toxic oil components or physically smothered by viscous and weathered oils and emulsions.

Animals may also become narcotised by the oil and be detach from the rock surface or emerge from burrows. They are then susceptible to predator or to be washed into an area where they can not survive.

Recolonisation of a shoreline by the dominant plant and animal species can be rapid : on rocks the initial stage is usually the settlement of sea-weeds followed by the slower return of grazing animals. However, the complete re-establishment of a normal balance may, in extreme situations, takes many years.

3.2.3 Impact of ballast water on fisheries and mariculture

The ballast spill can directly damage ships and gear used for catching or cultivating marine species. Floating equipment and fixed traps extending above the sea surface are more likely to become contaminated by floating oil whereas submerged nets, pots, lines and bottom trawls are usually well protected, provided they are not lifted through an oily sea surface. However, they may sometimes be affected by sunken oil.

Reduced catches of fish, shellfish and other marine organisms are occasionally reported after ballast water spilt. More often this is due to reduction in fishing effort and natural fluctuations in size of the stock.

It is comparatively easy to determine ballast water spill death rates in a cultivated stock of known size. Losses can be quantified by comparing post-spill production with yields and market values in previous years or in adjacent unaffected areas. The situation in the case of naturally occurring species is frequently more difficult since accurate stock assessment is impossible and any dead individuals are likely to be consumed by scavengers. Catch statistics are not sufficiently detailed to enable any decline due to a ballast water spill.

4 MONITORING

4.1 How to plan environmental controls on the activities

a) - Before a ship gets rid of the ballast water, an analysis should be done. The ballast water has to contain oil without tensio-actif, so the deballasting station will be able to treat them.

The final area of discharge should be equipped with a barrage, which allows the recovery of any accidental ballast water spillage.

b) - Valves can leak, so they should be equipped with special balloons capturing the leaking oil. The storage capacity of the balloons are around 16 cu.m, they are in a spiral and are buried. The oil is then sent back to the deballasting to be recycled.

c) - The ports should have their own special risk prevention plans. Every quay should have a dedicated fire fighting system providing a screen of water to protect staff and a video camera system covering the entire area.

In windy conditions, the guards should be at high alert procedures.

d) - In the case of a serious alert the ports should call a special group which could be comprised by one representative person of the following services :

- Port harbour master office;
- Management of the Oil and Chemical installation;
- Navy Fireman;
- Naval reparation and heavy packages;
- Service of the workers of Fos;
- Lighthouse and Beacon;
- Maritimes Services;
- Communication and public relations.

Pollution response operation involve three phases:

- Research of products and methods used, depending on the type of pollution involved;
- On-site implementation;
- Calling on specialised services to provide operational support.

e) - Sea environmental controls could regularly be done by a special plan. This plan could deal all the oil pollution. This plan should have several miles of high sea boom and more than 200 Karcher washing units, pillow tanks and a number of ships for skimming oil slicks.
This plan has to control the coast where oil pollution can occur. Special aircraft equipped to detect pollution implement the control. If a pollution incident occurs the plan is executed.

f) - Anti-pollution barrages are very useful for the collection of ballast water spilled on the sea. Three type of barrage can be used :

1. The first type called “fence” is held in vertical position by lateral floaters, filled with air.

2. The second type is called “curtain” and have cylindrical floaters held by ballast beneath.

For both of these barrages, water current plays an important part in the success of the technique. If the water speed is above 0.7 to 1 knot, the barrage will not be effective.

Wind is also a cause of overflowing leakage. An adequate solution is to use several barrages, backing each other. This technique permits the leakage recapture from the preceding barrages.

3. The third type of barrage is composed of a floating tube, which absorbs oils. They are used to get rid of the last traces of oil or to clean inaccessible places. Their absorbing power can reach three to six times their initial weight.

The waves action on oil slicks can promote the natural dispersion of oil into small droplets. Then the oil becomes more readily available for eventual degradation by micro-organisms. In order to accelerate this process it is sometimes appropriate to use a chemical dispersing. The removal of oil from the sea surface prevents the formation of persistent water-in-oil emulsions and residues.
Much oil spills results in the pollution of shorelines, despite efforts to combat the oil at sea and to protect the coastline. Shoreline clean-up is usually straightforward and does not normally require specialised equipment. However, the use of inappropriate techniques and inadequate organisation can aggravate the damage caused by the oil itself.

4.2 How to plan environmental controls in the environment

a) - There has been numerous authors who showed interesting methods to identify oil pollution in the environment like:

- The measure of sulphur, nickel, and vanadium;
- The infrared spectrophometry;
- The chromatography in gas phase at high resolution (capillaries column).

b) - The test of embryo-toxicity on the bivalves (oyster larvae, mussels) gives a good indication of the quality of the area (see § 4.2.3.2 worksheet “Port waters”).

c) - The objectives to plan an environmental control could be to:

- Plan the environmental littoral development, globally and locally;
- Help for planning and investment;
- Protect the immediate area, with quality objectives;
- Follow and evaluate the actions;
- Improve the knowledge about the area;
- Sensitise and communicate.

Coastal zone is divided into “homogeneous” areas. Three levels of impact could be studied :

1. The first area is the zone nearest to the coast. It corresponds to the area where there is a dilution of the rejects.
2. The intermediate area starts at the bathymeter 50 m and goes up to 100 m. In this area the pollutant concentrations are mixed up.
3. The last area starts at the bathymeter 100 m, and is related to the background noise.

Measures of oil contaminant should be done to analyse the quality of :

- The water column every trimester;
- The sediments once a year and every time the dredging activity is done;
- The living matter every trimester;
- The phytoplanktonic and microbiological quality of the water every trimester and every month in summer times;
- The area using the vitality of vegetal plantation as a biological indicator, twice a year;
- The physical-chemical quality of the bathing water, 2-4 measurements a month should be done in summer time.

These measures are done more often after ballast water spilt : just after the accident, and all the weeks during the following month.

5 MONITORING COSTS

The deballasting station have to be cheap so the ships deballast in special installations and not in the sea. The deballasting station in France costs 15 EURO/tonne of ballast water.

The special installation treating pollution and recycling oil is a ECOIL trade mark. It is worth a million dollars (780,250 EURO). It can be transported anywhere in the world. It transits in three 30 foot containers, and it requires 15 days to assemble.

6 DEFINITION OF INDICATORS AND CRITERIA: ASSESSMENT / EVALUATION OF MONITORING RESULTS

6.1 Environmental indicator

An indicator is a tool to the decision and the political evaluation. It will be a model of lasting development (Rechatin, 1996).

An environmental indicator is :

- Representative of the environmental conditions and the exercised pressures;
- Easy to interpret, able to give the trend;
- The reflect of the environment and human activities modifications;
- Comparable to a threshold.

The approach with fauna and flora gives synthetic data about the state (functioning, dysfunction, biological diversity, abundance) of the environment and the animal and vegetal populations. But it gives too synthetic data about the pollution through the perturbation of sensible species and the concentration of toxic substances in integrative species (Weber and Lavoux, 1994).

6.2 Organisation of Co-ordination and Environmental Development (OCED)

The OCED allows to the 25 States Member of this organisation to quantify the state of their environment, the pressures which are exercising on it, and the government answers to resolve this problem.
The environmental indicators regrouped by the OCED permit to compare and to measure the differences between industrialised countries.

The performance indicators are objectives, limit or recommended norms of quality and quality scale. They are defined from indicators of pressure, indicators state and indicators of response (Rechatin, 1996).

6.3 Uniform Norms of Emission (UNE) and Objectives of Water Quality (OWQ)

There are two strategies of fight against pollution :

- The limitation of the pollutant flows discharged in the environment : the UNE are adopted by the majority of the European states;
- The control of the environmental contamination not superior to the recommended levels is to guarantee of a good use of coastal waters : the OWQ (Mauvais and Alzieu, 1991).

6.3.1 The UNE

The European Directive dated May 4th, 1976 classifies the dangerous substances in two categories (see paragraph 1.2.2). The States Member have to take appropriated measures to:

- Eliminate the discharge of substances recognised like toxic, bio-accumulable and non-biodegradable (annex 1 of the European Directive);
- Reduce the water pollution by those ones enumerated in the annex 2 (European Directive).

For each substance, the States Member fix UNE applicable for each industrial branch.

The disadvantages of the UNE are that they do not consider the sensibility of the environment and they are not applicable for the diffuse discharges (Mauvais and Alzieu, 1991).

6.3.2 The OWQ

These norms of quality have to be respected to guarantee the life and the reproduction of the living organisms, the traditional use of the sea (bathing, sailing) and the exploitation of the living resources (non-contamination of the marine food).
The OWQ are function of the uses, they are used like objectives to the environmental management. They are taken in consideration during the fitting-out decisions.

First, it is necessary to determinate the “environmental capacity”. This concept was proposed by the Joint Group of Experts on the Scientific Aspects of Marine Pollution (“GESAMP” 1996). The coastal waters have a limited and quantifiable capacity to assimilate the wastes without alteration of resources and their uses (Mauvais and Alzieu, 1991).

The monitoring results on the deballasting activity are very important. More studies should be done all around the deballasting stations, to evaluate the real impact of the activity on the marine environment.

7 PRINCIPLES AND GUIDELINES FOR IMPROVEMENT / NEEDS FOR TECHNOLOGICAL INNOVATION

The needs for technological innovation could be set up by a new technique to limit the dispersion of oil pollution in the sea. The technique to create consists at the surface of the water a current opposed to the forward movement of the slick. A pipe placed on the sea bed makes a current of bubbles. The bubble volume increases as they reach the surface, and create a disturbance, which stops the spreading of the oil.

The efficiency of this method has still to be proved. It is easily used at a fixed position like on oil terminal. The installation is expensive but it is rapidly and easily used.

Experienced and trained personnel for anti-oil pollution activities, have to remember four essential operations when fighting oil pollution at sea or on land:

Identification of the pollutant
⇩
Immediate stopping of the pollution
⇩
Confining of the pollutant
⇩
Elimination and treatment of the pollutant

The concept of “biological indicators” (and a biological clues) applies to all levels of integration, from sub-cellular to the ecosystem.
From simple data, of synthetic value (taxon, reduce groups of taxons, function, metabolite, etc.) a global holistic approach is made possible, which leads to an accurate interpretation of a phenomenon as well as to the prediction of its evolution.
Nevertheless, their choice, their use, their interpretation indeed their validity necessitate more than precautions : they require competence (Bellan, 1992).

The monitoring of the coastal environment has to be made in accordance with the nature and each type of pollution.

There are three types of criteria:

- Subjective (smell, colour, appearance);
- Link with the hydrobiological factors (temperature, pH, turbidity, salinity, nutritive salts…);
- Toxic factors (origin, nature, toxicity threshold, etc.).

The three compartments must be considered : water, sediment and organism (Arnoux, 1992).

8 ANALYSIS OF TRAINING NEEDS

8.1 Sensitive areas

Because of the difficult decisions required during a ballast spill, in order to mitigate damage and to resolve conflicts of interest, much can be done at the contingency planning stage to identify sensitive areas and to determine priorities for protection. The mapping of sensitive areas can be a useful starting point.

Detailed consideration should be given to the likely impact that a spill would have on each habitat or activity, taking into account any seasonal variability.
It is important to identifying the areas that need to be protected. This will not be easy since each area of the community have different given weight depending upon the environmental, recreational, economic and political considerations.

8.2 Adapted products

Having determined priorities for protection, attention can be given to designating appropriate clean-up measures. It is necessary to make realistic assessment of feasibility. The recommendations to avoid more ecologically damaging response options may result in the no-adaptation of techniques.

Absorbent, dispersing and biodegradable products have to be used with precaution. Those products are not without any harm to the environment (except for the biodegradable products of the latest generation). They have a toxic action on marine organisms.

8.3 Lasting development

The impacts of anthropic activities in the environment are a growing worry for the concerned firms. The environmental management is a tool for the help of the regulation.
It is in this objective that the norm ISO 14,001 about the Systems of Environmental Management (SEM) was published in October, 1996 by the AFNOR (French Association for the Normalisation) and considered like European norm by the European Commission. It belongs to the international norms of the series ISO 14,000; The ISO 14,001 norm describes the requirements of the SEM.
The ISO 14,001 is a dynamic method to simplify and to elaborate the development of an adapted environmental politics. It permits to:

- Measure the effects of the activity which have some significant effects in the environment;
- Define the environmental objectives and aims;
- Elaborate some prevention and amelioration measures for a best control of the impacts of the activity in the environment.

The ISO 14,001 norm is based on five principles:

1. Adaptability: the norm is adapted for all the firms whatever their activities.
2. Complementarity: the ISO 14,001 completes the quality systems elaborated yet.
3. Prevention: it insists on the prevention and the capacity of the firm to react in case of accidents, and so to reduce the impact in the environment.

4. Engagement: the certification ISO 14,001 demonstrates the engagement for the constant progress of the environmental performance of the firm.
5. Universality: the ISO 14,001 is valuable at the international rank.

In port management, it appears necessary to get a sound perspective of the role of Environmental Audits (Ruling 1836/93) and of similar tools for environmental management in ports (ISO 14,000). It becomes necessary to prepare and deliver courses and seminars like :

- "Seminar on the European System of Environmental Management and Auditing and its application in the fields of ports";
- "Designing Environmental Management and Auditing Systems adapted to port sector requirements";
- "Training for Environmental Auditors specialising in the field of ports".

The ports have to preserve the environment but to inform and to guarantee to their partners (clients, insurance agents, shareholders, coastal inhabitants, etc.) that this management is effective too.

The community rule Eco-Audit ("EMAS" : European Management and Auditing System) proposes to the ports the definition of a programme permitting a contractual and voluntary engagement for the environmental management.

The Rio summit in 1992 presents the environment like a lasting development. So, it is necessary to research for each project the best balance between the environment, the society and the economy with respect of rules like the precaution principle and the right of the future generations (Brégeon, 1998).

9 PUBLIC COMMUNICATION

Public communications should be carried out to raise awareness of pollution detection. In fact a brochure should exist.

This brochure should be given to shipping agents, port company workers, sailors, health and safety staff, refinery and depot personnel, immigration officials, pilot personnel, customs officials, tug crews, coast guards, ship crews, visitors… Reaching zero pollution and avoiding pollution from oil terminals concerns everyone.

If pollution is detected by somebody, they should dial the emergency channel to alert the port. This person will have to use the special map and special messages explained in the brochure to advise of the oil pollution.

The brochure should also specifies the risk depending on the port location : wind force on the Beaufort scale, the wind speed, wind direction, as well as the direction and the movement of hydrocarbon layers.

The awareness is complementary asset. It can be done by:

- To take over from the operation of national communications;
- To participate at the local campaign;
- To favour the elaboration of an environmental education structure.

Some clef elements of the communication are :

- To modify the comportment of users against the environmental protection;
- To determinate the goal;
- To elaborate a simply and clearly message (crossed symbols for interdiction, several language, etc.);
- To choose efficacy supports;
- To study the points of diffusion;
- To maintain the supports where the messages are written (Ministère de l'Environnement, 1991).

The decision 86/85/EEC dated March 6th, 1986 institutes a community system of information to control and to reduce the pollution caused by discharge, in seawater or in intern waters, of hydrocarbons and other dangerous substances. It is modified by the decision 88/346/EEC dated June 16th, 1988.

According to the Directive "SEVESO", the Members States have to collaborate and to exchange information. The public has to be informed about the comportment to adopt in accident case and emergency.

The directive 90/313/EEC dated June 7th, 1990 is relative to access liberty to information in matter of environment.

It is important to use regional mediums (TV, radio, newspaper) to inform people living in proximity of the port about the different impacts (noise, view, smell…). People is more concerned by local information.

Some information meetings are organised by ports about the behaviour in the environment of dredged materials and the risks they represent. In these meetings are invited the nature protection associations, the administrations, the local communities…

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Ore dry bulk

ORE DRY BULK WORKSHEET

Contents *Page*

1 DESCRIPTION OF THE ACTIVITY

1.1 Generalities of ore dry bulk activities

To understand the smooth running of ports ore dry bulk terminals, it is important to know how are the intervenes and what are their roles :

- **The client** is the owner of the goods. The clients confide the goods to a stevedore whom realise the operation of loading and unloading ships;

- **The stevedore** belongs to a firm. He ensures (on request of the clients) the direction of the handling operation and the co-ordination for the dockers. The stevedore is an intermediate between the client and the Storage Park;

- **The operator of the Storage Park** realises investments on the terminal to store the ore;

- **Ports** ensure the control and the deal of the maritime traffic. Ports are also proprietary of the quay, tools and storage places. But ports are not responsible of the storage.

The ore dry bulk terminal of the ports allows to the ships to unload their ore dry bulk on the ground. The terminal will store them till they will be taken to industries requiring them for there process.

Most of the time the storage is done on the quay into the open air, but for special material like clinker, it will need to be stored under a shed, because it has to be kept in very dry condition.

The ore dry bulks stored can be coal, heavy bulk, fertiliser, phosphates, oil seeds, oil cake, clinker, etc.. Ports having industries processing the ore directly in the port area will also store ore mineral wastes like slag and ashes.

1.2 Laws

1.2.1 International laws

- The 1972 London Convention concerns the prevention of marine pollution by wastes and other materials.

- The 1972 Oslo Convention is about marine pollution prevention.

- The 1976 Barcelona Convention concerns the protection of Mediterranean Sea.

- The 1982 Montego Bay Convention on Marine Low, Part XII, articles 192 - 137 "Protection and preservation on marine environment".

- The Protocol concerning the Mediterranean particularly protected areas (articles 3 and 7);

- The 1998 Paris Convention which is the new version of Oslo Convention (Lainé, 1998).

1.2.2 European laws

- Directive 76/464/EEC concerns the pollution deriving from dangerous substances unloaded in water environment of the Community.

- Directive 77/585/EEC dated July 25th, 1977 is relative to the conclusion of the convention for the protection of the Mediterranean Sea against pollution.

- Decision 81/420/EEC dated May 19th, 1981 concerns the conclusion of the draft treaty relative to the co-operation in the struggle against pollution of the Mediterranean Sea by hydrocarbons and other dangerous substances.

- Directive 82/501/EEC called SEVESO I, concerns the risk of accident of some industrials activities. The Directive SEVESO II dated December 9th, 1996 n° 96/82/EEC concerns the control of danger due to accident. This Directive substitute the Directive SEVESO I.

The principles of these directives are : the industrials manipulating dangerous substances must take precautions to prevent accidents who can have consequences on humanity and environment.

The article 5 specifies that the States Member must dispose about a regulation requiring industrials to make danger study and to pass on competent administration.

- Directive 85/337/EEC is relative to the evaluation of the incidences of some projects.

- Directive 86/280/EEC about pesticides defines the limiting values as the objective of quality.

- Directive 90/164/EEC is there to prevent and reduce the environmental risk.

- Directive 96/61/EEC on Integrated Prevention Pollution and Control “IPPC” dated September 24th, 1996 is a copy of the French Classified Installations legislation.

1.2.3 Uniform protection areas

The decision 84/132/EEC dated March 1st, 1984 concerns the conclusion of the draft treaty relative to the special protected areas in the Mediterranean Sea.

The ZNIEFF are areas itemised for the national inventory of the natural patrimony, presenting an ecological interest. It is a tool for knowledge, and have a juridical value.

2 POLLUTION SOURCES (CONCERNED SUBSTANCES AND BY - PRODUCTS)

2.1 Phenomena responsible for metal pollution in marine environment

2.1.1 The wind

It can blow the ore at various distances. The wind constitutes a fundamental element in the terminal context because it diffuses the fine particles of ore.

2.1.2 The running water

The problem is caused by the intensity of few rainfalls. In fact the water have no time to infiltrate in the ground, which induce consequent water streaming. These big volumes arrive in seawater with the pollutants carried along the way.

2.1.3 The loading and unloading of ore tankers

The loading and unloading of ore dry bulk induce a little loose of ore between the ship and the quay. One percent of the ore transported in the storage place goes in the sea by the wind, the loose of the grab and the running water.

2.1.4 The cleaning

It is necessary to clean the equipment, the quays and platforms, the quay posts.

- Equipment : cleaning is operated during the operation, if the safety requires it, or in the end of the operation with the most adapted methods (high pressure, industrial aspiration, shovel…);
- Quays and platforms : during all the commercial operations, cleaning of the quay and platform are done by little loaders driven by dockers. After the vessel departure, specific operations of cleaning will be done frequently;
- Quay post : a part of ores falls in seawater and forms a cord in the bottom. To reduce this discharge, the port has to develop continue loaders and unloaders which the ore transport between the vessel and the quay.

The products recuperated after cleaning activity are dumped upon the stock if their quality has not been damaged, or in special areas in the north of the terminal.

2.2 The chemical substances of the ore terminal

2.2.1 Aluminium

Aluminium is contained in ores like bauxite, “l’hydragillite” and the “cryolithe”. And for example the coal ashes are composed by 32% of aluminium. The natural value of aluminium in the open sea water is under 1µg/l.

2.2.2 Chromium

Chromium comes from chromite ore ($FeOCr_2O_3$), iron and chromium ore. The chromium compounds found at dissolved forms are Cr (III) and Cr (VI). The chromium Cr (III) is an essential element for the human being nutrition. It is found in anoxic areas. Cr (III) is a reduce form that is rapidly adsorb. The chromium Cr (VI) is toxic and carcinogenic at high levels. It is found in oxygen oceanic water. Cr (VI) is an oxide form very soluble. The chromium Cr (I), Cr (II), Cr (IV), Cr (V) have not stable valences, so they are not found naturally in the environment.
The natural concentration in chromium of the oceanic water is 0.5 µg/l.

2.2.3 Manganese

Manganese is a soluble element very common in the nature. In the coal mine we often find it in association with “pyrite”.
The chlorides, nitrates, and sulphates of manganese are soluble in the water. The oxide, the carbonates and the hydroxides of manganese are partially insoluble. They deposit on the sea bottom. The coal ashes are composed by 0.9% of manganese.

2.2.4 Iron

Iron is a common metal. It is found in the nature in magnetite form, of “limonite”, “hematite” or “pyrite”.
The natural value of ocean water is around 0.03 µg/l. The coal ashes are composed by 3.5% of iron.

2.2.5 Sulphur

Sulphur goes in the composition of a lot of chemical products: sulphate, sulphur, sulphite, sulfones, sulfomates, and acids. The impacts are very different depending to the salts and their concentrations. Sulphur becomes oxidised easily with air, then the hydrolysis reactions form sulphuric acid. The sulphur is found in the coal.

2.2.6 Coal

The composition of coals is variable. They are composed by carbon, sulphur and by heavy metals too : zinc, cadmium, chrome, lead and mercury, frequently.
Each heavy metal, separately, is noxious to the organisms living in marine environment.
The combined action of the different pollutants is no more known. But there is a synergy between pollutants like cadmium and iron. This synergy can increase the toxicity.
A preventive action is necessary to limit the introduction of pollutants in seawater.

3 CONSEQUENCES

3.1 Effects on the environment

3.1.1 Effects on the sea environment

Sediment concentration are several orders of magnitude higher than seawater constitution. The release of harmful element is function of the sediment stability. This stability depends on:

- The metals concentration;
- Quantity of organic matter;
- Water salinity;
- pH, Eh (reduction-oxidation potential [1]);
- The mixing quality of the sediment/water;
- Micro-organism activity;
- Hydrodynamics.

3.1.1.1 Aluminium

Aluminium has a low toxicity. But when it is with nickel, cooper and zinc its effects are more dangerousness, particularly for the fishes.

3.1.1.2 Chromium

The chromium is not concentrated to a great extend by the living organisms in the environment.
The chromium is not a significant contaminant of the plants tissues (concentration of 5 mg/Kg of dry weight). In case of accute contamination, where the concentration can reach 50 mg/Kg (dry weight), the chromium perturbs the algae growth as the photosynthesis. The concentrations are generally about several mg/Kg in the plankton, as in the invertebrates and fishes. The toxicity level for the fishes are 0.07 mg/Kg. The chromium does not accumulate in the fishes.

3.1.1.3 Manganese

The manganese gets easily fixed on the free micro-organisms. The maganese is lowly toxic and there has to be important quantities to observe effects on the organisms.
In fact some support up to 500 mg/l. The salts of manganese are often toxic for the nerves. The permanganate of manganese is more toxic, but gets quickly destroy in the water.

3.1.1.4 Iron

Even if natural iron is present in high concentration in the human being, iron can be toxic if the metal exceeds the reasonable level. To much iron can generate asphyxia of fishes by sealing the

[1] Red-Ox potential characterises the evolution of the chemical and microbiological conditions in the sediments (Hily and Glémarec, 1990).

brunches, or inducing a slower growth of algae. The iron concentrates the most often in the fine sediment than in the rough. We have an important transfer of the iron stocked from the sediments to benthic fauna and flora. The soluble forms of the iron is accumulated essentially in the intern tissues by biological process.

3.1.1.5 Coal

A particular problem is the oxidation of the coal. This is an exothermic reaction, and it can bring an auto-combustion depending of the size of the storage. The parameters favourable to this auto-combustion are very well known, one of the principals is the time of the storage.

The exploitation law advises dispositions that have to be respected when the characteristics of the products are critical.

The coal is not toxic on his own but the heavy metals which composed it are harmful for the organisms living in seawater and sediment. The metals are the most dangerous. The most toxic metals for the organisms are:

- Mercury by solubility increases in the water. Bacteria methylate the free form of mercury (which is the process the most toxic). The methyl forms of mercury are stocked into living organisms;
- Lead become mobile if the pH decreases or the area gets oxygen. It will also have methylation process like mercury;
- Cadmium also becomes mobile in oxidising areas and will be very toxic.

Heavy metals have different reactions in the environment which undergoes chemical transformations that are given in Table 1.

Table 1: Chemical transformations led by the reactions of heavy metals in the environment

Complex form	Result
Carbon monoxide, carbon dioxide	Heavy metals are released when the salts are dissolving
Adsorbed on iron oxide or manganese oxide	The complexes become unstable and release metals
Bond with organic matter	Great stability of the complex
Sulphide	Instability, oxidation in sulphates and release of metals

3.1.2 Effects on the port area

The ore that goes in the sea reduces the depth of the dock and creates the need of dredging frequently the area to reach the ores, it is expensive. The products dredged during the cleaning operation will either be put back on the storage place, if they have a good quality, or stored in special deposit area on the bulk terminal.

3.2 Impact on the environment and the users

3.2.1 The biological impact

The integration of the pollutant is done at the sediment water interface. We talk about bio-mobilisation (integration of the pollutants in the living organism) giving bio-accumulation (accumulation of chemical substances directly by the aliments) and then bio-concentration (retention of the pollutants in the tissues).

The impact on the plankton is not important. The communities will develop resistance against the perturbation or “disturbance”.
The heavy metals alliterated the biological functions at the macroscopic, biochemical levels and on the natural cycle. The organic pollutants are mutagenic, carcinogen and genotoxic agents for living material.

3.2.2 Impact on the human area

The loose of ore between the ship and the quay, during the loading and unloading, increases the turbidity near the area of activity. It has an impact for the shellfishes production and the photosynthesis phenomena.

The ore spilled in the sea can be harmful for the organisms. Some of them in great quantities have a toxic impact on the trophic chain. The consumption of sea products by humans is dangerous.

3.2.3 Impact on the users

The contamination of fishes and shellfishes is a great loss for occupational fishing, leisure fishing and marine culture.

The turbidity created by the loose of the ore induces avoidance of this area by fishes and other organisms. They cannot reproduce them and there is an impact in the fishing.

4 MONITORING

4.1 How to plan environmental controls on the activities

4.1.1 Methods to monitor the dust

4.1.1.1 Environmental Laboratory Control and Studies for the Steel industry (LECES)

The Laboratory Environment Control for the Steel industry (LECES) created a special gluey product that is injected in the ore piles, to make a protection film on top of the mineral. This new technique allows to reduce a lot of the flying dust per year.
This gluey product creates a cover on the ore piles. This technique is very useful for the finest ore that fly very easily. This process is very useful against winds bellow 70 Km/hour.

4.1.1.2 Modelling

The numerical models will take in account:

- The nature of the materials;
- The shapes of the piles;
- The weather forecast.

The models make estimation, and measures the incidence of the physical treatment. It helps the manager of the bulk activity.
It is also useful to have scales at the top of the piles to measure the loose of ore.

4.1.2 Oxidation of the coal

The oxidation of the coal is an exothermic reaction, and it can bring an auto-combustion depending of the size of the storage. If this combustion happened it would be a disaster for the environment.

The parameters favourable to this auto-combustion are very well known, one of the principals is the time of the storage. The exploitation law advises dispositions that have to be respected when the characteristics of the products are critical.

The prevention of auto-combustion must be done periodically by checking the temperature on the storage staying more than two months. For the coal rich in sulphur the check is more important. If the temperature is higher than 70°C, the watering of the coal stock will be immediately stop and the products is spread on a spare storage area specially reserved for it. After a complete cooling down the coal is stock back as usual.

4.2 How to plan environmental controls in the environment

The test of embryo-toxicity on the bivalves (oyster larvae, mussels, etc.) gives a good indication of the quality of the area (see § 4.2.3.2 worksheet “Port waters”)

The objectives to plan an environmental control could be to :

- Plan the environmental littoral development, globally and locally;
- Help for planning and investment;
- Protect the immediate area, with quality objectives;
- Follow and evaluate the actions;
- Improve the knowledge about the area;
- Sensitize and communicate.

Coastal zone is divided into “homogeneous” areas. Three levels of impact could be studied:

1. The first area is the zone nearest to the coast. It corresponds to the area where there is a dilution of the rejects.
2. The intermediate area starts at the bathymeter 50 and goes up to 100 m. In this area the pollutant concentrations are mixed up.
3. The last area starts at the bathymeter 100 m, and is related to the background noise.

Measures should be done to analyse the quality of :

- The water column (temperature, dissolved oxygen, suspended solids, nutrients);
- The sediments once a year and every time the dredging activity is done. The concentration of heavy metals is measured because of their toxicity;
- The living matter every six-months period;
- The phytoplanktonic quality of the water when eutrophisation can occur;
- The area using the vitality of *Posidonia oceanica* meadows as a biological indicator, once a year.

The monitoring of the coastal environment has to be made in accord with the nature and each type of pollution.

There are three types of criteria:

- Subjective (smell, colour, appearance);
- Link with the hydrobiological factors (temperature, pH, turbidity, salinity, nutritive salts, etc);
- Toxic factors (origin, nature, toxicity threshold, etc.).

The three compartments must be considered : water, sediment, organisms (Arnoux, 1992).

5 MONITORING COSTS

The best technique used to pack the ore, it is the wheel machine. It costs 7,813,000 EURO, and has fewer loose than the normal grabs.

By using the LECES process, the ore dry bulk activity can economise a certain amount of ore per year, witch correspond to a great economy. In fact, the coal costs around 46,20 EURO/tonne.

The measure of mercury, cadmium, copper, zinc and lead in water costs 72.20 EURO. The analysis of the living matter costs 362.90 EURO.

6 DEFINITION OF INDICATORS AND CRITERIA : ASSESSMENT / EVALUATION OF MONITORING RESULTS

The definition of indicator for the ore dry bulk activity can be done by a good survey of the quantities of ore stored. A scale measuring the diminution of the piles is an adequate indicator. It measures the quantities of ore lost depending to different conditions (wind, rainwater, or loose during the transport).

The evaluations of the monitoring results are positive but have still to progress. The different techniques engaged concerning the diminution of the flying ores have to go on. The interest of monitoring the loose of the ore is a valuable item.

A good criteria to measure the concentration of a pollutant substances in the coastal zone is the mussel. Mussels filter and stock the contamination information about the quality of the water. So they are very good indicators of industrial water pollution.

IFREMER (French Institute of Research in the Sea) gives a scale of the quality of the seawater (1993) in function of the concentration of pollutants (C) found in the mussels (Table 2).

Table 2: Scale of the quality of the seawater (d.w. = dry weight)

	Very good quality	Good quality	Medium quality	Bad quality
Zinc (mg/Kg d.w.)	C < 100	100 < C < 150	150 < C < 200	C > 200
Mercury (mg/Kg d.w.)	C < 0.2	0.2 < C < 0.3	0.3 < C < 0.4	C > 0.4
Cadmium (mg/Kg d.w.)	C < 1	1 < C < 2	2 < C < 4	C > 4
Lead (mg/Kg d.w.)	C < 2	2 < C < 4	4 < C < 6	C > 6

To know if the prevention measures are effective, the reduction of the impacts can be measured in the area influenced by the ores dry bulk activity. The measures of accompaniment are :

- The survey of the marine environment (sediment compartment);
- The chemical characterisation of the sediments;
- The evolution of the granulometry and the living organisms (CREOCEAN, 1997).

Some biologic indicators can be used to calculate an index of pollution and to survey the alteration of the environment. Some species are used : Bryozoaires, Echinodermes, Polychetes, Crustaceans (IFREMER, 1985). The benthic population is a good indicator of the evolution of the environment because it only lives in the same place.

In fact, to have a better analysis of the danger of toxic elements to human health, more experiment will have to be done. For the moment, all the experiments that have been done are only estimation and research efforts. In fact, experiments are not as exact as the natural environment.

7 PRINCIPLES AND GUIDELINES FOR IMPROVEMENT / NEEDS FOR TECHNOLOGICAL INNOVATION

7.1 Loading and unloading equipment

The best methods set up to reduce the spill between the quays and the ships are done by continuous loading and unloading equipment. It permits the safe transport of the material and limits the spills of ore. Every ore dry bulk activity should use those techniques.

But if the ports keep the barge methods, there will have to be set-up a better survey of the watertight integrity of the valve barges. It would allow fewer spills of ore during the unloading and loading of the ships.

7.2 Organisation of the road traffic

On the bulk terminal areas, there is an organisation of the circulation to limit the dust pollution. The public circulation is forbidden, so the only circulation are the lorries.

7.3 “Concentration” of the storage

The “concentration” of the storage is represented by a ratio tonnes/cu.m. This ratio is very important to limit the impact of the dust. The “concentration” is done directly by reducing the surface on which circulate the trucks as the surface offered to the wind effects.

The other method used to limit the wind action is to round the ore stocks, and to pulverise water on it, especially in very dry or windy conditions. The watering will be adjusted with the rainy weather. So the ore storage will stay at the same level of humidity. If the watering is not forecast additive composed by “colgarde”, and “selore” is used to fix the dust.

7.4 Cleaning of the area

The cleaning is regularly done to limit the flying of little ore particles. The ore terminal has centre divider strip composed by pebble in which the fine goes and creates a fine coat. Also, the quay and the divider strip are cleaned every day during the commercial operations. It is then completed by specific cleaning operation when the ship leaves.

7.5 Adequate methods used on the terminals

The grabs are very wide to recuperate ore and coke, and avoid spill. They have good waterproofs for fine materials and are systematically maintained to reduce the leaks.

The transports of the ore and coal are covered by a “goulotte”, and have a disposition against the wind. There is also a telescopic “goulotte”, to adjust the height of the fall, and bring the solid at the nearest point of the ore or coal pile.

To limit the loading break creating dust, some extractor loading are directly done in the trucks. If there is an overflowing of ore, it will be stop by an automatic regularisation of the machines.

7.6 The running water

A flat area is a good way to limit the speed of the water running.
The roof of the storage pile is regularised to avoid the running of the rainwater. The washing water and the rainwater are collected in special retention areas to be treated.

7.7 Biological indicators

The concept of "biological indicators" (and a biological clues) applies to all levels of integration, from sub-cellular to the ecosystem.
From simple data, of synthetic value (taxon, reduce groups of taxons, function, metabolite, etc.) a global holistic approach is made possible, which leads to an accurate interpretation of a phenomenon as well as to the prediction of its evolution.
Nevertheless, their choice, their use, their interpretation indeed their validity necessitate more than precautions : they require competence (Bellan, 1992).

8 ANALYSIS OF TRAINING NEEDS

There is still a needed for training concerning the control of the ore piles flying away with the wind, the running water or during the loading or unloading of the ore from the ships to the storage area.

The port should organise some formations/actions and try to improve the qualifications and the methods of work.

The formations could be an aid to the accompaniment and to the evolution of the organisation and to the methods of work. They would destined to:

- The port personal;
- The clients or partners;
- Be an initial formation.

The formation awards a diploma to the concerned persons.

The port could apply the following principles:

- On-going programme modifications according to needs as identified by a pilot group overseeing all training;
- Working groups set up in parallel with training in order to put theory into practice;
- Evaluation of training to ensure the transformation of work methods by drawing up individual and collective plans of action.

The training programmes are set at three levels:

- General or cross-function training at company level;
- Specific or technological training at departmental level;
- Personal training on an individual timescale.

To have a real database about the quality of the environment, it is necessary to do observations regularly in the time, for example twice a year. These observations could be about benthic population, fishes, and all the fauna and flora.
Some analysis about water and sediment in the area of ore dry bulk activity are necessary too.
In this way, with an initial knowledge, we could see the evolution of the organisms after measures taken to improve the activity.

Also their should be made studies about the ore spilled in the sea impact and their effects to marine environment.
The ecotoxicological analysis are the most adapted to examine the effects of pollutants on the living organisms. They allow to know if there is a danger to human life who are the last link in the food chain.

The impacts of anthropic activities in the environment are a growing worry for the concerned firms. The environmental management is a tool for the help of the regulation.

It is in this objective that the norm ISO 14,001 about the Systems of Environmental Management (SEM) was published in October, 1996 by the AFNOR (French Association for the Normalisation) and considered like European norm by the European Commission. It belongs to the international norms of the series ISO 14,000; The ISO 14,001 norm describes the requirements of the SEM.

The ISO 14,001 is a dynamic method to simplify and to elaborate the development of an adapted environmental politics. It permits to:

- Measure the effects of the activity which have some significant effects in the environment;
- Define the environmental objectives and aims;
- Elaborate some prevention and amelioration measures for a best control of the impacts of the activity in the environment.

The ISO 14,001 norm is based on five principles:

1. Adaptability : the norm is adapted for all the firms whatever their activities;
2. Complementarity : the ISO 14,001 completes the quality systems elaborated yet;
3. Prevention : it insists on the prevention and the capacity of the firm to react in case of accidents, and so to reduce the impact in the environment;
4. Engagement : the certification ISO 14,001 demonstrates the engagement for the constant progress of the environmental performance of the firm;
5. Universality : the ISO 14,001 is valuable at the international rank.

In port management, it appears necessary to get a sound perspective of the role of Environmental Audits (Ruling 1836/93) and of similar tools for environmental management in ports (ISO 14,000). It becomes necessary to prepare and deliver courses and seminars like :

- “Seminar on the European System of Environmental Management and Auditing and its application in the fields of ports”;
- “Designing Environmental Management and Auditing Systems adapted to port sector requirements”;
- “Training for Environmental Auditors specialising in the field of ports”.

9 PUBLIC COMMUNICATION

Public communications should be carried out to raise awareness of pollution detection. In fact a brochure should exist.

This brochure should be given to shipping agents, port company workers, sailors, health and safety staff, refinery and depot personnel, immigration officials, pilot personnel, customs officials, tug crews, coast guards, ship crews, visitors… Reaching zero pollution and avoiding pollution from oil terminals concerns everyone.

If pollution is detected by somebody, they should dial the emergency channel to alert the port. This person will have to use the special map and special messages explained in the brochure to advise of the oil pollution.

The brochure should also specifies the risk depending on the port location: wind force on the Beaufort scale, the wind speed, wind direction, as well as the direction and the movement of hydrocarbon layers.

The awareness is complementary asset. It can be done by:
- To take over from the operation of national communications;
- To participate at the local campaign;
- To favour the elaboration of an environmental education structure.

Some clef elements of the communication are :
- To modify the comportment of users against the environmental protection;
- To determinate the goal;
- To elaborate a simply and clearly message (crossed symbols for interdiction, several language,…);
- To choose efficacy supports;
- To study the points of diffusion;
- To maintain the supports where the messages are written (Ministère de l’Environnement, 1991).

The decision 86/85/EEC dated March 6th, 1986 institutes a community system of information to control and to reduce the pollution caused by discharge, in seawater or in intern waters, of hydrocarbons and other dangerous substances. It is modified by the decision 88/346/EEC dated June 16th, 1988.

According to the Directive “SEVESO”, the Members States have to collaborate and to exchange information. The public has to be informed about the comportment to adopt in accident case and emergency.
In the classified installations, a public enquiry must be done during one month to have the authorisation. This enquiry permits a good information of the public and the workers.
The directive 90/313/EEC dated June 7th, 1990 is relative to access liberty to information in matter of environment.

The LECES gluey process set up, should be known and used by all the ports. This technique allowed a good diminution of the flying ore on the storage area. In France nothing is really done concerning the public communication about the ore dry bulk storage activity because the state has not set up rules.

It is important to use regional mediums (TV, radio, newspaper) to inform people living in proximity of the port about the different impacts (noise, view, smell, etc.). People is more concerned by local information.

Some information meetings are organised by ports about the behaviour in the environment of dredged materials and the risks they represent. In these meetings are invited the nature protection associations, the administrations, the local communities, etc..

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Cleaning activity

CLEANING ACTIVITY WORKSHEET

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1 DESCRIPTION OF THE ACTIVITY

1.1 Cleaning activity

In accordance with the Directive 91/156/EEC, a waste is “all substance abandoned by the owner, or unwanted by the owner”. The solid wastes can be shovelled out, the liquid wastes can be pumped (Leroy, 1997).

1.1.1 Industrial wastes

Industry generates wastes compromising environment protection measures. The wastes should be stored in close boxes and in special areas planned for them before treatment. The storage areas have to be kept always clean.

The producer has to discharge the waste by himself or by contacting a company specialised. In all the cases, the producer of the wastes pays for the elimination.

The industries producing the waste should periodically precise to the inspector of the Ministry of the Industry the quantities eliminated and the name of the companies selected to eliminate the waste. Some industries can eliminate or valorise by themselves their wastes.

The treatment plant receiving wastes have also to declare the origin, the quantities and the nature received.

A note on each waste have to mention:

- the carrier;
- the date of the removal;
- the quantity of wastes;
- the nature and the particular characteristic of the wastes;
- the identification of the industry concerned by the wastes elimination;
- the methods used for the elimination.

This note will be put at the inspector of the Ministry of the Industry disposal at least for two years. The note represents a justification of the work done by the carrier and by the company in charge of the elimination. In case of infraction of the laws the industry will receive a warming.

The types of wastes treated in the port area are:

- Households refuse wastes (packages, foods..);
- Wrapping wastes (plastics, papers..) that can be valorised;
- Green wastes (trees, grass...);
- Special dangerousness wastes (acids, mercury...);
- Solid macro-waste (boxes, containers, chairs, glass plastic…).

1.1.2 Ship wastes

Before the ship leaves, the wastes will have to be disposed of in the containers the put at the disposal area. Some of the ship wastes can be evacuated directly in the sea without treatment (table 1).

Table 1: Standards permitting to evacuate the wastes in the sea

Type of wastes	All the ships out of the special areas	All the ships in special areas
Plastic material	Throwing forbidden	Throwing forbidden
Wrapping material	More than 25 nautical miles from the coast	Throwing forbidden
Paper, glass, metal, bottles..	More than 12 nautical miles	Throwing forbidden
All the other wastes crushed	More than 3 nautical miles	Throwing forbidden
Aliment wastes	More than 12 nautical miles	Throwing forbidden
Crushed aliment wastes	More than 3 nautical miles	More than 12 nautical miles
Mix-up of different wastes	The disposition the most severe is applied	The disposition the most severe for all the waste is applied

The compacting of the wastes facilitates the storage, their transfer to the port reception, or their evacuation in the sea when it is authorised. The compacting effect facilitates the wastes to sink and avoid the waste to reach the coast, or to be swallowed by marine animals, in particular mammals.

The crushing machine can be used on ships to increase the dissolution of the waste in the sea. The wastes have to pass in a crusher that has a mesh diameter under 25 mm. Throwing the wastes in the sea is a cheap and quick solution, but it is better to give the priority to bringing back those wastes to the port installations.

The wastes including germs (bacteria, virus, parasite) brought back to the port have to be stored in closed tanks. The areas of storage of the waste have to be kept very clean to avoid contamination risk.

To evaluate the quantity of wastes which have to be taken into account, the port installation has to defined:

- The nature of the wastes (solid or liquid wastes, green wastes, toxic or noxious wastes, macro-wastes, etc.);
- The type and the conception of the ship creating wastes;
- The route of the ship;
- The number of peoples on board;
- The quantity of wastes produced/day;
- The time the ship stayed in the area where the evacuation of the wastes is forbidden;
- The time passed in the port.

The material receiving the wastes used by the port has to be adapted to the different types of wastes received. This container has to present low risk of pollution. In the ports, floating barge or special boats receiving ship wastes can be more appropriate than special installation on the land to collect them.

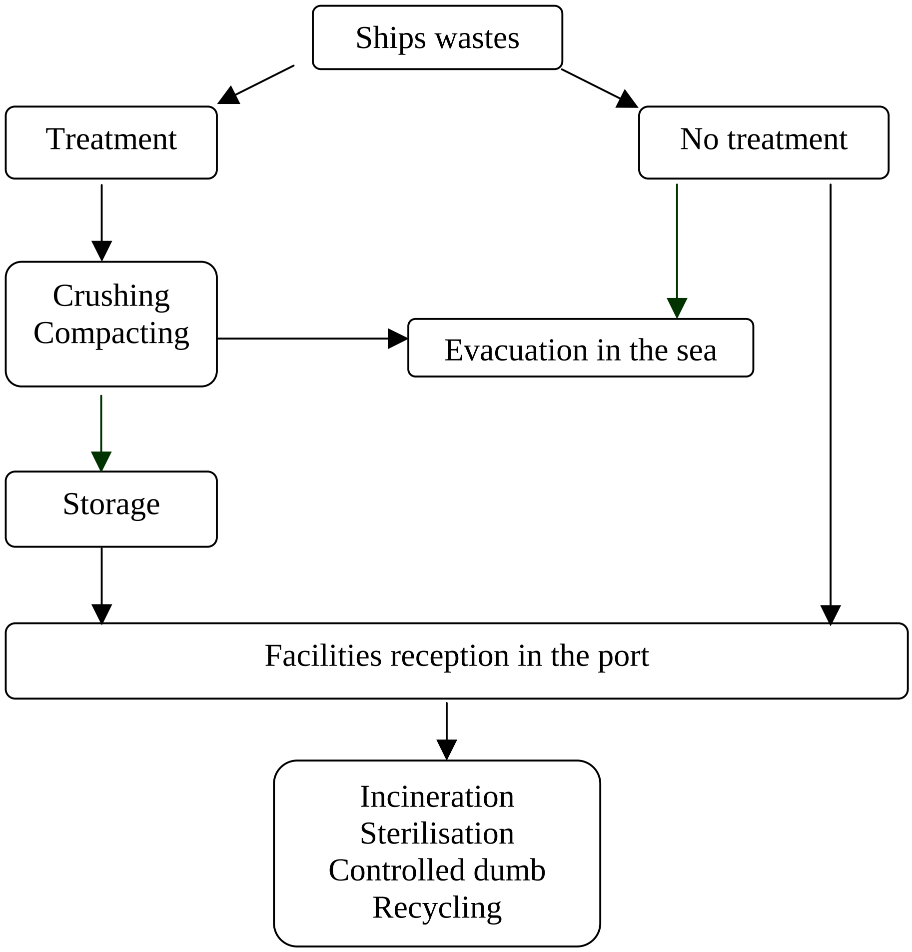

Figure 1. Different becoming of the ships wastes

When a ship needs to discharge wastes, the manager must be advice before the ship comes on-shore. So a quick treatment of the ship wastes will go on.

Cleaning wastes out from the ships comes within the area of responsibility of the captain. He is free to call for any services company of his choice. The services of the ports will make cleaning wastes out from ships easier by giving advice but would not intervene directly into the cleaning operation. For the cleaning out of solid wastes and refuses from ships, captains may have recover to the following possibilities :

- Regular shipping lines berthing at priority berths uses bins permanently placed in sheds or on storage areas assigned to their shipping lines. The stevedoring companies collect them;
- Ordering of a bin placed as close as possible to the ship. Specialised companies may supply this service;
- Specialised companies will undertake the removal of special waste;
- Specialised companies can purify wastes water cleaning.

1.1.3 Elimination and treatment of wastes

1.1.3.1 Dump

The residues of incineration are disposed in dump. They are clinker, flying ashes, ashes coming from the smoke after the elimination of Chlorine (Leroy, 1997).

The REFIDI (Residues from the purification of the incineration smoke produce by the industrial wastes) are ultimate industrial wastes that have to be sent in special dump for toxic waste. The ultimate wastes (REFIDI) could be recycled if the technique allows a diminution of their annual volume.
The REFIOM (Residues from the incineration of household refuses) are disposed in dump too (Leroy, 1997).

1.1.3.2 Centre of storage

The centre allows the transformation of the organic part in wastes to stabilise it and can use it in agriculture without inducing olfactory or other pollution (Leroy, 1997).

The regulation (Directives 80/68/EEC and 80/778/EEC) aims to the protection of soils against :

- The migration of noxious substances in vegetal;
- The possible migration in direction of subsoil waters (Leroy, 1997).

All centres must have a protection of the soil. A waterproof membrane does protect the soil. There is also artificial drain allowing the purification of the dirty waters and the recovery of the smelling gas. The area of the storage zone is limited, and when the site is full, it has to be restructured and monitored for a long term time.

1.1.3.3 Incineration with recovery of energy

The incineration presents several advantages:

- Avoidance of the microbiological and bacterial contamination, because virus and bacterium are killed with a temperature higher than 200°C;
- Reduction of volume and weight of wastes;
- Recovery of energy;
- The industrial wastes (phenols, hydrocarbons, cyanide) loose all toxicity when they are decomposed in their constituents (Leroy, 1997).

Some installations are linked to the thermic treatment centre of solid wastes:

- The laboratory identifies the wastes and the management of the treatment plant in accordance with the regulation;
- The storage permits the separation of wastes that they have not be mixed to themselves;
- The water treatments concern the running water, the waters coming from the cleaning of tanks, or the waters coming from the clarification of oils wastes (Leroy, 1997).

The incineration permits the treatment of industrial special wastes with a minimum diffusion in the environment (table 2).

Table 2: Treatment of industrial special wastes (Leroy, 1997)

Heavy metal treated	Diffusion in the environment	Solid residues
Mercury (Hg)	0.38%	99.62%
Cadmium (Cd)	0.01%	99.99%
Arsenic (As)	0.25%	99.75%
Lead (Pb)	0.12%	99.88%
Copper (Cu)	0.04%	99.96%
Zinc (Zn)	0.03%	99.97%

The treatment with recuperation of energy will differ depending to the products retreated. The non-halogened wastes can be incinerated in classic collective centre. While the halogened wastes (PCB..) have to be incinerated in specific centre. The energetic wastes (oil, pneumatic, etc.) will be incinerated in cement oven.

The incineration is a real treatment because it permits to concentrate the dangerous substances in the twentieth of their initial weight (Leroy, 1997).

1.1.3.4 Physical-chemical treatments

The wastes concerned are :

- The noxious wastes in extreme pH;
- The wastes with an oily dominant;
- The toxic wastes (Leroy, 1997).

The physical-chemical treatments allow to the waste to be chemically stable. The process can be :

- The neutralisation of acids with bases;
- The regeneration of oils;
- The separation of the mixing oil-water;
- The treatment of toxic wastes in accordance with their nature. For example, the cyanides are oxidised in cyanates by ozone or hydrogen peroxide. For components like arsenic, there is no treatment; the metal is put into capsules and stored in hold salt mines. In the old salt mines, there is not infiltration in the ground and so no danger for the subsoil waters (Leroy, 1997).

The physical-chemical treatments allows the waste to be re-usable, by the regeneration of the solvents and the catalyses, by a separation of the hydrocarbon from the water, and by specific treatments (mercury..).

1.1.3.5 Elimination of pathogen organisms and viruses

Wastewater contains high concentration of bacterial indicator (faecal coliform) and is frequently contaminated by pathogen organisms and viruses. This contamination could induce sanitary risks when the disposal area is in marine zone with intense humans activities (bathing, occupational fishing, etc.).
To avoid such a contamination, an adapted treatment must be carried out for the fate of the micro-organisms. Each treatment has obvious advantages and disadvantages. For all treatments, the quality of water upstream of the disinfection process must be good quality specially for the elimination of suspended solids and the decrease of ammonia concentration (Audic, 1990).

1.1.3.6 Biological process

This process is realised by the micro-organisms. In the natural environment, the micro-organisms recycle the molecules elaborated by superior beings. It is an ecological process.

In case of contamination by pathogens micro-organisms, the biological process allows to eliminate 90% to 99% of the total coliforms (Audic, 1990).

The micro-organisms like bacteria, yeast, moulds, and algae develop different interaction process with metals. The process adapted to the industrial metals are :

- The biological lixiviation is done by *Thiobacillus ferrooxidans*, *Sulfolobus*, *Pseudomonas*, *Spirogyra*, *Oscillatoria*, *Rhizoclonium*, *Chara* and *Synechococcus*. The metals concerned are the cadmium, the copper, the mercury, the nickel, the manganese, the lead, the molybdenum, the selenium and the tin;
- The accumulation by the adsorption-exchange of ions in cells is done by *Chlorella pyrenoidosa*, *Penicillium* and *Cladosporium* (Duverneuil *and al*., 1997).

The biological process is adapted for the waste water with a dominant organic pollution. The industrial waters carry out hydrocarbons, tensio-actifs and pesticides in seawater. The organic pollution is constituted by a nitrogenous micro-pollution, a carbonated micro-pollution and a phosphorous micro-pollution.

In the case of nitrogenous micro-pollution, there are exchanges between the water, the sediment and the atmosphere. The different exchanges are:

- The fixation of molecular nitrogen by blue algae (*Cyanophycae*), the aerobic bacteria (*Azobacter*) and the anaerobic bacteria (*Clostridium*);
- The ammonification is the liberation of ammoniac after the decomposition of animal or vegetal cells by a lot of micro-organisms like *Achromobacter*, *Clostridium*, *Flavobacterium*, etc.;
- The nitrification is the formation of nitrates. There are a autothroph nitrification done by autotroph bacteria (Nitrosomas, Nitrosococcus, Nitrospira, Nitrobacter) and an heterotroph nitrification done by the heterotroph bacteria;
- The denitrification is the reduction of nitrates by bacteria, algae, mushrooms and superior vegetal (Doré, 1989).

1.1.3.7 Treatment of waste residues

There are different types of residues:

- Inert residues :excavations, rubbles of demolition, mineral residues. They will be recycled in industries of aggregates;

- Banal residues, above all packages, will be treated like household refuse;

- Special residues appear into an official list (list I, Directive 76/464/EEC). One part is directed in centre of storage. This part is composed of:
  - Solid or liquid organic wastes coming from refinery, tars, used oils and solvents;
  - Residues of surface treatment or pickling;
  - Solid wastes like sands of smelting works, mud of metallic hydroxides, flying ashes of incineration factories, residues of fabrication, etc.

1.2 Laws

1.2.1 International laws

- The first international convention, the 1954 OILPOL convention, in London, is about the prevention of pollution in the sea.

- The Brussels convention dated November 29th, 1969 concerns the intervention in seawater in case of pollution caused by hydrocarbons and other substances.

- The Oslo convention dated 15th February, 1972, is about the prevention of the marine pollution by dumping operations from ships or aircraft.

- The 1972 London convention concerns the prevention of marine pollution by the dumping of wastes.

- The international laws concerning the cleaning activity are under the MARPOL convention 1973-1978, dated November 2nd, 1973 in London.

Annex IV concerns the regulations and the prevention of pollution by the sewage from ships. This Annex specify, on the Regulation 10, that each State Member has to facilitate the reception of sewage, in the port area and terminals, adequate to meet the needs of the ships using them.
Annex V concerns the regulations for the prevention of the pollution by garbage from ships. This Annex specifies, on the Regulation 9, that every ship of 400 tons gross tonnage and above, and the ship certified to carry 15 persons or more, shall apply a garbage management plan. This plan is applied by the crew and shall provide written procedures for collecting, storing, processing and disposing of garbage, including the use of equipment on board.

The government members of the convention undertake to provide facilities to port and terminals for the reception of garbage, without causing undue delay to ships, and according to the needs of the ships using them.

- The1974 Solas convention concerns the safety at sea and the maritime pollution.
- The Paris convention dated 4th June, 1975, is about the prevention of marine pollution with telluric origin.
- The Barcelona convention in 1976, is about the interdiction of spilling oils in the sea. This convention is related to the co-operation concerning the fight against oil pollution in the Mediterranean sea.
- The Paris memorandum in 1982 is about the control of the ships in ports, to see if they respect the Marpol construction norms.
- The La Haye conference in 1990 has the objective to reduce the discharges in seawater.
- The accidental spilling of oil in the sea is covered by an international law. So the polluter has to pay for the damage done by oil. This convention was done in London November 27th, 1992.
- The 1992 Paris convention is about the protection of the north-east Atlantic. One of its objectives is the reduction of the discharges in seawater.
- The 1998 Paris convention which is the new version of Oslo convention (Lainé, 1998).

1.2.2 European laws

- Directive 61/96/EEC is about prevention and reduction of pollution.
- Directive 73/404/EEC dated November 22nd, 1973 concerns the rapprochement of the States Member legislation for the detergents case.
- Decision 75/437/EEC dated March 3rd, 1975 concerns the conclusion of the convention for the prevention of the marine pollution with telluric origin.
- Directive 75/439/EEC dated June 16th, 1975 concerns the elimination of used oils; it was modified by the directive 87/101/EEC dated December 22nd, 1986.
- Directive 75/442/EEC dated July 15th, 1975 is relative to the wastes management.
- Directive 76/464/EEC dated May 4th, 1976 concerns the pollution caused by harmful substances discharged in aquatic environment. It defines two categories of pollutants in function of their toxicity, persistence and bio-accumulation.
- Directive 77/585/EEC dated July 25th, 1977 is relative to the conclusion of the convention to the protection of the Mediterranean sea against pollution.
- Directive 78/319/EEC dated March 20th, 1978 is relative to the toxic and dangerous wastes; it was modified by the directive dated December 21st, 1990.

- Decision 81/420/EEC dated May 19th, 1981 concerns the treaty conclusion relative to the co-operation in matter of fight against Mediterranean Sea pollution by hydrocarbons and other harmful substances.

- Directive SEVESO dated June 24th, 1982 is relative to accident risks in classified installations in matter of environment protection.

- Decision 84/358/EEC dated June 28th, 1984 concerns the treaty conclusion relative to the co-operation in matter of fight against North Sea pollution by hydrocarbons and other harmful substances.

- Directive 85/337/EEC is relative to the evaluation of the incidences of some projects.

- Decision 86/85/EEC dated March 6th, 1986 institutes an information community system to control and to reduce the pollution caused by discharge of oils and other harmful substances. It is modified by the decision 88/346/EEC dated June 16th, 1988.

- Directive 90/164/EEC is there to prevent and reduce the environmental risk.

- Directive 91/689/EEC dated December 12th, 1991 concerns the dangerous wastes and classify them in annexes III, IV and V.

- Directive 91/156/EEC dated March 18th, 1991 modifying the directive EEC n° 75/442 dated July 15th, 1975 concerns the definition of the wastes. This directive classify 15 operations qualified for the elimination and 13 others qualified for the valorisation.

- The fifth European Programme of Action, 1992, concerns the stabilisation of the wastes production at the level of the community average in 1985 (300 Kg/inhabitant) in the horizon of the year 2000. The States Member have not to overstep this limit (Rechatin, 1996).

The States Member have to use those techniques of valorisation and elimination as best as they can. As dated 2002, the installation of elimination for the wastes by storage (traditional dumb) will only accept ultimate wastes.

The taxes exist since July 1st, 1993, concerning all the storing wastes installation, it is worth than 3 EURO/tonne. The tax will be collected by an agency of the energy control (like ADEME in France) will use at least 10% of the amount to develop new techniques for wastes treatment, to resettle the polluted lands and the storage areas.

- Directive 96/61/EEC is about, the integrated prevention and the reduction of pollution.

- The norm ISO 14,001, dated October 1996, is about the System of Environmental Management (SEM). It belongs to the international norms of the series ISO 14,000. The ISO 14,001 norm describes the requirements of the SEM.

2 POLLUTION SOURCES (CONCERNED SUBSTANCES AND BY - PRODUCTS)

2.1 The different types of pollution

The waste coming from ports are source of pollution. They can cause damage to the security and the health of human beings.

Each type of waste induces a type of pollution :

- Plastic matters (bottles, bags) are not biodegradable. They stay in the environment during hundreds of years. The plastic matter is composed by a high polymer and induces a pollution by macro-wastes;

- The organic pollution is caused by:
  - The sewage water, coming from the ships, discharged into the sea brings an important concentration of organic matter which induces a bloom of phytoplankton;
  - The PCB coming from transformer and condenser;
  - The industrial activities induce the discharge of tensio-actifs, hydrocarbons and pesticides in the environment. The domestic and industrial activities induce the discharge of detergents, fertiliser, explosives, colorants and corrosion inhibitors too;
  - The leaching of the road network induces the presence of pesticides in the environment. This nitrogenous pollution is conveyed by water running and is accumulated along the food chain (Doré, 1989).

- The mineral pollution is caused by:
  - Mercury metal and acids coming from battery;
  - The diffuse pollution comes from the dispersion of several metals in the soil surface (chromium, copper, iron, manganese, nickel, zinc,…);
  - The punctual pollution comes from the urban used waters with or without preliminary treatment (metals refinery, electrotyping, …). It comes from the solubilisation by rainwater of several manufactured metals too (Doré, 1989).

2.2 The negative effects of the wastes

- The obvious dangers:
  - corrosive substances (sulphuric anhydride dissolved in water induces the corrosion of rainwater) or explosive substances (mercury fulminate, nitro-glycerine, nitrobenzene);
  - substances with acute toxicity like the gas hydrogenous cyanide or a solution of sulfhydric acid;
  - immediately toxic substances like oily wastes with gaseous exchanges between air and water compartments.

- Long term dangers :
  - substances are accumulated in the organisms all along the food chain (heavy metals, pesticides).

- Supposed dangers:
  - they are simulated by mathematical models (Leroy, 1997) like the dispersion of pollutants in seawater.

2.3 The principal risks caused by wastes

- Acute intoxication by contact or inhalation (risk linked to the chemical composition);
- Explosion (risk linked to the chemical composition and the physical characteristics);
- “Ecological” risks of the oily wastes (Leroy, 1997) destroying benthic populations (fauna and flora) and getting caught the birds;
- Suffocating of marine mammals and turtles which ingest plastic materials.

A particular problem is the case of the packages. They represent 40% of the wastes volume and 15% of the wastes weight. The incineration of wastes permits to reduce the volume at the tenth and to recuperate the energy (Leroy, 1997).

3 CONSEQUENCES

3.1 Effects on the environment

The increase of the nitrates concentration, coming from the leaching of the lands in the port area, induces an increase of the primary production and so a decrease of oxygen concentration.

These wastes are source of multiple nuisances:

- Esthetical nuisance;
- A bad smell due to the fermentation of organic wastes;
- Eutrophication with the discharge of non-treated waters (Ministère de l'Environnement, 1991);
- Sailing trouble for macro-wastes like trunks, containers, tins, can and old nets which could be trapped into screw-propeller.

3.2 Impact on the environment and the users

3.2.1 Impact on the environment

The plastic products (bags, bottles, containers, canvas cover) have a very slow degradation process. The buoyant remain suspended at the sea surface for a long time, and those that are not, sink and remain to the bottom layer for many years. Each plastic product has an impact in the environment:

- The plastic bottles and containers can contain some traces of hydrocarbons, pesticides, detergents, …or other dangerous substances packaged like that;
- The plastic bags and canvas covers take a great surface in the bottom where the benthic population (fauna and flora) can not develop it because of the lack of luminosity;
- The exchanges of gases and matter between the different compartments (soil/ water and water/air) are limited when the canvas covers stay in the bottom or in the water surface.

3.2.2 Impact on the organisms

The accumulating of wastes represents significant threats to marine mammals, seabirds, turtles, fishes, and crustaceans. The threats are strength forward and mechanical.

The marine beings become physically entangled in loops or ingest small fragments of materials.
The marine animals also ingest plastic wastes. They are unable to distinguish between normal prey (jellyfish) and small pieces of floating plastics for example. The ingested plastic bags block the digestive tract or remain in the stomach for extended periods. By the feeding derive, they cause ulceration and injury to the stomach lining, or perhaps provides a source of toxic chemicals.
Once entangled, animals may drown, suffer impaired ability to catch food or avoid predators, incur wounds and infections from the abrasive or the cutting action of attached wastes, or exhibit altered behaviour patterns that place them at a survival disadvantage.

3.2.3 Sanitary impacts

Human health risks linked to sea-shore microbial pollution are mainly affected by swimming activity and raw shellfish consumption. Retention or elimination of bacteria in shellfish, and the significance of faecal-coliform as faecal bacteria indicators are the main concerns to know if the human health is endangered.

The seawater has a lot of germs, virus and bacteria which can induce infectious troubles gastro-enteritis, food poisoning) for the shellfishes consumers and the bather. The principal bacteria species are : *Clostridium perfringens*, *Clostridium botulinum*, *Aeromonas hydrophila*, *Listeria monocytogenes*.

The required quality for the bathing water is fixed by the Directive 76/160/EEC dated December 8th, 1975. The presence of enterocoques (*Enterococcus*) or faecal streptococcus is linked with the observed pathologies (nausea, vomiting, diarrhoea). Faecal coliforms (*Escherichia coli*) is not the best indicator of bacteria contamination. *Enterococcus* seems to be better.
The required quality for the conchylicole water is fixed by the Directive 79/923/EEC dated October 30th, 1979. The treatment of used waters before discharge has decreased the human health risk. The shellfishes consumers are three time more exposed to enteric illness than non-consumers (Poggi, 1990).

4 MONITORING

4.1 How to plan environmental controls on the activities

4.1.1 Preventive actions

The first preventive action is to reduce the source of waste and residence time along the coastline : to put on the right place the adapted bins (liner, rubbish) with the right frequency of bin collection. The collection will depend on the seasonal period (Ministère de l'Environnement, 1991).
The second action is to reduce as possible the ships volume of wastes. It is possible by:

- Having goods in big quantities with only one package. It permits to reduce the number of packages. This method can be successful if other factors have been taken into account, as the expiry date of the goods. This is to avoid other wastes;
- Avoiding throwaway articles preferring washing articles (plates, glasses, etc.).

A third action is to contribute at the sanitary protection of the coastline. It could be done by:

- To install a sufficient number of sanitary equipment and well managed;
- To control the different discharge sources in the ports;
- To incite the port users to use the sanitary equipment on commercial ports. Some measures of wastes reduction can be taken like the fitting-out of the harbour equipment, and the awareness of the sailors (decanter/separator tank to avoid the direct discharge of rainwater in the environment, to control the use of paint against marine fouling…);
- To reduce sanitary risk by information of the users (notices of hygiene rules) (Ministère de l'Environnement, 1991).

The fourth action is to improve the quality of the coastal water by:

- The purification of the domestic and industrial wastes);
- The reduction of pollution due to the rainwater ("porous" roads, stilling basin, storage basin, storm overflow, network storage, etc.);
- Action against all pollution sources. The industrials have to respect the norms of discharge and to complete their equipment with a purification installation adapted to the produced effluents (Ministère de l'Environnement, 1991).

4.1.2 Curative actions

The monitoring of the cleaning activity can first to be done by a serious control of the becoming of the wastes. Different solutions are possible. In fact the waste will have to be put in a dump, valorised, or incinerated.

For the cleaning of macro-wastes, we must consider:

- The volume and the nature of wastes;
- The size, the accessibility and the configuration of the coastline;
- A good management (Ministère de l'Environnement, 1991).

The collection of algae is made in seawater with nets or with material to collect hydrocarbons (floating barrier).

In the case of the solid wastes, the same machines used for public works are used for quays (bin-lorry, road-sweeper). Manual cleaning is made for floating pontoons with landing net. The floating wastes are caught from the quay or barge.
In the case of basin sediments, a regular dredging is necessary (Ministère de l'Environnement, 1991).

The marine pollution is often caused by the discharge of oils or chemical substances during the loading and unloading activity of the ship, affecting the cargo, or breaking of the land pipes. In accordance with the importance of the pollution, the fight and the responsibility of the interventions are different (Ministère de l'Environnement, 1991).

The fight and the responsibility of the intervention are described in the MARPOL 73/78 Convention in accordance with the cause of the pollution : oil (annex I), noxious liquid substances in bulk (annex II), harmful substances in packaged form (annex III), sewage from ships (annex IV) and garbage from ships (annex V).

4.1.3 EMARC project

The monitoring of the cleaning activity is also studied by the EMARC project. This project is in the 4th research development programme of the European union. EMARC project will make an assessment of the MARPOL rules application. It will notify the existent legislative system and the one which needs to be improved. The final goal of the project is the reduction of the ship pollution and the prevention of accidental pollution. The EMARC project axes are :

- The collect and the analyse of the actual data on the wastes, as the pollution coming from the ships;
- The creation of a model permitting to describe the evolution of the pollution coming from the ships due to the MARPOL rules;
- The research and the implementation of new solutions to improve the ship waste treatments.

Six studies were developed:

1. Constitution of a database about the sea and air pollution;
2. Inventory of the actual waste treatments in ships;
3. Consequences of the MARPOL rules on the environment;
4. Assessment of the constraints taken in account for the improvement of the waste treatment systems;
5. Research of solutions for the waste deal;
6. Consequence of a good inventory of the wastes.

4.2 How to plan environmental controls on the environment

The objectives to plan an environmental control could be to:

- Plan the environmental littoral development, globally and locally;
- Help for planning and investment;
- Protect the immediate area, with quality objectives;
- Follow and evaluate the actions;
- Improve the knowledge about the area;
- Sensitise and communicate.

Coastal zone is divided into “homogeneous” areas. Three levels of impact could be studied:

1. The first area is the zone nearest to the coast. It corresponds to the area where there is a dilution of the rejects.
2. The intermediate area starts at the bathymeter 50 and goes up to 100 m. In this area the pollutant concentrations are mixed up.
3. The last area starts at the bathymeter 100 m, and is related to the background noise.

Measures should be done to analyse the quality of :

- The sediments once a year and every time the dredging activity is done;
- The living matter every trimester;
- The phytoplanktonic quality of the water when eutrophisation can occur;
- The vitality of the *Posidonia oceanica* meadows, as a biological indicator, twice a year;
- The physical-chemical criteria (pH [recommended value in marine and coastal waters is 6.5-8.3], toxic substances) in water used for bathing one measurement/month and one measurement/week after an accident;
- The microbiological quality of the bathing water and the shellfishes production area, one measurement/month, and one measurement/week in case of contamination, for the following indicators of faecal pollution:

  - Enterococci
  - *Escherichia coli*
  - Klebsiella
  - Enterobacter-Citrobacter
  - *Pseudomonas aeruginosa*
  - *Aeromonas hydrophila*
  - *Vibrio parahaemolyticus*
  - Faecal coliforms
  - Total coliforms
  - *Clostridium perfringens*
  - Staphylococci

4.2.1 Ecotoxicological monitoring

The test of embryo-toxicity on the bivalves (oyster larvae, mussels, etc.) gives a good indication of the quality of the area (see § 4.2.3.2 worksheet “Port waters”). These sorts of tests could be used for microbiological and mineral pollution.

4.2.2 Numerical models

The fate of the effluent discharged into the sea depends on the mixing and the transport mechanisms by the surface currents and the tide currents (Thouvenin, 1990).

In order to assess the fate of particulate or adsorbed contaminants from urban sewage disposal. The cohesive sediment transport models have been developed.
The modelling is a tool for applied research, because of the necessary field or laboratory experiments for calibrating the process laws (Le Hir *and al*., 1990).

5 MONITORING COSTS

The incineration of liquid wastes costs 91.50 EURO/tonne for the solvents to 244 EURO/tonne for the liquid which are composed with a lot of water (water dirtied with oils). There is a supplement cost if they are packaged : 3.4 EURO/tonne for a barrel to 230 EURO/tonne for a can
The incineration of solid wastes like packages costs 915 EURO/tonne.

The physical-chemical treatments cost 150 EURO/tonne for a weak acids like mineral acids to 275 EURO/tonne for strong acids like sulphuric acids.

6 DEFINITION OF INDICATORS AND CRITERIA: ASSESSMENT / EVALUATION OF MONITORING RESULTS

6.1 The port role

A study should define the adequate equipment needed to be settled for the ships and the ports installations. The method to know if a port installation retreating waste is sufficient, will have to encompass : the needs of all the ships, the number and the type of ships using the port installations.

The definition of indicators and criteria by the port to monitor the pollution by ships and industrial wastes are in the international MARPOL Convention (see § 1.2.1).

The monitoring of the activity will need to be improved. There has been a recent evolution of the rules (Directive SEVESO, Directive 91/156/EEC, the 1992 European Programme of Action, the norm ISO 14,001), so the ports will have to define the policy and the realistic objectives concerning the treatment of the port wastes.

6.2 Environmental indicator

An indicator is a tool to the decision and the political evaluation. It will be a model of lasting development (Rechatin, 1996).

An environmental indicator is:

- Representative of the environmental conditions and the exercised pressures;
- Easy to interpret, able to give the trend;
- The reflect of the environment and human activities modifications;
- Comparable to a threshold.

The approach with fauna and flora gives synthetic data about the state (functioning, dysfunction, biological diversity, abundance) of the environment and the animal and vegetal populations. But it gives too synthetic data about the pollution through the perturbation of sensible species and the concentration of toxic substances in integrative species (Weber and Lavoux, 1994).

6.3 Organisation of Co-ordination and Environmental Development (OCED)

The OCED allows to the 25 States Member of this organisation to quantify the state of their environment, the pressures which are exercising on it, and the government answers to resolve this problem.
The environmental indicators regrouped by the OCED permit to compare and to measure the differences between industrialised countries.

The performance indicators are objectives, limit or recommended norms of quality and quality scale. They are defined from indicators of pressure, indicators state and indicators of response (Rechatin, 1996).

6.4 Uniform Norms of Emission (UNE) and Objectives of Water Quality (OWQ)

There are two strategies of fight against pollution:

- The limitation of the pollutant flows discharged in the environment: the UNE are adopted by the majority of the European states;
- The control of the environmental contamination not superior to the recommended levels is to guarantee of a good use of coastal waters : the OWQ (Mauvais and Alzieu, 1991).

6.4.1 The UNE

The European Directive dated May 4th, 1976 classifies the dangerous substances in two categories (see paragraph 1.2.2). The States Member have to take appropriated measures to:

- Eliminate the discharge of substances recognised like toxic, bio-accumulable and non-biodegradable (annex 1 of the European Directive);
- Reduce the water pollution by those ones enumerated in the annex 2 (European Directive).

For each substance, the States Member fix UNE applicable for each industrial branch.

The disadvantages of the UNE are that they do not consider the sensibility of the environment and they are not applicable for the diffuse discharges (Mauvais and Alzieu, 1991).

6.4.2 The OWQ

These norms of quality have to be respected to guarantee the life and the reproduction of the living organisms, the traditional use of the sea (bathing, sailing) and the exploitation of the living resources (non-contamination of the marine food).
The OWQ are function of the uses, they are used like objectives to the environmental management. They are taken in consideration during the fitting-out decisions.

First, it is necessary to determinate the “environmental capacity”. This concept was proposed by the Joint Group of Experts on the Scientific Aspects of Marine Pollution (“GESAMP” 1996). The coastal waters have a limited and quantifiable capacity to assimilate the wastes without alteration of resources and their uses (Mauvais and Alzieu, 1991).

7 PRINCIPLES AND GUIDELINES FOR IMPROVEMENT / NEEDS FOR TECHNOLOGICAL INNOVATION

7.1 The principles and the guidelines for improvements

- All the ships should be equipped with system permitting to deal with the security and the prevention of the pollution in accordance to the code ISM (International Safety Management).

- The different techniques to treat the waste are not the same and do not have the same cost. So it can be a benefice to separate the different types of wastes when they are disposed of. To reply to this, different bins have to be used.

- For the sanitary water they should always be stocked on board, treated and them rejected into the sea. In accordance with the treatment standard and the law allowing the discharge at a certain distance of the cost.

- In 2002, 75% of wrapping wastes will have to be valorised, by recycling forms or incineration. This will allow to reduce the pollution by macro-wastes.

- Bad loading and unloading create waste. So to limit waste it is required to be careful during these operations.

- How to manipulate wastes should be part of the manual of navigation, describing the specific equipment functions.

- When the fishermen find macro-wastes in their nets, they should not to throw back them to sea but they should to bring back them into the port area and prevent the environmental manager.

7.2 The needs for technological innovation

- The ships should dispose special equipment permitting to compact and to shred… the wastes. The equipment would reduce the volume of the wastes and facilitate their storage on the ship, avoiding throwing them into the sea.

- The producers of goods are invited to develop new techniques to reduce wastes and having less impact on the marine environment. Those new techniques can be as follow:
  - Creating new methods permitting to recycle synthetic materials,
  - Developing new biodegradable synthetic products (to replace plastic products).

- Ports should encourage the use of these new products.

- An action plan has to be lead up to determine different methods and tools to reduce the risk for human health.

- If the producers of washing powder take off the phosphate of their products, the phosphates coming from the domestic wastes will be reduced of half.

7.3 Recycling and valorisation

In accordance with the fifth programme of European action, the rate of recycling/re-using of the paper, glass and plastic industries should be superior to 50% in the year 2000.
Always in accordance with this programme, the emission of dioxin coming from identified sources should be reduced of 90% in 2005, in comparison with the level of 1985. This action belongs to the norms and objectives concerning the atmospheric discharges linked to the incineration of wastes (Rechatin, 1996).

The directive 94/62/EEC dated December 12th, 1994 is called the directive “Package”. It specifies that 50 to 65% (in weight) of packaging wastes will be valorised. It specifies that 25 to 45% (in weight) of packaging materials will be recycled, with a minimum of 15%.

Other objective is the valorisation of domestic wastes by the agricultural valorisation of organic matter and the energetic valorisation. The rate to valorise will be estimate in function of the composition of domestic wastes (Rechatin, 1996).

8 ANALYSIS OF TRAINING NEEDS

8.1 Knowledge of the products and the new technologies

The training needs should be done for the ship personnel. The personnel should have lessons about the new methods and technique used to treat the wastes.

The education and the knowledge concerning the new methods to treat wastes are very important. For example the United States set up a method to deal with the plastic wastes. They collect all the plastics wastes and melt them together. The benefits of this method are that the volume of waste is really reduced. Also the plastic are all together and have higher density, so if they are thrown in the sea in authorised area, those waste will sunk easily and will not perturbs the mammals. In fact their technology holds all plastics wastes safely and securely with minimal impact. Plastic is melted and formed into disks. Once ashore the disks are recycled. This state of the art technology completely eliminates plastic wastes disposal from ships.

To know well the industrial impacts generated by products, the analysis of the life cycle (“ACV”) is necessary. The ACV is an assessment of the matter and energy exchanged between the different compounds and their environment, since the production of raw material to the treatment of industrial and packaging wastes in the end-life time.

The ACV knows a rapid development because of the regulation pressure against the environmental management and the competitiveness of industries for the respect of environment.

The ACV is a tool of environmental evaluation to compare and to improve the firms of production and treatment. It is a mathematical tool and a neutral tool because it does not permit to interpret the results (Rousseau, 1998).

The “eco-stamps” indicate the products which, during their life cycle, induce the less pollution for all the environments.

8.2 Lasting development

The impacts of anthropic activities in the environment are a growing worry for the concerned industries. The environmental management is a tool for the regulation help.

This is the objective of the norm ISO 14,001 about the Systems of Environmental Management (SEM) published in October, 1996. It belongs to the international norms of the series ISO 14,000. The ISO 14,001 norm describes the requirements of the SEM.

The ISO 14,001 is a dynamic method to simplify and to elaborate the development of an adapted environmental politics. It permits to:

- Measure the effects of the activity which have some significant effects in the environment;
- Define the environmental objectives and aims;
- Elaborate some prevention and amelioration measures for a best control of the impacts of the activity in the environment.

The ISO 14,001 norm is based on five principles:

1. Adaptability : the norm is adapted for all the firms whatever their activities;
2. Complementarity : the ISO 14,001 completes the quality systems elaborated yet;
3. Prevention : it insists on the prevention and the capacity of the firm to react in case of accidents, and so to reduce the impact in the environment;
4. Engagement : the certification ISO 14,001 demonstrates the engagement for the constant progress of the environmental performance of the firm;
5. Universality : the ISO 14,001 is valuable at the international rank.

In port management, it appears necessary to get a sound perspective of the role of Environmental Audits (Ruling 1836/93) and of similar tools for environmental management in ports (ISO 14,000). It becomes necessary to prepare and deliver courses and seminars like :

- “Seminar on the European System of Environmental Management and Auditing and its application in the fields of ports”;
- “Designing Environmental Management and Auditing Systems adapted to port sector requirements”;
- “Training for Environmental Auditors specialising in the field of ports”.

The ports have to preserve the environment but to inform and to guarantee to their partners (clients, insurance agents, shareholders, coastal inhabitants…) that this management is effective too.

The community rule Eco-Audit (“EMAS” : European Management and Auditing System) proposes to the ports the definition of a programme permitting a contractual and voluntary engagement for the environmental management.

The Rio summit in 1992 presents the environment like a lasting development. So, it is necessary to research for each project the best balance between the environment, the society and the economy. With respect of rules like the precaution principle and the right of the future generations (Brégeon, 1998).

9 PUBLIC COMMUNICATION

A good public communication can be done by pedagogic material like : photography, documents, films, tapes, publicity, poster, etc. They inform how to eliminate wastes at is best. In fact it is very useful to inform the public how to deal with their wastes. The pedagogic material is good waste pollution awareness. General information is also necessary to inform the people interested on the effects of the wastes on the marine fauna and flora.

The awareness is complementary asset. It can be done by:

- To take over from the operation of national communications;
- To participate at the local campaign;
- To favour the elaboration of an environmental education structure.

Some clef elements of the communication are :

- To modify the comportment of users against the environmental protection;
- To determinate the goal;
- To elaborate a simply and clearly message (crossed symbols for interdiction, several language, etc.);
- To choose efficacy supports;
- To study the points of diffusion;
- To maintain the supports where the messages are written (Ministère de l'Environnement, 1991).

The decision 86/85/EEC dated March 6th, 1986 institutes a community system of information to control and to reduce the pollution caused by discharge, in seawater or in intern waters, of hydrocarbons and other dangerous substances. It is modified by the decision 88/346/EEC dated June 16th, 1988.

According to the Directive "SEVESO", the Members States have to collaborate and to exchange information. The public has to be informed about the comportment to adopt in accident case and emergency.

The directive 90/313/EEC dated June 7th, 1990 is relative to access liberty to information in matter of environment.

It is important to use regional mediums (TV, radio, newspaper) to inform people living in proximity of the port about the different impacts (noise, view, smell, etc.). People is more concerned by local information.

Some information meetings are organised by ports about the behaviour in the environment of dredged materials and the risks they represent. In these meetings are invited the nature protection associations, the administrations, the local communities, etc..

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Dredging

DREDGING WORKSHEET

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1 DESCRIPTION OF THE ACTIVITY

1.1 Dredging activity

1.1.1 Generalities

Dredging is an essential activity for ports and offers a solution to the problems of siltation of channels and to the trends of increasing ship sizes, in case of loose sediments. Dredging scarps the bottom of canals or access passages of ports, to have a constant depth and to facilitate the way for the ships. For ports the dredging operations are guided by :

- the laws;
- the need for the exploitation;
- the availability of the machines and the opportunity to do the work (rising/ebbing tide, for ports concerned).

Ports makes sounding when a port manager requests it, because his ship could touched the bottom. The sounding evaluates the depth and determines the required dredging.

The dredging activity is divided in 3 phases : excavation, transport, and deposition.

1.1.2 Excavation, by mechanical or hydraulic dredging (first step)

There are two principal types of excavation: hydraulic dredging and mechanical dredging.

Hydraulic dredging is used for fine low cementation and medium density sediments such as clay and silt deposits. Suction tubes pumps up to the deposition site the dredged mud. Principal advantages are low sediment suspension in the water column, high excavation rate, facility in transport.

- Trailer dredgers are self-moving and self charging boats. The suction tubes have cutters and can operate in presence of waves 1 m high. They hollow furrows into the sediment. Maximum working depth is 35 - 40 m.

- Suction dredger and cutter dredger are used for pump and transport (from dredging site to discharge area) non-cohesive sediments. They put in suspension the material to dredge in a high water current. They cannot move alone. Maximum working depth is 35 - 40 m. Cutter dredger can take also rocks moderately strong. In large distances are used booster stations for help pumping.

Ports can use the excavation by **mechanical dredging** to remove material with a grab (or a dredge). This technique is optimal to take out coarse non-cement sediment.

- Bucket dredger is used for cohesive sediments, coarse sediments and broken rocks, excavated material is discharged in a barge.
- Dipper dredger is used for cohesive clays and broken (or weak) rocks, excavated material is discharged on an inclined plane to a barge.

The material is removed by a dredge or grab and transported in the deposit site by barges or pontoons. Principal advantages of the second method are possibility of working at great depth, high precision in sediment removal, low costs. The environmental impacts of this operation are short in time and limited to local scale : suspended matter, turbidity, chemical oxygen demand, nutrients scattering increase.

The dredging material can be classified by the particle sizes:

- Gravel: Diameter > 2 mm
- Sand: 2 mm > Diameter > 0,036 mm
- Silt: 0,036 mm > Diameter > 0,004 mm
- Clay: Diameter < 0,004 mm

In most of the country, the excavation step is never subjected to regulation.

1.1.3 Transport (second step)

The choice of transportation of excavated material depends on its grain size, packing and cementation. If there’s a short distance from disposal site (minus than 10 Km) fine material is pumped through tubes, coarse material is transported by barges or pontoons. If the distance is longer barges, pontoons or hopper dredge are used.
This step can be subjected to regulation if excavated material is transported by land roads (in trucks, lorries).

1.1.4 Disposal of dredged material (third step)

Near-shore (marine disposal) or offshore (land disposal) deposition has different impacts. Near-shore deposition occurs in confined areas named Confined Disposal Facilities, out of the area there’s no impact. Different problems can have off-shore deposition : eutrophication caused by released nutrients; increase in biological and chemical oxygen demand due to decomposing organic matter; heavy metals and chlorinated organic compounds release.

1.1.4.1 Marine disposal

Non polluted dredged material is deposited in a special marine area. Also, only the clay and sandy materials are authorised to be deposit, other materials are totally forbidden. The definition of polluted sediment has to be defined by each state.

This type of deposition is made by tube from the dredge site or directly by boat.

The dredge operator has to inform the harbour master office when he starts his operations. The harbour master insures the organisation of the ship movements and gives the advice necessary for navigators. He can forbid the access to the dumping site.

1.1.4.2 Alternative solution : land disposal

- The sandy materials dredged are noble material, lowly contaminated and can be deposited on the ground to be used in public works, embankment, civil engineering, creation of platform, loading of the beaches, cement works, sea walls, agriculture, creation of artificial reef. They are deposited in confined area.

- The contaminated sediment (related could not be deposited in the sea). They will be either treated by special firms, or stored in a landfill facility. The special firms collect, treat and eliminate or valorise the dredged materials.

- The dredged materials can be deposited in basin of drying, to reduce the volume to deposit.

- The polluted sediments can be decontaminated by chemical treatments to reduce the quantity of pollutants in accordance with the legislative standards. For example, the pathogen organisms will be eliminated by chlorine treatment (PANSN, 1982/83).

The disposal of dredged material is always subjected to regulation.

1.1.5 Biological treatment in situ

This new method consists in the decomposition of the organic matter *in situ* by autochthonous bacterial flora. This permits to reduce the volume of material to dredge and the quantity of pollutants which are adsorbed in it (Polychlorobiphenyls or PCB, hydrocarbons).
The advantage is that this is a natural method. It does not need addition of chemical products.

1.2 Laws

The disposal of dredged material receives increasing attention, especially for sites where the material is contaminated. The requirements to reduce contaminant inputs to the sea are under international conventions.

The International Conventions, which interest dredging and sea dumping, are :

- the 1954 London Convention about the discharge of hydrocarbons in coastal waters (OLIPOL 1954);
- the 1972 London Convention on the marine pollution prevention by wastes and other materials;
- the 1972 Oslo Convention about marine pollution prevention;
- the 1973 London Convention on the marine pollution prevention by oil (MARPOL);
- the 1976 Barcelona Convention on protection of Mediterranean Sea and the enclosed Athens protocol on marine pollution prevention by dumping of waste and other substances (1982);
- the 1982 Montego Bay Convention on Marine Low, Part XII, articles 192 - 137 "Protection and preservation on marine environment";
- the Protocol on Mediterranean particularly protected areas (articles 3 and 7);
- the 1992 OSPAR Convention about marine pollution by dumping of waste and telluric discharge, precaution principles and polluter pays principle; it covers the sea areas of the north-east Atlantic and the North Sea;
- the 1998 Paris Convention which is the new version of Oslo Convention (Lainé, 1998).

International conventions concerning the disposal of dredged material were set up in the 1970. These conventions are the London Convention (LC'72), the Oslo/Paris Convention (OC'72) and the Helsinki Convention.

1. The London Convention, LC' 72 dated December the 29th, 1972 is applicable for all the seas, and it is very similar to the OC ' 72 Convention specified to Atlantic Ocean. LC' 72 Convention regulates the dumping of the dredged material. A certain number of articles, address the obligations of the contracting parties to ensure the properties of the material disposed of at sea in accordance with the convention requirements. The Parties encourage co-operation between them and seek the formation of regional agreements. Those measures are taken to prevent and punish any behaviour in contradiction to the convention. Other articles are concerned mainly with the details of procedure for setting up and operating the convention.
2. Barcelona Convention dated February 16th, 1976 is about the monitoring of dredging activity. The monitoring is done: by the analyse of the composition of the material, by the place of the dumping, by the method used for dumping the dredged material in the deposit site, and at last by measuring the effects on benthic organisms.
3. The Convention for the protection of the Mediterranean Sea dated October 10th, 1978, prohibits the dumping of certain wastes described on the Annexe I (article 4).

The protocols were set up primarily to regulate the disposal of noxious substances into the oceans, and to protect the marine environment and other legitimise sea utilisation. Dredged material disposal at sea generally comes under these conventions. Specific guidelines for dredged material have been incorporated. At the heart of the conventions there are two basic principles (the precise wording varies and is abbreviated here):

- The precaution principles; by virtue of which preventative measures are to be taken when there are reasonable grounds for concerned substances or energy introduced into the marine environment may bring about hazard, harm, damage or interference, even when there is no conclusive evidence of a causal relationship between inputs and the effects.

- The polluter pays principle; by virtue of which the costs of pollution prevention, control and reduction measures are to be borne by the polluter.

2 POLLUTION SOURCES (CONCERNED SUBSTANCES AND BY - PRODUCTS)

Dredging activities can be source of pollution if the dredged material is polluted. In fact sediment are contaminated by pollutants coming from the industrial discharged: waters, ships, soils washed by the rains, polluted rivers, ports activities as ore dry bulk or noxious liquid.

The pollutants founds in the sediments can be: nutrients (they consume a lot of oxygen), pathogen elements (bacteria, virus), metals (aluminium, iron, manganese) heavy metals (arsenic, cadmium, chromium, mercury, zinc, lead, copper), total hydrocarbon and chemical toxic products (organochloride affecting the genetic code, as polychlorobiphenyl), radio-elements (^{137}Cesium, ^{129}Iode or ^{238}Uranium).

Dredging activities have a variety of negative effects on marine flora and fauna from disturbance of habitats of benthic communities in the dredged area, to physical smothering or chemical contamination of those on the disposal site.

During the dredge most of the silt particles are swept in suspension, transporting the contaminants in an adsorbed form. The finest sediments (clay) can bind nutrients (nitrogen, carbon, phosphorus) or pollutants (heavy metals, organic pollutants) scavenged, ad-sorbed and absorbed into their structure.
The suspended particles can release some of those. In that case, contamination risk can occur notably if the elements are dumped at sea.

The release of harmful element is function of the sediment stability. This stability depends on :

- pH, Eh (reduction-oxidation potential; Hily, Glémarec, 1990).
- The metals concentration.
- Quantity of organic matter.
- Water salinity.
- The mixing quality of the sediment/water.
- Micro-organism activity.
- Hydrodynamics.

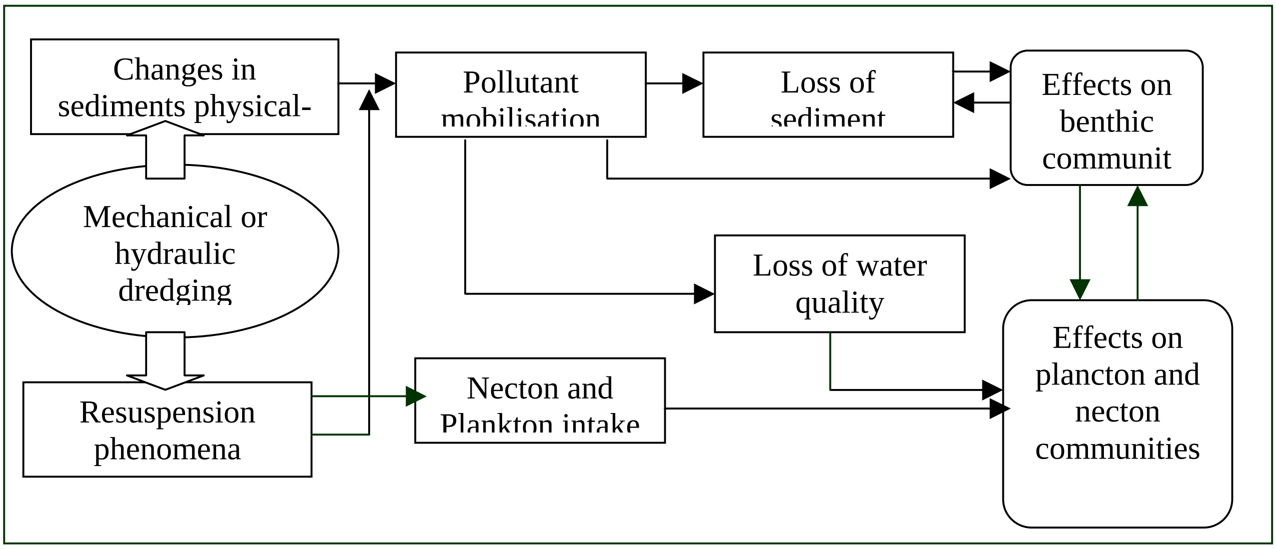

Figure 1. Different effects of pollutants discharged into the sea.

2.1 Heavy metals

Between the pollutants present in the sediments the metals are the more dangerous for their mobility as free ions. The most toxic metals for the organisms are:
Mercury by solubility increases in the water. Bacteria methylate the free form of mercury (which is the process the most toxic). The methyl forms of mercury are stocked into living organisms.
Lead become mobile if the pH decreases or the area gets oxygen. It will also have methylation process like mercury.
Cadmium also becomes mobile in oxidising areas and will be very toxic.
The most polluted part of sediment is usually the finest (less than 63µm), vector of heavy metals and organic pollutants. The metals are fixed through water-sediment ions exchange; in this complex portion process physic-chemical conditions of the environment play an important role.
The dissolved materials are mostly ionic shapes. Some of them can precipitate with insoluble complex of other elements by Red-Ox potential (it characterises the evolution of the chemical and microbiological conditions in the sediments; Hily, Glémarec, 1990) reactions.
Heavy metals have different reactions in the environment which undergoes chemical transformations that are given in table 1 below:

Table 1: Chemical transformations led by the reactions of heavy metals in the environment

Complex form	Result
Carbon monoxide, carbon dioxide	Heavy metals are released when the salts are dissolving
Adsorbed on iron oxide or manganese oxide	The complexes become unstable and release metals
Bond with organic matter	Great stability of the complex
Sulphide	Instability, oxidation in sulphates and release of metals

Evaluation of metals effects discharged into the sea (cf. figure 1) is difficult because :

- It is not easy to differentiate the anthropic and the natural origin of the pollutant.
- Metal in particular has a pollution degree harmful for a specific ecosystem at long or short term. It is difficult to appreciate it. The effects depend on the physico-chemical characteristics of the water and sediment compartments.

2.2 Organic chemicals

Is important for control purpose make a complete list of possible "priority" chemicals which are usually observed in environment and are know to have the potential to cause adverse ecological and biological effects.
For each of this "priority" chemicals is important to consider five factors (MacKay, 1991):

1) Quantity;
2) Persistence;
3) Bioaccumulation;
4) toxicity;
5) all others possible adverse effects.

List of chemicals commonly found on Priority Chemical Lists factors (MacKay, 1991):

Class	Name of chemical
Volatile halogenated hydrocarbons	Chloromethane, Methylene chloride, Chloroform, Carbon tetrachloride, Chloroethane, Dichloroethane, Dichloroetylene, Thrichloroethane, Thrichloroetylene, Tetrachloroetane, Tetrachloroethylene, Hexachloroethane, Dichloropropane, Dichloropropylene, Hexachlorobutadiene, Hexachlorocyclopentadiene, Chloroprene, Bromomethane, Bromoform, Ethylenedibromide, Chlorodibromomethane, Dichlorobromomethane, Dichlorodibromomethane, Freons (chlorofluoro-hydrocarbons), Dichlorodifluoromethane, Trichlorodifluoromethane.

Class	Name of chemical
Alkanes	1,3-Butadiene.

Class	Name of chemical
Monoaromatic hydrocarbons	Benzene, Toluene, Xylenes, Ethylbenzene, Styrene.

Class	Name of chemical
Polycyclic aromatic compounds (PAHs)	Napthalene, 1-Methylnaphtalene, 2-Methylnaphtalene, TriMethylnaphtalene, Biphenyl, Acenaphtene, Acenaphtylene, Fluorene, Anthracene, Fluoroanthene, Phenanthrene, Pyrene, Chrisene, Benzo(a)anthracene, Dibenzo(a,h)anthracene, Benzo(b)fluoranthrene, Benzo(k)fluoranthrene, Benzo(a)pyrene, Perylene, Benzo(ghi)perylene, Indeno (1,2,3)pyrene.

Class	Name of chemical
Halogenated aromatics	Chlorobenzene, Dichlorobenzenes, Trichlorobenzenes, Tetrachlorobenzenes, Pentachlorobenzene, Hexachlorobenzene, 2,4,5-Trcihlorotoluene, Octochlorstyrene, 1-Chloronapthalene, 2-Chlornaphtalene.

Class	Name of chemical
Biphenyls and halogenated biphenyls	Biphenyl, Polychlorinated Biphenyls (PCBs), Polybrominated biphenyls (PBBs), Aroclor and Aroclor mixtures (PCBs).

Class	Name of chemical
Chlorinated and brominated dibenzo-p-dioxines	

Class	Name of chemical
Chlorinated dibenzofuranes	

Class	Name of chemical
Alcohols and phenols	Benzyl alcohol, Phenol, Cresol, Hydroxybiphenyl, Eugenol.

Class	Name of chemical
Halogenated phenols	Chlorophenol, Dichlorophenols, Trichlorophenols, Tetrachlorophenols, Pentachlorophenol, 4-Chloro-3-methylphenol, 2,4-Dimethylphenol, 2,6-Di-t-Butyl-4-Methylpenol, Tetrachloroguaiacol.

Class	Name of chemical
Nitrophenols, nitrotoluenes and related compounds	Nitrophenols, 2,4-Dinitrophenol, 4,6-Dinitro-o-cresol,Nitrobenzene, Dinitrotoluenes, 1-Nitronaphtalene, 2-Nitronaphtalene, 5-Nitroacenaphetene.

Class	Name of chemical
Nitrogen and sulphur compounds	N-Nitrosidimethylamine, N-Nitrosidiethylamine, N-Nitrosidiphenylamine, N-Nitrosi-n-propylamine, Diphenylamine, Indole, 4-Aminoazobenzene, Acrylonitrile, Benzidine, 3,3-Dichlorobenzidine, Benzeneacetonitrile, Aniline, Acrideine, Ethylenethiourea, Hydrazine, 2-Mercaptobenzothiazole, Morpholine.

Class	Name of chemical
Acids	Abietic Acid, Dehydroabietic Acid, Chlorodehydroabetic Acid, Oleic Acid, Primaric Acid.

Class	Name of chemical
	Diphenylether, 4-Chlorophenyl-phenylether, bis(2-chloromethyl)ether, bis(2-chloroethyl)ether, bis(2-chloroisopropyl)ether, 4-Bromophenyl-phenylether, Diphenyl ether, bis(2-chloroethoxy)methane, Formaldehyde, Benzaldehyde, Butanal, Methylethylketone.

Class	Name of chemical
Others	1,4-Dioxane, Dimethyl disulphide.

Class	Name of chemical
Phtalates Esters	Dimethylphthalate, Diethylphthalate, Di-n-buthylphthtalate, Di-n-octylphthalate, Di(2-etylhexyl)phthalate.

Class	Name of chemical
Pesticides	Acrolein, Aldicarb, Aldrin, Alachlor, Atrazine, α-Endosulfan, β-Endosulfan, Endosulfan sulfate, α-BHC, , β-BHC, , δ-BHC, , γ-BHC, Chlordane, Chlorpyrofos, Dicamba, Dieldrin, 4,4'-DDE, 4,4'-DDD, 4,4'DDT, Endrin, Fenitrothion, Heptachlor, Heptachlor epoxide, Isophorone, Malathion, Parathion, Methylparathion, Methoxychlor, Mirex, Toxaphene.

3 CONSEQUENCES

3.1 Effects on the environment

3.1.1 Effects on the sea environment

3.1.1.1 Dredging installations

They induce some modifications of the Red-Ox (Oxidation-Reduction potential) conditions in the water-sediment interface when the sediments are stirred up. Heavy metals are released.

3.1.1.2 Dredged materials

From a functional point of view pollutants can be divided in two major groups: those that affect the physical environment and those that are directly toxic to organism, including humanity.

The pollution can come from a nutrients superabundance which, on its turn, can give rise to enrichment of the ecosystem, or from a mix of toxic potentially carcinogenic, mutagenic (cause damage to genes) or teratogenic (cause abnormalities in developing embryos) compounds. The physical changing of the environment can be also considered.

Dredging can also seriously damage the shallow-water habitats. Clay and silt suspension decreases the penetration of light into the water, can cause a decrease in the primary productivity in the water column; this in turn reduces the amount of oxygen in the water and the supply of phytoplankton at primary trophic level. The burial and the massive injection of nutrients perturb the benthic communities: hence the original ecosystem is destabilised. Risks of chemical contamination on the deposit ground site are very low, because the sedimentology and geochemistry (then the pollutant concentrations) of the dredged material must be similar to the receiving area. The contamination of the water body is possible, but if the deposit site is enough far from the coast, it will not pollute the coastal water.

There are not relevant long-term effects. The possibility of long term effects are due to bio-transformation, bio-concentration and bio-magnification phenomena.
Some bacteria transform the pollutants like arsenic. They create toxic gas products accumulating in organisms. The waves and the wind forced currents can put again in suspension the finest material. This phenomena is studied by the rheologic properties of the materials dredged.

3.1.2 Effects on the physical area of the port

3.1.2.1 Dredging installations

Wind conditions have to be less than 8 m/s (16 knots), because afterwards the evolution and the manoeuvre of the loaded barge can became difficult.
Installation alters the natural flow in the port.

3.1.2.2 Dredged materials

In fact, the current and the swell have two hydrodynamic impacts on the disposal activity:

- Dispersion of the dredged material on the water body (turbide cloud).
- Shifting material on the bottom after deposit.

3.1.3 Effects on the sedimentation

3.1.3.1 Dredging installations

Installations alter the sedimentation in the port.

3.1.3.2 Dredged materials

According to their physical characteristics, sediments have not the same comportment:

- The rough elements (with a diameter of 1 mm) have sedimentation around 10 cm/s. So the sediment takes 3 to 4 minutes to reach the bottom of the deposit site, assuming 25 m water depth;
- It takes ten times more for sediments of 100 µm having speed sedimentation of 1 cm/s, so the deposited material reaches the ground 30 to 40 minutes latter;
- Flocculation can be used to help the sedimentation of fine particles;
- Fine sediments are slow to packing down because of the water in it (Migniot, 1998).

The sediment seep shows us that most of the material reaches the ground in less than one hour. The only problem could be with the clay sediments of less than 2 µm. They will disperse in the water body for a long period. A temporary turbidity of the water body will disturb the benthic fauna as the photosynthesis processes.

3.2 Impact on the environment and the users

3.2.1 The biological impact

3.2.1.1 Dredging installations

Benthic population is crushed and fishes avoid dredging area. Organisms living into the sediment are destroyed.

3.2.1.2 Dredged materials

The integration of the pollutant is done at the sediment water interface. We talk about bio-mobilisation (integration of the pollutants in the living organism) giving bio-accumulation (accumulation of chemical substances directly by the aliments) and then bio-concentration (retention of the pollutants in the tissues).

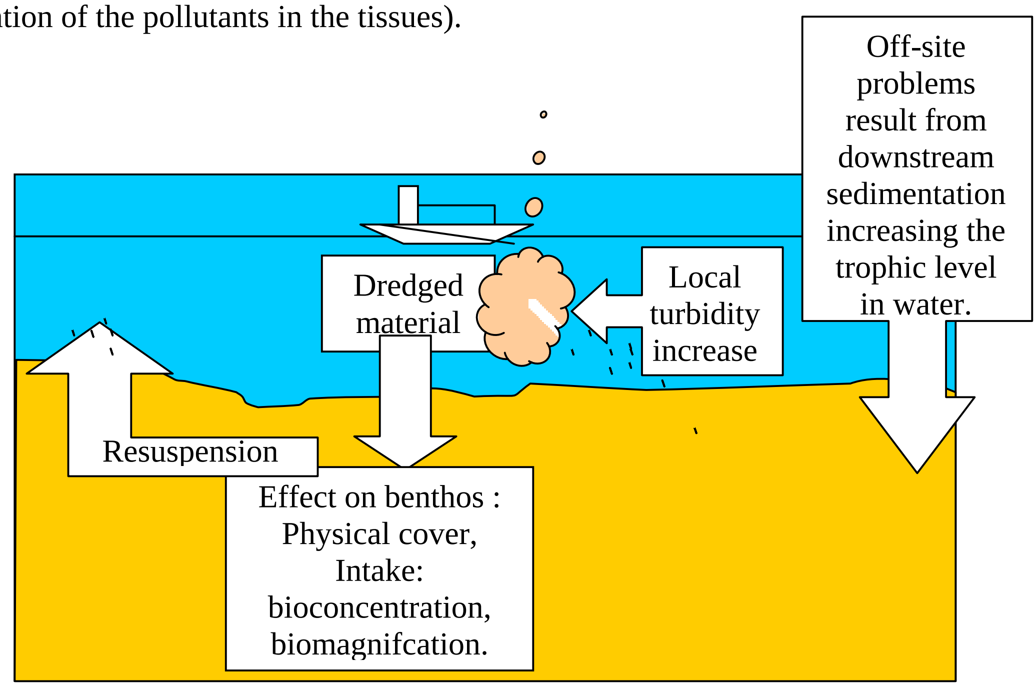

Figure 2. Different impacts of the dredged materials

The impact on the plankton is not important. The communities will develop resistance against the perturbation or “disturbance”. So there are no precautions or protection needed to be taken. The heavy metals alliterated the biological functions at the macroscopic, biochemical levels and on the natural cycle. The organic pollutants are mutagen, carcinogen and genotoxic agents for living material.

The impact for the benthic population will depend on the materials dumped. The benthic population is notably disturbed. Then slowly there will be a restoration of the community, but it will never be has it was before. The existing organisms are robust, and well adapted to a changing area, with the difficult condition of life. The quality of the material can cause damage, in particular if it is rich in organic elements (more than 10 %).

Most of the species will disappear and a new community of worms would take place like *Capitella capitata*. The worms are opportunist species that have the maximum density near the pollution sources. But those conditions should not stay longer than three to four months if no more polluted material are deposited. Then other species would take their place.

It is better to dredge during winter time. The consequences will be less important in reproduction activity and algae are in reduced form (cyst, spore).

The quantity of dredged material laid on the deposit site can have an impact if it is over 2 - 5 mm. It would destroy the most fragile population, and incur modification on the keel of the ecosystem. Three to four months latter the community should recover and find again here keel after 1 or 2 years.

The impacts are different in the environment according to the activity and the resources (cf. table 2).

Table 2: Different types of impact in the environment

	Activity ⇩	Dredging	Transport	Marine disposal	Land disposal
Resources ⇩					
1. Ecosystem					
1.1 Biotic components		R1*l*	L1*l*	R1*l*	L1*i*
1.2 Abiotic components		R1*l*	Z0*n*	R1*l*	L1*i*
1.3 Scenic values		Z0*n*	Z0*n*	Z0*n*	M1*i*
2. Space					
2.1 Settlement		L1*l*	L1*l*	Z0*n*	Z0*n*
2.2 Movement		L1*l*	L1*l*	Z0*n*	Z0*n*
2.3 Communication		L1*l*	L1*l*	Z0*n*	Z0*n*
3. Culture					
3.1 Archaeological remains		(a)	(a)	(a)	(a)
3.2 Man made structures		L1*l*	Z0*n*	Z0*n*	(a)
3.3 marine knowledge		Z0*n*	Z0*n*	Z0*n*	Z0*n*

Note: (a) possible impact

Codes:

Impact strength	Zero = Z	Low = L	Medium =M	Relevant = R
Impact dimension	Null = 0	Little ~ 1km ^{2} = 1	Local ~ 10 km ^{2} = 2	Regional ~ 100 km ^{2} = 3
Impact duration	Null = *n*	Low = *l*	Medium = *m*	Irreversible = *i*

3.2.2 Impact on the human area

3.2.2.1 Dredging installations

- The navigation and the fishing near the dredging activity should be defended during all the operation (48 hours). It is to facilitate the barges movements.
- The dredging activity will modify the area of fish's frequentation.

3.2.2.2 Dredged materials

- The dredging activities increase the turbidity near the dredged and the deposit area. The turbidity can have negative impact in the aquaculture facilities.
- Some pollutant like mercury can concentrate in fishes, them when humans eat those fishes they will have nerves problem.

3.2.3 Impact on the users

3.2.3.1 Dredging installations

- Disturbance of navigation and sailing activities;
- Disturbance of occupational fishing;
- Disturbance on tourism activities because of noise, view and smell;
- Suspension of bathing activity and water sports.

3.2.3.2 Dredged materials

- Turbidity induce avoidance of dredging area by fishes;
- Disturbance of waters quality in turbide cloud area;
- Disturbance on tourism activities because of noise, view and smell;
- Leisure fishing is forbidden in turbide cloud area.

4 MONITORING

4.1 How to plan environmental controls on the activities

4.1.1 General environmental controls of the dredging activity

4.1.1.1 The environmental control can be done by the reliability of the technique used

- Watertight integrity of the valve barge.
- Good positioning in the area of the activity.
- Good weather (wind) and sea conditions (rising/ebbing tide, waves) for the barge.
- Analyse of the impact to the recreational activity depending to the current.
- A control of the bathymetric condition in the disposal area.
- The instantaneous deposit of the material will induce a quick sedimentation and a good management of the quantity and an equal spread of material at the disposal area.

4.1.1.2 The environmental control can be done by respecting the rules

- Chemical and physical analyses of the dredged material before dumping in the sea. The test of embryo-toxicity on the bivalves (oyster larvae, mussel, etc.) give a good indication of the quality of the sediment in witch live the organism analysed (see § 4.2.3.2 worksheet “Port waters”).

- If the dredged materials are polluted they will be stored in special ground site.

- If the dredged materials have some radioactivity, the immersion is forbidden.

- The sediment deposit should not be over 10 to 20 cm. So the deposits have to be equally laid out on the deposal area.

- Interdiction to dump large volume with metals material.

- The granulometry of the deposit must be similar to the natural sediment.

- Eliminate all floating elements from the dredged material.

- Limit the use of the disposal site (the concession is for a precise volume).

- Maritime traffic, around the deposit site, will be deal by the harbour master’s office.

- The contractor will have to take note of the dredging and deposit positions.

- The port will have to control the bathymetry once a year all around the disposal area.

- In bad meteorological conditions the dredging activity will be stop.

- The technique of dredging should avoid mixing up sediment and water, because more the material is concentrated better the deposit of the sediment at the marine deposit site will be

- done. Also the diminution of the quantities of water in the sediments will permit to reduce the quantities and the weight of the total sediment transported.

- The operation should not be done in winds over 8 m/s (16 knots), or over 1 m of swell.

- The position is debenture so the harbour master's office can follow the dredge operation in real time.

4.1.2 Ports environmental control of the dredging activity

Ports should inform Water police, three months before the beginning of the dredging activity. Ports must specify the volume dumped, and the area that will be dredged.

This information given to the Water police should permits to control the quality of the dredged material. In fact the dredged material can be immersed only if it correspond to non polluted referenced values (according to the states standards or to the international convention values).

A cartography of the seafloor deposit site is essential. A complete monitoring programme goes from the collect of data before and after the deposit of the dredged material, to the observation of the physical modification of the site.
The sediments low-grade in metals must have normalised analysis protocols. Also a particular care for the sampling has to be taken to avoid contamination. The samples must be taken on the dredged material.

The Water police should controls the quality of the dredged material at each dredging, or unexpectedly and should have the free access to the dredging activity.

The dredged material should be sampled by an inspector of the Water police and analysed by a laboratory agreed by the Minister of the Environment. The number of samples will depend if the area is free or confined.

4.1.2.1 Free exchange area

The number of samples need to be done depends of the volume dredged (cf. Table 3)

Table 3: Number of samples according to the volume dredged

Volume dredged (m^3)	Number of samples
V < 25,000	1
25,000 < V < 100,000	2
100,000 < V < 250,000	3
250,000 < V < 1,000,000	1 sample / 100,000 m^3
V > 1,000,000	10 samples + 1/1,000,000 m^3

4.1.2.2 Confined area

Those areas are characterised by a low water circulation. It is the case of most of the port area. One analyse will be done for each operation and for 5,000 m^3.

An automatic diagnostic should be done during the dredging activity. The dredging operator records all the parameters necessary to make a good operation: date, hour, minute, position, nature of the materials, volume, co-ordinated, and bathymetry of the dredged site.

A copy of this register should be addressed each week during the dredging work, to the Water police. Then at the end of the dredging campaign, the dredging company addresses an assessment to the Water police.

4.2 How to plan environmental controls in the environment

The objectives to plan general environmental control could be to :

- Plan the environmental littoral development, globally and locally.
- Help for planning and investment.
- Protect the immediate area, with quality objectives.
- Follow and evaluate the actions.
- Improve the knowledge about the area.
- Synthesise and communicate.

Coastal zone is divided into “homogeneous” areas. Three levels of impact could be studied:

1. The first area is the zone nearest to the coast. It corresponds to the area where there is a dilution of the rejects.
2. The intermediate area starts at the bathymetric line 50 m and goes up to 100 m. In this area the pollutant concentrations are mixed up.
3. The last area begins at the bathymetric line 100 m, and is related to the background noise.

Measures should be done to analyse the quality of:

- The water column every trimester.
- The sediments every time the dredging activity is done.
- The living matter every year at the disposal site.
- The area using the vitality of vegetal plantation as a biological indicator, once a year.
- The microbiological quality of the bathing water, 12 measurements / year should be done in summer time.

Their should also be made an evaluation of the water quality and the sediments of the port areas. It will permit to:

- Have a global apprehension of the pollution created by ports.
- Bring to the environment port manager, actualised data on the quality of the sediments and the water.

- Create adequate norms relating to the elimination of the dredging wastes.
- Evaluate the port quality per basin.
- Have objective information to incite the ports managers to researches good solutions permitting to eliminate the source of pollution.

5 MONITORING COSTS

5.1 The bathymetric activity

The equipment for the bathymetric measurements cost around 2,000 EURO/day. The ground treatment equipment (the computer equipment, the elaboration material, the processing of the plans by one hydrographer) cost 620 EURO/day. So the bathymetric survey costs approximately 590 EURO/hectare.

5.2 Cost of the analyses

The cost to analyse one sample of the dredged sediment is about 54O EURO (heavy metals, polychlorobiphenyls, hydrocarbons).

5.3 Cost of the dredging

The dredging activity cost around 15 EURO/m^3 of sediment dredged.

6 DEFINITION OF INDICATORS AND CRITERIA: ASSESSMENT / EVALUATION OF MONITORING RESULTS

The prevention of the risk of contamination needs knowledge about the sediment: physic-chemical condition as oxidation-reduction of the area that will receive the dredged sediments, the way the metals are associated to the sediment. So it is important to have a normalisation technique to analyse it.

The assessment of the ecotoxicological acceptability of the dumping of dredged material has to be based upon quantitative sediment quality criteria. The preconceived assessment scenario is based on:

A sediment quality criterion (target value) under which dumping of dredged material is allowed.
A limit value which prohibits the dumping of dredged material.
A “grey zone” between these two values of which the decision concerning the ecotoxicological acceptability can be based on bio-assays or limiting conditions (SEBA, 1998).

This permits to know in an objective point of view the quality of the dredged material and then to decide if the material can be deposited in the sea.

The London Convention (LC’72) has adopted a new method of assessment of the suitability of dredged material for disposal (DMAF) which is based on the Waste Assessment Framework (WAF). The dredged material guidelines (DMAF) have been formed in such a way as to complement the WAF and is summarised in Figure 3 (Fletcher, Burt, Papai).

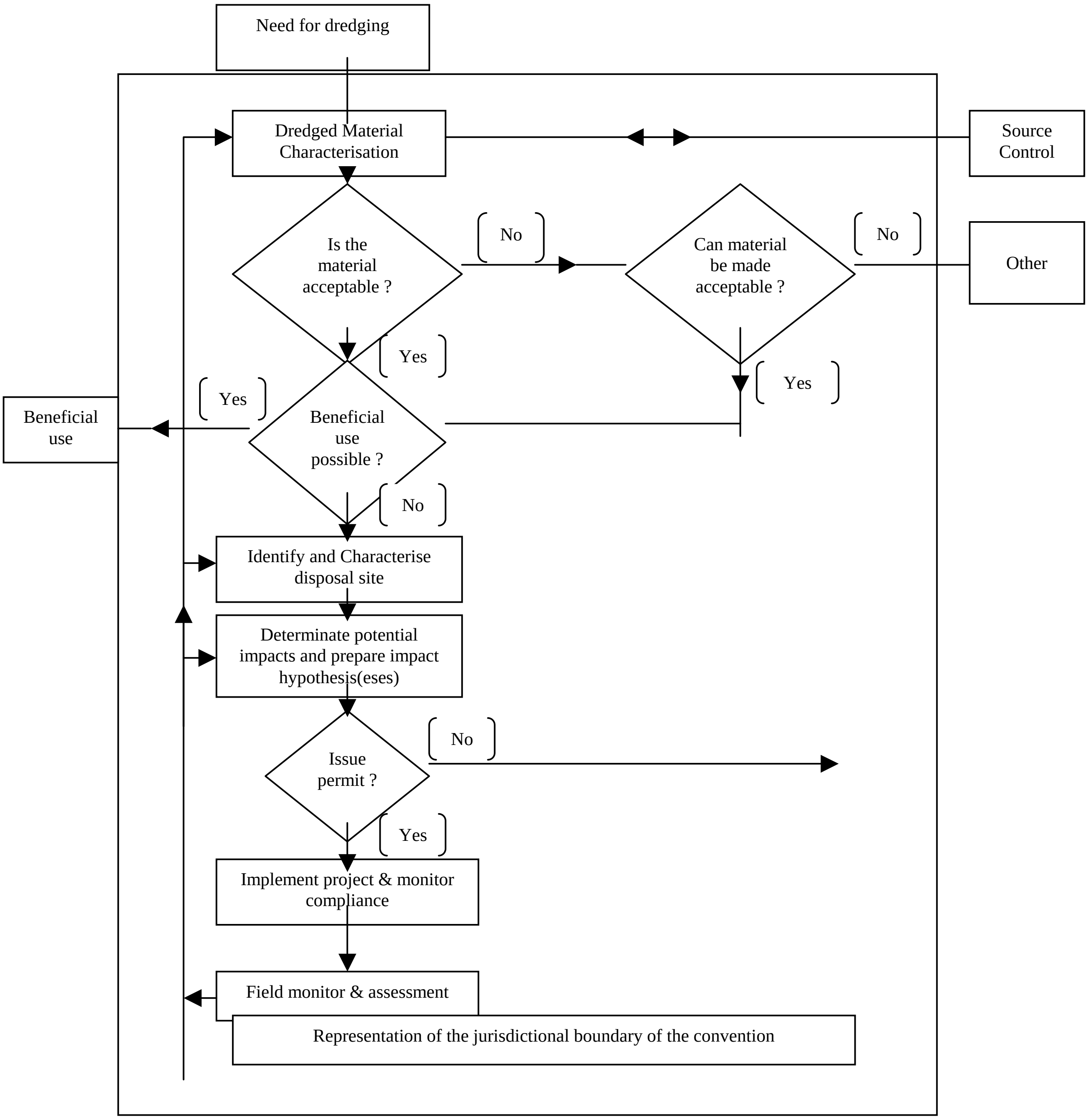

Figure 3. Dredged material assessment framework

7 PRINCIPALS AND GUIDELINES FOR IMPROVEMENT / NEEDS FOR TECHNOLOGICAL INNOVATION

7.1 The dredging activity

The control of the dredging activity can be done by:

- Positioning systems (GPS, SYLEDIS, TORAN, AXYLE). Best will be the position of the dredging activity better will be the survey of the marine environment.

- Technique of drawing (DALI). This is a logical improvement in precision and reliability. It gives a quick view of the evolution of the water depths. Consequently the control of water depth quality is more efficient, which allow quick intervention. It is also an improvement for the navigation conditions and an actualisation of the water depth dredged in real time.

- It is also possible to use a sounding camera to study the thin coat of dredged material that has been deposit and to determine its physical proprieties.

7.2 Knowledge of the pollutants dredged

The high levels of pollutants are always in the harbour area. Those places are favourable to settling of fines material and pollutants. The same phenomenon happens in stale area, with low water dynamic. The port areas represent only a small percentage of all the dredging works.

A model of the hydro-sediment area should be made, with a special attention to the suspended solids. In fact a improvement of the physic-chemical and geochemical processes in the suspended solids comportment needs more investigation and research. It is important to define biological criteria to know the effect on the environment. The dredging activity is not there to create disaster or unacceptable risk. The dredging is a necessary activity bringing modification of the physical, chemical and biological environment. So it is important to evaluate the impacts between the different dredging methods.

One important point is to try to reduce the suspended solids by using good dredging equipment and adequate dumping sites. A good way to reduce the cost of the dredging activity is to find the pollutant at is source, and see if there are not any methods to stop the pollution of the sediments.

7.3 Valorisation of the dredged sediments

The non-polluted dredged sediments can be valorised by different ways. If they are concentrated in organic material they can be lead on plants and serve as a fertiliser, or use for the building of route embankments. The sandy material can be spread on beaches.

There are different types of valorisation:
Environment valorisations: wild environment (damp areas, habitats with high biodiversity) and public environment (leisure areas, shoreline protected areas).
Long-time valorisation with financial interest.

Social valorisation: tourism, farming, employment, industrial activity.
Construction materials.

The valorisation of the dredged material is done because there is a benefit that can be taken compared to the deposit in the disposal site. Even if most of the times advantages of the valorisation mode cannot be transferred in money value (it is notable the case when there is a improvement for the environment). The choice of a valorisation option is not only based on the comparison of it's cost and intrinsic advantage, but has to take into account all the other factors affecting the opinion.

7.4 Environmental situation

- Dredged material characterisation : sediment quality, pollution sources …

- Disposal area characterisation : geography, physical characteristics, biologic characteristics, human activities and users, protected areas.

8 ANALYSIS OF TRAINING NEEDS

The personnel of the ports treating with the dredging activity and the Police Water personnel must have a good knowledge of the dredging activity. That is essential to minimise the environmental damage and maximise the port activity.

They must attend formations which treat different subjects and acquire knowledge about:

- The different types of dredge and their functioning conditions (depth, volume to dredge, quality of the sediments);
- The different effects and impacts of technologies proposed by contractors to prevent them;
- The new techniques used in the others countries and their results (they will acquire this knowledge during meetings);
- The Water Police and laws put into practice in ports. These texts need them in their choice.

9 PUBLIC COMMUNICATION

Radio information in nautical bulletin must be done. The harbour master office should inform the author and operator concerned by the moment when the dredging activity is done.

It is important to use regional mediums (TV, radio, newspaper) to inform people living in proximity of the port about the different impacts (noise, view, smell…). People is more concerned by local information.

Some information meetings are organised by ports about the behaviour in the environment of dredged materials and the risks they represent. In these meetings are invited the nature protection associations, the administrations, the local communities…

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Painting

PAINT WORKSHEET

Contents *Page*

1 DESCRIPTION OF ACTIVITY

1.1 Process

The paint job operation consists in a process of superficial covering of objects that can be constructed with materials of various nature (as an example metals), in order to improve the superficial resistance and the aesthetic aspect. The methods of application of varnishes are the following:

I) Paint job with paint-brush or seam.

II) Paint job with spray, with these three methods:

a) with atomisation of air: the varnish, to the state of the most fine fog, is sprayed by means of a compressed air jet casts (5 - 7 atm);
b) airless method: the varnish is set under pressure (80 - 450 atm) and sprayed through a thin nozzle;
c) electrostatic method: the varnish sprayed to low pressure (inferior to 1 atm) is loaded electrostatically to approximately 100,000 volt in the head of the gun used for the operation. For effect of the electrostatic field between gun and piece to paint, connected electrically to earth, the varnish not directed towards the piece is from this however attracted for effect of the lines of force of the field.

1.2 Products

Specify the data related to the type of varnish used in the operation (enclose the related card of emergency, the technical card and the composition percentage of the varnish):

Chemical name of the product	
Composition/information on components	

1.3 Legislation

- Council Directive n° 61, 24 September 1996 concerning integrated pollution prevention and control.

- Commission Decision n° 511, 29 July 1996 concerning the questionnaires provided for in the Council Directive 80/779/EEC, 82/884/EEC, 84/360/EEC and 85/203/EEC.

- Council Decision n° 904, 22 December 1994 providing a list of dangerous waste according to article 1, paragraph 4 of Directive 91/689/EEC concerning dangerous waste.

- Commission Decision n° 3, 20 December 1993 providing a list of waste according to article 1 a) of the Council Directive 75/442/EEC concerning waste.

- Council Rule (EEC) n° 259, 1 February 1993 concerning the supervision and control of shipments of waste within, into and out of the EC.

- Council Rule (EEC) n° 2455, 23 July 1992 concerning the export and import of certain dangerous chemicals.

- Council Directive n° 57, 24 June 1992 concerning minimum prescriptions on safety and health in temporary or mobile yards (eighth specific Directive according to article 16, paragraph 1 of Directive 89/391/EEC).

- Council Directive n° 689, 12 December 1991 concerning dangerous waste.

- Council Directive n° 656, 30 November 1989 concerning minimum prescriptions on safety and health about the use of Individual Protection Devices by labours (third specific Directive according to article 16, paragraph 1 of the Council Directive n° 391, 12 June 1989).

- Council Directive n° 391, 12 June 1989 concerning measures to promote the labours' safety and health improvement.

- Commission Directive n° 178, 22 February 1989 concerning the adjustment to the technical development of the Council Directive n° 379, 7 June 1988 on the approximation of laws, rules and administrative disposals related to the classification, packaging and labelling of dangerous preparations.

- Council Directive n° 609, 24 November 1988 concerning restrictions on air emissions of certain pollutants coming from combustion great plants.

- Council Directive n° 379, 7 June 1988 on the approximation of laws, rules and administrative disposals related to the classification, packaging and labelling of dangerous preparations.

- Council Directive n° 203, March 1985 concerning air quality rules for nitrogen dioxide.

- Council Directive n° 360, 28 June 1984 concerning the fight against air pollution made by industrial plants.

- Council Directive n° 884, 3 December 1982 concerning a maximum limit for lead in the air.

- Council Directive n° 605, 28 July 1982 on workers' protection to risks related to exposure to metal lead and to its ionic compounds (first specific Directive according to article 8 of the Council Directive n° 1107, 17 November 1980).

- Council Directive n° 501, 24 June 1982 on relevant accidents risks related to certain industrial activities.

- Council Directive n° 1107, 17 November 1980 on workers' protection to risks related to exposure to chemical, physical and biological agents.

- Council Directive n° 779, 15 July 1980 concerning air quality maximum values and guide values for sulphur dioxide and dust.

- Council Directive n° 728, 7 November 1977 on the approximation of laws, rules and administrative disposals related to the classification, packaging and labelling of paints, varnishes, print inks and others.

- Council Directive n° 769, 27 July 1976 on the approximation of laws, rules and administrative disposals related to the commerce of certain dangerous substances.

- Council Directive n° 442, 15 July 1975 concerning waste.

2 POLLUTION SOURCES

a) Organic solvent emission by evaporation during the application of the varnish and the drying of the same one. Organic solvent emission by evaporation during the operations of washing of the tools and in the phases of preparation and drawing of varnishes to apply. The emitted organic solvents are constituted mainly from aliphatic and aromatic hydrocarbons, ketons, alcohols, esters, ethers.

b) Emission of metals, as oxide of lead, chromium, cadmium, zinc, pond, etc., during the spray application of varnishes. The emission consists in the dispersion of varnish particles.

c) Noise deriving from the machines used for the application of the varnish (compressors, sprayers, etc.).

d) Refusals deriving from empty containers, old tools, cleaning materials, etc.

3 CONSEQUENCES

3.1 Effects on the environment and the users

The effects on the external atmosphere deriving from the use of the varnishing products are identified with the potential toxic effects involving the workers who carry out the paint job operations and the surrounding population. Such effects can come out from the action of the following kinds of substances:

- *Solvents*, contained in elevated percentages inside the varnishes (up to the 70-75%). The kinds of found solvents in varnishes are:

Alcohols	butyl, isobutyl, isopropyl, diacetone alcohol
Ketons	acetone, methyl ethyl keton, methyl isobutyl keton, cyclohexanone
Esters	ethyl, isobutyl, butyl, isopropyl acetate
Aliphatic hydrocarbons	hexane, heptane, turpentine
Aromatic hydrocarbons	toluene, xilene, solvent naphtha
Chloro compounds	dichloropropane, trichloroethane, perchloroethylene, trichloroethylene
Glycol	butylcellosolve, carbithol, butilcarbithol, propylenic glycol methylic ether

The solvents, in general, if inhaled in great concentrations are all narcotics, and many are considered neurotoxic also to low concentrations. The solvents, being liposoluble substances, can interact with the structures of the central and peripheral system, provoking irreversible lesions also with deficit of the psychical abilities. In particular way, great part of solvents frequently provokes characterial alterations associated to the loss of memory and modification of the personality. Moreover, the exposure in the long term involves annoying effects to the breathing ways, the skin and the ocular mucosae; are not rare also breathing ways and cutaneous allergies. It would seem also that the extended exposure to organic solvents produces cancerogenous and degenerate effects.

- *Metals* (inside the pigments). According to the pigment added to the varnish the typology of organic or inorganic compounds may vary, that could interact with the living organisms:

whites	titanium dioxide, lithopone, zinc oxide
yellows	lead chromate, cadmium yellows, natural and synthetic iron oxides, arilamidi, poliazoici, pirantroni, diarylanilide
greens	trivalent chromate greens, phtalocianine greens
oranges	lead chrome molybdates, cadmium oranges, diarylanilide, poliazoici, arilamidi, naphtols
reds	natural and synthetic iron oxides, molybdenum reds, cadmium reds, naphtols, toluidins, chinacridone, lithols
metallic	aluminium, bronzes
anticorrosives	zinc chromates and tetraoxidechromates, strontium chromate, lead minium, lead silicochromates, zinc phosphates

All the metals listed in the table can potentially produce a great variety of toxic effects. In some cases it is possible that this is due to the inhibition of a single enzyme or a single biochemical process, while in other cases the metals cause acute local irritation of the breathing ways or, like in the case of some compounds of the aluminium, can provoke, after extended exposures, serious alterations of the bronchopolmonar tissue.

- *Powders*, deriving above all from the operations of preparation of the surfaces before the treatment of paint job. They can be characterised taking into account their dimension; the most dangerous for man turn out to be those having dimensions less than 15 μm that can be easy inhaled interesting several parts of the breathing system until arriving to lungs (dimensions less than 1 μm). The extended particle inhalation can provoke in the breathing apparatus chronic fibrous reactions and necrosis of the tissues that take the name of pneumoconiosis. The powders have some effects also to the external atmosphere reducing the visibility and the brightness of the atmosphere and provoking corrosions and erosions to materials and metals.

Moreover to these polluting agents, we must consider also the noise that is cause for multiple disturbs for the man and, under shape of vibrations, also for the external atmosphere.

In particular, the disturbing effects for the man are in charge:

- of the organism;
- of the sleep;
- of the psycho-physical performances;
- of the oral communications, that turn out altered regarding the condition of noisiness absence. In particular, the acoustic impact can in this way be related to the level of noisiness:

Noise level [dB(A)]	Acoustic impact
< 55	very low
between 55 and 60	low; may disturb very sensible persons (old persons)
between 60 and 65	may have effects on sleep and may disturb a wider part of population
>65	heavy constriction situation

4 MONITORING

4.1 How to plan environmental controls on the activities

The emissions of the operation of paint job carried out inside the harbour areas are of a diffused type and can hardly be driven through the normal systems of aspiration. Consequently, it can be supposed that the emission depends on the used varnish amount, its composition and the modalities of application. Holding account of this dependency, it will be necessary to record data on the consumption of raw materials (table 1) and to carry out more measurements about concentration in working places in different operating conditions.

In a way to have the maximum effectiveness of the environmental controls, it is necessary that the related data to the type of varnish used in the operation are specified (enclose the related card of emergency, the technical card and the composition percentage of the varnish):

Table 1: Varnish chemical-physical and applying features

Product chemical name	
Composition/information on components	
Applying modalities	
Varnish colour	
Product function	
Used amount (tons per year)	
Painting cycle	days/year
	hours/day

and strictly related to the used varnish parameters are checked:

- VOS;
- powders;
- metals.

Parameter		Date of measurement	Measured concentration	Measurement method	Time taken
VOS					
Powders					
Metals					

According to the purpose of the controls it could, moreover, be increased the level of detail of the determination, measuring also the concentrations of some "indicating" substances chosen among those forming the varnishes (as an example a particular solvent).

Noise

To closely examine this aspect, see worksheet “Noise”.

Waste

The monitoring of waste produced by the activity must first develop through the classification of the waste, attributing them the code and the codified name previewed in the European Code of Waste (ECW - attached to decision 93/3/CE). The necessary information, in order to characterise adequately the potential environmental dangerousness of waste are the following:

WASTE CODE
WASTE CODIFIED NAME
PHYSICAL STATE
CLASSIFICATION (D = Dangerous; ND= Not Dangerous)
AMOUNT (Specify if in kg or tons)

In order to correctly classify waste and to give it the correct code and codified name it is necessary to make reference to the information, contained in the card of emergency and in the technical card of the varnish, related to the characteristics of composition and dangerousness and to the modalities indicated for the draining.

- To the aim to comprise which and how many problematics are connected with the generation and the treatment of waste, can be opportune to characterise the waste themselves through a chemical analysis mainly turned to determine the concentrations of the metals and eventual residual solvents.

4.2 How to plan environmental controls in the environment

In order to plan the environmental controls outside of the site in which the paint job activity is carried out, it is necessary to characterise some aspects of the site itself. In particular, must be known the weather - climatic and environmental parameters that condition the transport, the dispersion and the dissemination of the potentially harmful substances. On the base of the supplied data of composition the specific dangerous substances will have to be characterised (solvents, metals, etc.) and their concentration will have to be determined in reference to the single substance and, cumulatively, with others having chemical-physical affinity with this. In particular, the single substances that will be the object of the control will be following:

Parameter	Date of measurement	Measured concentration	Measurement method	Time taken

while parameters to be cumulatively determined will be as follows:

Parameter	Date of measurement	Measured concentration	Measurement method	Time taken	Anemonologic conditions
VOS					
Powders					
Metals					

The problems connected with these determination are to be connected:

- to the necessity of having at disposal a series of equipment and accessories of analysis (see monitoring costs);
- to the difficulty connected to the separation of the contribution just of the activity from that one of other assets that could generate similar emissions.

From the deepened acquaintance of the chemical composition of varnishes and the weather-climatic data of the site, the necessary data for the built up of simulation models can also be gained, that allow to forecast which will be the course of the dispersion of the dangerous substances allowing also to forecast which will be their concentration in the time and in the site surrounding space. The problems connected to the use of such models can be characterised first place in the complexity of the scene to be represented, that unavoidably leads to carry out approximations processing the model, and in the necessity to have at disposal the right data on the nature of the considered substances.

5 MONITORING COSTS

The main voices of cost for the installation and the management of a monitoring system of the polluting products during the paint job operation are the following:

- purchase of the instrumentation;
- installation of the instrumentation;
- maintenance;
- costs of the specialist staff;
- operating costs.

In the following table are specified the cost involved to install and manage a monitoring station that measure dust, aromatic organic substances (BTX), noise and meteo parameters.

Device	Cost (EURO)
1 cabin equipped for air monitoring	20658
installation of telephonic and electric connections	12911
1 local acquirer	10329
1 statistical noise analysers	7747
1 BTX analyser	46481
1 hydrogen generator	5165
1 sample calibration air generator	2066
1 sequential dust sampler	6198
1 meteo monitoring station	25823
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1 noise analysis	155
management of monitoring station	5165

6 DEFINITION OF INDICATORS AND CRITERIA: ASSESSMENT / EVALUATION OF MONITORING RESULTS

In order to estimate the result of the monitoring, various terms of comparison can be used:

- the toxicological standards of reference reported to the population potentially exposed to the effects of the emission of injurious substances. The main standards are: TLV, LC, LD, IDLH, LHL, UHL;
- the limits of law contained in the directives of the European Community concerning the emissions in atmosphere of dangerous substances;
- banns of organisations operating in the environmental and sanitary field at a world-wide level, such as the WHO and the EPA;
- location of potential targets of the emission of dangerous substances, as the entire population or one specific fraction of it, determined in function of the age, the state of health, the nearness to the point of emission, etc.

7 PRINCIPLES AND GUIDELINES FOR IMPROVEMENT / NEEDS FOR TECHNOLOGICAL INNOVATION

- choice of varnishes towards minimal toxic varnishes, such as high solid powder or water varnishes, that allow to considerably reduce the risk of solvent emission.
- choice of the application technology that makes minimum the risk of dangerous emissions. As an example, if a pneumatic atomisation paint job equipment is used, is advisable to change it with those ones that use the hydraulic atomisation to medium or high pressure.
- centralisation of preparation and drawing of varnishes to apply so as to reduce the manual dexterity, the dispersions of solvents and wastes in the environment.
- regulation of the activities so that is prevented the spray paint job in presence of determined anemonologic situations.
- installation of acoustic screen or barriers where is not possible to attenuate the noise to the source.
- adoption of active coal filters on the conveyed emissions deriving from the forced aspirations enslaved to the activities of painting inside the ships.
- installation of stills to recover solvents used for the cleaning of the machines.
- agreements in order to give back to the supplying companies the varnishes and solvents empty containers.

8 ANALYSIS OF TRAINING NEEDS

The formation of the staff who carries out the paint job operation is particularly important because it allows to establish the correct modalities according to which must be carried out the operation, in order to guarantee a high level of safety for the staff, and the most suitable behaviours in order to reduce the risk for the external environment. In particular, the formation would have to deeply deal about the following arguments:

- general Directive 67/548/EEC and particular Directives 73/173/EEC (solvents) and 77/728/EEC (paintings and varnishes), concerning the labelling of varnishes and diluting;
- storage of the varnishes and solvents containers used for the equipment cleaning, taking into account their chemical-physical characteristics and incompatibility;
- transport of the containers from the storage point to the point of use;
- manipulation of the containers and their content;
- correct use of the equipment used during the paint job operation;
- respect for the norms of safety on the work places, on the use of the Individual Protection Devices, on the duties of good job;
- correct management of injury events caused by accidental inhalation, contact or ingestion of solvents or varnishes;
- maintenance of the equipment;
- elimination of the waste of the paint job operation.

9 PUBLIC COMMUNICATION

The result of the monitoring activity and the environmental data can be diffused through various way such as local newspapers and some the Internet site, such as that of Port Authority, if existing. This one, particularly, represent a communication medium very effectiveness to reach a very large part of the citizen and have to be developed to improve the quality of communication.

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Noise

NOISE WORKSHEET

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1 DESCRIPTION OF ACTIVITY

1.1 Legislation

- EEC Directive n. 61/96 concerning integrated pollution prevention and control.
- EEC Directive n. 25/94 on the approximation of the laws, regulation and administrative provisions of the MS relating to recreational crafts.
- EEC Directive n. 533/84 on the approximation of the laws of the MS relating to the permissible sound power level of compressors.
- EEC Directive n. 534/84 on the approximation of the laws of the MS relating to the permissible sound power level of tower cranes.
- EEC Directive n. 535/84 on the approximation of the laws of the MS relating to the permissible sound power level of welding generators.
- EEC Directive n. 536/84 on the approximation of the laws of the MS relating to the permissible sound power level of power generators.
- EEC Directive n. 113/78 on the approximation of the laws of the MS relating to the determination of yard machinery and materials noise emissions.

2 POLLUTION SOURCES / LIST OF ACTIVITIES

The acoustic phenomena are perturbations of oscillating type which spread with a certain frequency in an elastic mean (gas, solid or liquid). Such perturbations come out as an effect of the solicitations of pressure generated from the vibrations of a solid body, the source, and are able to excite the auditory system of the man.

An acoustic phenomenon is defined, in any case, like a pressure variation that man can feel. The number of the variations per second is called frequency of the sound, and is measured in Hertz (Hz). Knowing the speed of sound (1238 Km/h to the ambient temperature) and the frequency we can also calculate the wavelength, that is the distance from the advanced cuspid of a sonorous wave to the advanced cuspid of the successive one. The frequency υ and the wavelength λ have opposite course, the higher is the frequency the smaller is the wavelength and viceversa.

The auditory field of the man extends from 20 Hz until 20000 Hz, under this interval are the infrasounds, over the ultrasounds.
If an acoustic phenomenon is considered in relationship with the individual that perceives it, we can define a sound like noise when it provokes an unpleasant auditory feeling, for the auditory feelings are various from person to person and often depend on particular interests: state of mind, physical state, etc.

The location and the census of noise sources are aimed at those activities and machinery that, potentially, can give place to not negligible acoustic impacts, distinguishing between inner impacts, exclusively to the harbour area (and, consequently, in the within of work places) and to the outside of the same area (and, therefore, also in the life atmosphere within).

Preliminarily to the location and the census, and to the consequent appraisal of acoustic impact of the harbour activities, it is opportune to proceed to the collection of information related to the "port system" (including the harbour area in tight sense and the practicability of access to it) and to the surrounding context; these information are classifiable in the following categories.

1. *Information on the atmosphere in which the harbour area is set:*

- plant of the harbour area and of the near zones;
- dislocation of sources near the harbour area with possible sonorous fallen back;
- practicability of access, inner and in proximity of the harbour area;
- ingoing, outgoing and inner port traffic flows.

2. *Information related to the harbour area:*

- list of the productive activities by type;
- list of the service activities;
- number of wharves, type and number of ships in berthing and ground services to the ships;
- list of the harbour area present companies;
- modality of inner movement.

3. *Information related to the harbour area single operating companies:*

- list of noisy activities;
- list of the employed machines, of their noisiness and of the sites of employment (inside or outside the sheds);
- distinction between machinery and activity sources of possible acoustic problems only inside the company or also outside of the enterprise perimeter.

The main sources of noise in the harbour, meaningful for the eventual impact on the surrounding external areas, can usually be led to the following general categories:

- service systems, even if on duty, of the moored ships;
- railway traffic;
- road traffic, above all of heavy trucks;
- naval traffic (as an example the noise of the siren);
- load and download of the material handled with the freight elevators;
- industrial activities (as an example the iron worker industries);
- operations of metallic carpentry;
- repairs (separation of the old varnish through sand-blasting operations and application of new varnish through the paint job) and shipbuilding;
- various operations of metallic carpentry;
- surge (oils - petrochemical port).

3 CONSEQUENCES

To fully understand the possible effects and the possibilities for a correct management of the noise problem, have to be analysed the external and inner areas, separately, of the same harbour area, distinguishing therefore between work places, "the free" zones, in which can transit or carry out activities those people that approach or are employed in harbour services, and the inhabited zones, surrounding the harbour area. In this various within, in fact, different acoustic phenomena, in particular for the intensity of the levels and therefore characterised by various consequences on the exposed subjects, sually taken place.

Various types of effects of the noise on man can be characterised as follows:

- *Damages of specific type*: auditory damage;
- *Damages of not specific type*: action on the nervous, endocrine and cardiovascular system, action on the psyche, disturbance and alteration of the sleep;
- *Psycho - social effects*: subjective disturbance, effects on the social relations.

3.1 Effects on the environment

Exists no human activity that does not contemplate, in any measure, the transformation of mechanical energy in pressure waves that, through the air, catch up our ear, evoking in us some sonorous feeling.
Our place of life, work, fun and rest, is abundantly polluted by the noise that our same activity produces.
The environmental impact connected with the noisiness has to be at least considered as potential origin of disturbance to the quiet or the accomplishment of working activities that demand concentration: sensitive increments of the noisiness can involve one true damage on the psycho-physical equilibrium and even on the auditory apparatus therefore, in a generalised manner, on health.
As for the other fields involved in the environment definition, also in the field of the control of the noise the progress calls for ulterior progress in order to cancel the deleterious effects of the previous step, and at this rate we proceed to the gasping attempt to realise a "quality of life" that unavoidably escapes from our hands.

Damages of not specific type

In the greater part of the cases the levels of noise which the man is subordinate to, outside of the work places, are such not to determine a specific damage to the auditory apparatus. However, the levels endured in the course of the daily life can, in the long run, give origin to disturbs that can be distinguished, in a generalised manner, in effects in the short term and in the long term.
The effects in the short term (as an example temporary movements of the auditory threshold, alteration of the cardiac heartbeat and of the respiration, muscular contractions and effects on the peripheral circulation) are due to stimulations of short duration of generally unexpected character (from few minutes till to the maximum of few hours); it seems that the effects in the long term can directly involve also tissues and inner organs.The harmful effects of extended exposures to the noise, in fact, influence not only the auditory apparatus, but they can also damage the cardiovascular and the neurovegetative systems causing hypertension, insomnia etc.

Psycho - social effects

To these closely physiological effects can be added also others disturbs of psycho - social type. Psycho - social disturbs are those effects caused indirectly through the psychological mechanism of stress, which can hit in a relevant way in relation also to the individual predisposition.
These, also without carry out a direct action on the organs, systems or tissue, determine however an action of disturbance that can be limited in the personal within or can reflect itself on interpersonal relations and on relationships between the man and the collectivity.
Another noise closely-related disturbance is the alteration of the sleep; this determines difficulties or slowness in falling asleep and quantitative and qualitative alterations in the cycle of the sleep.
A great number of studies demonstrated that, in order to guarantee a good sleep, in a generalised manner, the optimal value of noise in a room does not have to be higher than 30-35 dB(A).

The OECD supplies the following general indications on the expected effects according to different levels of noise:

- under a 55 dB(A) diurnal equivalent level of exposure (Leq), the possible disturbs are very light; between 55 and 60 dB(A) the acoustic impact is still limited but it can begin to cause disturbance for the more sensitive persons, in particular the old ones;
- between 60 and 65 dB(A) there can be effects on the sleep and, in particular, the degree of disturbance increases remarkably;
- above the 65 dB(A) the behaviour is determined by a constriction situation and this is symptomatic of a serious damage caused by the noise.

3.2 Impact on the work place

Damages of specific type

The damages of specific type are usually due to the exposure to the noise in the work place, in which the levels of noise are usually higher than those in the extraworking life places.

Generally, the damage to the hearing caused by the noise can be distinguished in "acute" damage and in "chronic" damage, the damage of acute type being related to stimulations of elevated intensity (more than 125 dB).

The damage of chronic type is caused by the continued and extended exposure to levels of noise for a period of many years; the evolution of the disease is usually slow, depending also on the predisposition of the single subject, and is generally characterised by an auditory loss at first limited to vhf (3 - 6 Khz) that later extends to the lower frequencies (including also those correspondents to the voice).

Norm ISO R 1999 (1971) supplies percentages of risk that a loss of hearing takes place, in function of the level of exposure to the noise and of the duration of the exposure (in years) in the work place; according to such norm the percentage of risk, that turns out low under the threshold of 80 dB(A) (the fixed one from the same norm), increases with the growing of the level of exposure and its duration.

4 MONITORING

The monitoring previews the measure of the level of noise; the measures give a clear indication of the level to which the sound can provoke damages to the hearing and consequently they let us take the opportune corrective measures. In order to measure the noise the phonometer is used, which is an instrument to estimate the amplitude of the sound and to supply objective and reproducible measures of the level of sonorous pressure. Generally a phonometer is composed by a microphone, a treatment unit and a data reading unit.

During the measure operation some fundamental rules must be followed:

- to assure preventively that the instrument has been calibrated;
- if the noise comes from more directions it is better to use an omnidirectional microphone;
- if outdoors measures are carried out or the environmental conditions are not the best, must use the counter wind;
- to hold the instrument at an arm distance;
- to keep far from reflecting surfaces;
- to measure at an appropriate distance from the source;
- to assure that the sonorous source is not obstructed by any obstacle;
- not to accept the values from the instrument when it is overload.

Among the main purposes of the monitoring the following can be draw:

- to estimate the sound levels that characterise the inhabited zone surrounding the harbour area, according to the standards of acceptability;
- to collect the acoustic data useful to estimate the environmental impact of the new activities;
- to obtain informative base in order to characterise, at a planning level, the reclamation actions to be put on;
- to characterise the characteristics and the area of influence of the harbour area internal and external
- specific sonorous sources (roads, railroads, productive sites, etc.);
- to estimate the levels of exposure of the communities and to correlate the acoustic levels with the reactions of the exposed population.

An acoustic surveying must preventively be sized according to:

a) objectives to reach;
b) instrumental resources;
c) availability of specialised staff able to manage the monitoring network and to process the related data;
d) company’s economic resources.

4.1 How to plan environmental controls on the activities

The environmental monitoring of the noise produced by the productive site can develop by the compilation of two tables common to the following three types of activity:

1) temporary and extemporaneous activities;

2) new activities;

3) existing activities.

It would be opportune to enclose to the two tables a sketch of the place where it has been executed the measure showing: dimensions of the place, dimensions of the machine in examination, position of the microphones, position of the measured objects.

Table:1 General information on the activity

Activity name		
Activity duration (if temporary)		
Noise sources	number	type
Number of the exposed workers		

Table:2 Measure report

Legislation	European		National
Instrument type and serial number			
Instrument calibration method			
Mechanism used	Slow	Fast	Impulse
Measures date of execution			
Environmental conditions			
Sound signal type (pure tones, impulse, continuous)			
Non pondered sound pressure level			
Background noise level dB(A)			
Immission level to site bounders dB(A)			

Once carried out the measures to determine the level of personal exposure to the noise in the work place we must proceed like suggested by the directive EEC 86/188.

Aim of the present norm is to supply an operating instrument for the calculation of the level of exposure to the noise in relation to the risk of associated auditory damage due to noise in the work places:

1) Pondered equivalent continuous noise level: Laeq,Te

$$LAeq, Te = 10\log\left[\frac{1}{T_e}\int_0^{Te}\left(\frac{PA(t)}{Po}\right)^2 dt\right] dB(A)$$

2) Personal daily exposure level: LEP,d

$$LEP, d = LAeq, Te + 10\log\left(\frac{T_e}{T_0}\right) dB(A)$$

3) Weekly exposition level: Lw

$$Lw = 10\log\left[\frac{1}{5}\sum_{K=1}^{m} 10^{0,1(LEP,d)K}\right] dB(A)$$

Data obtained can be drawn in a table, as follows:

	dB(A)		
LAeq,Te			
LEP,d			
Lw			
	Has the exposure to the noise got to be considered relevant according to the **ISO R 1999** (1971)	YES	NO

4.2 How to plan environmental controls in the environment

The complexity of the aspects connected to the acoustic problem leads to indicate like favourable a reference team, in a position to represent a point of exchange of information, to know the harbour reality from the point of view of the noisiness and its transmission outside the harbour area, to act as a point of connection among the authorities that have competence in noise matter, to suggest and to plan actions aimed to obtain an acoustic reorganisation within and outside the harbour area. From the acquaintance of all the present activities in harbour area, and from the result of the carried out monitoring, a map of the noisiness can be realised; such a kind of map has to be considered one of the first actions of acoustic reorganisation.
The measures of the noise level, necessary for the construction of the map, are obtained from noise records in a certain number of positions around the interested zone. More the measure points will be numerous more precise will turn out the map.
From the supposed considerations it seems opportune that every company operating in the port and carrying out noisy activities process an esteem, supported by an instrumental determination, with the aim to estimate the own acoustic breaking out of the border of the site. The company can make this following one of the two indicated ways:

- to acquire a noise meter and to execute the measures of noise itself;
- to ask to a consulting company.

5 MONITORING COSTS

The main voices of cost for the installation and the management of a noise monitoring system are the following:

- purchase of the instrumentation;
- installation of the instrumentation;
- maintenance;
- costs of the staff;
- operating costs.

The companies characterised by an important sonorous impact could be equipped with an instrumentation including an alarm system to show overcoming of the limit values of the chosen acoustic parameters, so as to respect normative ties and also to give additional useful information to the aim to avoid, or at least to contain and to manage, possible situations of risk.

In the following table are specified the cost involved to install and manage a monitoring station that measure dust, aromatic organic substances (BTX), noise and meteo parameters.

Device	Cost (EURO)
1 cabin equipped for air monitoring	20658
installation of telephonic and electric connections	12911
1 local acquirer	10329
1 statistical noise analysers	7747
1 BTX analyser	46481
1 hydrogen generator	5165
1 sample calibration air generator	2066
1 sequential dust sampler	6198
1 meteo monitoring station	25823
1 sampling and chromatographic analysis of VOS	155
1 sampling of suspended dust	52
1 noise analysis	155
management of monitoring station	5165

6 DEFINITION OF INDICATORS AND CRITERIA: ASSESSMENT / EVALUATION OF MONITORING RESULTS

Depending on information we need, a monitoring system can be dedicated:

1. to the generic measure of the environmental noisiness (and therefore to the successive comparison with the prefixed standards);
2. to the location of the situations of "warning" and "alarm" due to the overcoming of the prefixed thresholds.

In the first case, the fundamental parameter to measure is the continuous equivalent level of exposure to the noise, comparable with the normative standards.
The activity of monitoring and evaluation of the disturbance in the zones near to the harbour areas, normally carried out by the interested territorial agency, assumes that the measured levels are compared with the standards of reference also with the aim to establish if plans of reorganisation are necessary.
More complex from the point of view of the location of the reference indexes to monitor, is the second case; the choice of the parameter on which setting up the alarm condition and of the site where to place the instrumentation, in fact, represent critical factors because such choice comes down from a more or less high probability to characterise, respectively, the specific type of activity and the specific companies cause of the alarm conditions. Holding into account the equivalent level of exposure to the noise as a global measure, we see that this parameter could be used like criterion on which setting up the alarm condition very rarely.
In order to set up an alarm condition it is better to estimate one of the following statistical parameters:

a) The percentile level "Ln" or cumulative statistical level.
Level percentile "Ln" is the level reached or been exceeded for an interval of time of the "n%" of the considered time of measure as an example, the value of L40 of 72 dB indicates that the level of 72 dB has been present or exceeded in 40% of the time of measure). It supplies the indication of the medium level and of the fluctuation of the level.

b) Cumulative distribution of the levels.

It allows to determine the percentage of time in which a certain level of noise has been present or exceeded during the phonometrical measure. The curve of the cumulative distribution of the levels gives a statistical description of the percentiles levels of a sonorous source, showing how they distribute themselves in the time.

7 PRINCIPLES AND GUIDELINES FOR IMPROVEMENT / NEEDS FOR TECHNOLOGICAL INNOVATION

Aiming to pursue a continuous improvement of the modalities to resist the environmental effects produced by the harbour activities and by the technologies applied in such activities, it is necessary to make reference to some guidelines, contained in instruments such as the dispositions established by EC Directives, the national legislation, the ISO (or CEN for Europe) specific for the acoustic thematic technical norm, to which the directives UNI EN ISO 14000 and EMAS can be placed side by side, that allow to face in a total and rationalised way the environmental problematic.
In particular, deepening the aspect of the technological innovations for the control and the mitigation of the noisiness in the harbour within, some main actions are needed:

- Acquisition of new machinery characterised by a lower level of acoustic emissions:
  - machines constructed with phono-absorbing materials (metal layers alternate with medium density mineral wool layers).

- Development of more efficient (and economically convenient) arranges of discouragement of the noisiness:
  - realisation of coverings with high acoustic absorption and strengthening of the acoustic isolation with phono-absorbing panelling;
  - realisation of acoustic barriers protecting the inhabited sites;
  - insertion of external noises suppressor on the fans, evaporative towers, etc, aimed to decrease the level of noisiness outside;
  - insertion of high acoustic seal locking.

- Processing of new models of organisation of the various working phases that concur, as an example, to limit the duration of the noisiest activities and/or to confine the same ones in the less sensitive hour bands:
  - limiting the use of heavy means for the internal movement of the materials in the diurnal hours;
  - trying not to carry out particularly noisy activities in the nocturnal hours, that are those dedicated to rest (22:00 - 06:00);
  - reorganising the staff.

8 ANALYSIS OF TRAINING NEEDS

According to what exposed, turns out obvious that the staff assigned to the controls, beyond possessing a specific technical acquaintance in acoustic matter, must necessarily be put to acquaintance of the particular problematic connected to the types of present sources of noise in harbour area through formation aimed on the argument.
In a more generalised manner, so that real goals can be effectively caught up concerning the problematic related to the reduction and the control of the noisiness, it is indispensable that all the operating staff in the harbour area be made aware of these problems through appropriate moments of formation and information aimed to instruct the workers and the responsible on the technical and organisational provisions having the aim to reduce the emissions of noise.

9 PUBLIC COMUNICATION

The result of the monitoring activity and the environmental data can be diffused through various way such as local newspapers and some the Internet site, such as that of Port Authority, if existing. This one, particularly, represent a communication medium very effectiveness to reach a very large part of the citizen and have to be developed to improve the quality of communication.

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Port planning and development

PORT PLANNING AND DEVELOPMENT WORKSHEET

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1 DESCRIPTION OF THE ACTIVITY

1.1 Port planning and development activities (industry)

A port, through its activities, can produce a more or less high impact on the environment where it is settled. So, it is necessary to adopt a global approach taking into account the port integrated in its entire environmental context.

Several types of ports can be distinguished:

- Commercial ports;
- Industrial ports;
- Mixed ports (commercial and industrial);
- Marinas.

The ports impacts are different, according to their features:

- The kind of goods shipped (bulk materials, liquid materials, containers);
- The kind of cargo ship and terrestrial vectors involved in transport;
- The kind of harbour facilities.

A maritime port is a place onshore planned and developed. The port allows seagoing personnel to shelter and facilitate the operations of loading and unloading of ships. Quays and docks of the ports, allow ships to accost. There are also infrastructure works and material used for the port activities. The objectives of ports are to build a huge industrial zone in direct contact with the sea. The port planning and development are facilitated if there is not too much population near by. The space is also very important because factories need space land for development.

The port is responsible for the development and for the management of operations into the industrial zone. The ports planning and development activities set up the land, supply the user of the port, and are responsible of the internal roads system.

Because ports have high level of industrial demand and a large variety of industries they will have to set up environment rules. Sufficient spaces have also to be planed for security reasons between the biggest factories. Furthermore, industries will be recommended to land-space the land they do not built on.
A careful look has to be given to what might cause problems. Then solutions have to be found to avoid them. Ports defined the necessary rules into technical specifications addressed to industries operating in the ports areas.

When the port is planed, there will have to be thought to the introduction of the vegetation. This programme can consisted in lining the service roads with bushes and plants that will serve as decorative and protective screen in addition to planting the land between the factories and the road. All this vegetation creates a “landscape barrier”.

The ports will also participate to the maritime public infrastructure works, which are essentially the state’s responsibility. The Port of Marseilles Authority (France) for example, finances 20% of the

cost of dredging and 40% of the cost of constructing public quays. Public equipment (cranes and gantry cranes for handling containers, etc.) are entirely financed by the Port Authority.
Responsibility for the local land communication systems (telecommunications, railways and electricity network) is share by the parties concerned with the ports in their planning, their execution and their funding.

This priority is translated into a development policy based on the following three objectives :

- Improving port operations productivity, inducing a reduction in port dues and ships' downtime costs, by the introduction of high-performance equipment;

- Improving the port's operational reliability and cargo security by restructuring terminals and modernising their equipment;

- Adapting services to customer needs, with special reference to developing trades, by commissioning new facilities or by refurbishing existing installations.

1.2 Laws

1.2.1 International laws

- The first international convention, the 1954 OILPOL convention, in London, is about the prevention of pollution in the sea.

- The Brussels convention dated November 29th, 1969 concerns the intervention in seawater in case of pollution caused by hydrocarbons and other substances.

- The Oslo convention dated February 15th, 1972, is about the prevention of the marine pollution by dumping operations from ships or aircraft.

- The 1972 London convention concerns the prevention of marine pollution by the dumping of wastes.

- The International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto (better known as MARPOL 73/78) is one of the must important international agreements on the subject of marine pollution. It concerns construction norms, like separated ballasts and double hull, and controls the activity of the oil tankers in special zones.

Detailed regulations covering the various sources of ship-generated pollution are contained in five annexes of the convention.

- Annex I : regulations for the prevention of pollution by oil;
- Annex II : regulations for the control of pollution by noxious liquid substances in bulk;
- Annex III : regulations for the prevention of pollution by harmful substances in packaged form;
- Annex IV : regulations for the prevention of pollution by sewage from ships;

- Annex V : regulations for the prevention of pollution by garbage from ships.

The annexes I and V must be applied by all the States.

- The1974 Solas convention concerns the safety at sea and the maritime pollution.

- The Paris convention dated June 4th, 1975, is about the prevention of marine pollution with telluric origin.

- The Barcelona convention in 1976, is about the interdiction of spilling oils in the sea. This convention is related to the co-operation concerning the fight against oil pollution in the Mediterranean sea.

- The Paris memorandum in 1982 is about the control of the ships in ports, to see if they respect the Marpol construction norms.

- The La Haye conference in 1990 has the objective to reduce the discharges in seawater.

- The accidental spilling of oil in the sea is covered by an international law. So the polluter has to pay for the damage done by oil. This convention was done in London November 27th , 1992.

- The 1992 Paris convention is about the protection of the north-east Atlantic. One of its objectives is the reduction of the discharges in seawater.

- The 1998 Paris convention which is the new version of Oslo convention (Lainé, 1998).

1.2.2 European laws

- Directive 61/96/EEC is about prevention and reduction of pollution.

- Directive 76/464/EEC dated May 4th, 1976 concerns the pollution caused by harmful substances discharged in aquatic environment. It defines two categories of pollutants in function of their toxicity, persistence and bio-accumulation.

- Decision 81/420/EEC dated May 19th, 1981 concerns the treaty conclusion relative to the co-operation in matter of fight against Mediterranean Sea pollution by hydrocarbons and other harmful substances.
- Directive SEVESO dated June 24th, 1982 is relative to accident risks in classified installations in matter of environment protection.

- Decision 84/358/EEC dated June 28th, 1984 concerns the treaty conclusion relative to the co-operation in matter of fight against North Sea pollution by hydrocarbons and other harmful substances.

- All projects of works that destroy a part of the environment landscape, identified in a “POS” (zoning regulations), have to obtain authorisation from the state and from the European

- community. The Directive n° 85/337 obliges to do an environmental evaluation before the authorisation is given.

- The coastal areas have reinforced their protections. The rules n° 85/797 introduced the notion of areas ecologically sensible.

- Directive 90/164/EEC is there to prevent and reduce the environmental risk.

- The directive of 1979 is related to the protection habitats of wild birds. The directive of 1992 concerns the natural habitats of the fauna and flora. Those two directives have to be taken into account for port planning activities.

- The ZICO (Important area where the birds are protected) are areas set up by the European Directive n° 79/409 dated April 6th , 1979. This directive is related to the protection of all the birds living naturally at a wild stage in European States.

- EC Directive 93/42/EEC (Conservation of Natural Habitats and wild Fauna and Flora) was agreed in December 1991. This directive creates Special Areas of Conservation aimed at maintaining and restoring natural habitats. Sites to be designated will need to be agreed by the year 2000.

- Directive 96/61/EEC is about, the integrated prevention and the reduction of pollution.

- The norm ISO 14,001, dated October 1996, is about the System of Environmental Management (SEM). It belongs to the international norms of the series ISO 14,000. The ISO 14,001 norm describes the requirements of the SEM.

2 POLLUTION SOURCES (CONCERNED SUBSTANCES AND BY - PRODUCTS)

The port planning activities are source of pollution. The possible pollution sources are as following:

- Pollution of the air by the port industries. The gases produce a greenhouse effect (carbon dioxide, carbonic anhydride, methane, nitrous oxide…). The European Union has decided in the Kyoto protocol dated December, 1997 the reduction of 8% of the emissions (Laszlo, 1998);

- Pollution of the ground (as an example by workers that can break down a canalisation with their mechanic engine. And as a result the canalisation will spill);

- Pollution of the landscape, covering up the lagoon areas. The lagoon area are affected by the ports activities and by the industrial installations that spoil the landscape, by creating factories, by building, by chumminess, and by infrastructures. In fact, lagoon is very rich in fauna and flora, it is natural “Race way”. So when lagoon was recovered by ground, an irreversible destruction of the nature was created, with an important loose of natural biotope;

- Pollution of the marine environment in accordance with the port activities. For example, in an industrial port:

  - The dredging activity is a source of pollution if the dredged material is polluted. In fact, sediments are contaminated by pollutants coming from the industrial discharges : waters, ships, soils washed by the rain, polluted rivers, port activities…During the dredge, most of the silt particles are swept in suspension, transporting contaminants (nitrogen, carbon, phosphorus, heavy metals, organic pollutants) in an adsorbed form.
  - The essential risk of pollution in the oil storage activity is created by the leak of the storage area, which induces the percolation of the oil in the ground. The oil pollutes the soil and the ground water.
  - The industrial polluted waters bring organic matter and toxic elements like pesticides, detergents, heavy metals, hydrocarbons, nutrients and salts in the marine environment.
  - For the ore dry bulk activity the wind, the running water, the loading and unloading of ore tankers, and the cleaning activity are the cause of contamination. The chemical substances discharged in seawater are: aluminium, chromium, manganese, iron, sulphur, and coal which contains heavy metals.
  - The cleaning activity concerns the wastes coming from the port. They can cause damage to the security and the health of human beings : plastic, sewage water coming from ships, mercury metal coming from battery, and polychlorobiphenyls (PCB) coming from transformer…
  - In the deballasting treatment activity, the pollution sources are a bad treatment of slops or deballasting station leaks.

The quantity and the toxicity of pollutants can increase in case of accidental pollution. So the negative effects and the impacts in the environment and the users will be more important and more difficult to correct.

3 CONSEQUENCES

3.1 Effects on the environment

The port modifies the physical environment by using natural areas to implement industries and port infrastructures. When the ports increase his size, it creates docks in different communes with new urban area around. The consequence of this phenomenon is the disappearance of natural areas and so the decrease of the tourist attractions.

The urban and port developments induce physical modifications of the natural landscape and disturb the natural equilibrate of the environment. The development induce pollution : smell, noise, the decrease of the environment quality.

Some industries have field up lagoons into their areas. The effects induced is a diminution of the wild birds and other fauna and flora.

The port development induces the development of the road traffic, so the air pollution increase, and the modification of the layout being.
The consequences of this traffic are the increase of the number of people frequenting the area and the increase of the wastes they produce (plastic materials like bags and bottles, domestic wastes, use of public toilets,…).

An other effect is the development of the maritime traffic. So there will be more possibility to introduce invasive species, transported and fixed to the hulls.

3.2 Impact on the environment and the users

Since 1970 the demand transport sector increase around 2.3% for the goods and 3.1% for the passengers. The maritime transport is the right answer in terms of economy of energy, pollution and cost of infrastructures.
But the increase of the maritime traffic induces the increase of the ships wastes (see worksheet about Cleaning Activity).

A port area is not very attractive and so perturbs the tourism and the leisure activities (water sports, bathing, leisure fishing). It is a perturbation for the occupational activities too (fishing, shellfishes production).

A solution to develop new industries is to build embankments into the sea (non-polluted dredged materials, as an example). This action allows to gain space and to valorise some materials. But this solution increases the perturbation of the leisure and occupational activities.

The port development induces the development of the employment. So, the people working in the port area would to live near this zone. This phenomenon of urbanisation and the port development cause the disappearance of the natural (marshes) and agricultural areas and the increase of the volume of wastes to treat (used waters, household refuse, green wastes,…).
The phenomena of bio-accumulation and bio-amplification along the food chain is a danger for the human health. It takes a lot of years to decontaminate the food chain and to eat seafood without risk of contamination.

The marine ecosystems are modified because of the competition of the autochthonous species and these ones transported on the hulls (algae, superior vegetal, Molluscs, Crustaceans, larvae of fishes,…). If the introduced species are more resistant than the others, they will take their place and modify the ecosystem.

4 MONITORING

4.1 How to plan environmental controls on the activities

The port police should help to control and protect the environment. Each port should have a code saying "no one is allowed to perturb the ports functioning in the deeps and cleanness of their installation".

The ports should deal with the respect of the national and international rules concerning the protection of the environment for his own activities, but also for industries located on the area.

The Port management must have 2 objectives:

- The ports planning activities;
- The protection of the environment.

Particular procedures have to be set up when a planning activity is done, like impact studies and public enquiries, to reduce the environmental effects of port works. New installations projects have to encompass studies (using physical or mathematical models) to analyse the possible impact in the environment.

For the port establishments, the objectives of development on a long-term basis are focused on:

- The maintenance of the access canal and basin;
- The pre-planning of the platforms for the future implementation of new industries and logistics activities.

Some natural phenomena have to be taken in consideration. They are seism risk, coastal erosion, great tide phenomenon and wind direction, for examples.

The seismic protection of the industrial installation situated in a risky area has to be integrated at the first stage of the work.
The definition of the seismic risk relative to the classified installation is done by a definition of the characteristic of a maximal historical seism possible (SMHV) and a majored seism of security (SMS). The intensity of SMS is calculated by:

$$I_{SMS} = I_{SMHV} + 1 \ _{\text{(unity MSK)}}$$

It is necessary to take in consideration the coastal erosion. This natural phenomenon can destroy the new constructions in few weeks. So, if there is a risk, the port development manager has to protect the coastline with anti-erosion process (sea wall, groin to rescue the sand, re-choking process,…).
An other harmful natural phenomenon is the great tides phenomenon. It occurs frequently in the Atlantic littoral. In spite of the ports are protected areas, the water can go over the sea walls and destroy the constructions.
In the rivers, it can occur all the 2, 5, or 10 years and so concerns the port near mouth. It increases the river flow which becomes very important in the mouth level.
It is necessary to consider the wind direction because of the wind could carry the industrial smokes in direction of the dwelling places.

4.2 How to plan environmental controls in the environment

The objectives to plan an environmental control could be to:

- Plan the environmental littoral development, globally and locally;
- Help for planning and investment;
- Protect the immediate area, with quality objectives;
- Follow and evaluate the actions;
- Improve the knowledge about the area;
- Sensitise and communicate.

Coastal zone is divided into “homogeneous” areas. Three levels of impact could be studied :

1. The first area is the zone nearest to the coast. It corresponds to the area where there is a dilution of the rejects;
2. The intermediate area starts at the bathymeter 50 m and goes up to 100 m. In this area the pollutant concentrations are mixed up;
3. The last area starts at the bathymeter 100 m, and is related to the background noise.

Measures should be done to analyse the quality of:
- The water column (temperature, dissolved oxygen, suspended solids, nutrients) in the site of pollutant discharge (industrial outlets);
- The sediments once a year and every time the dredging activity is done;
- The benthic living matter before the embankments building into the sea;
- The phytoplanktonic quality of the water when eutrophisation can occur;
- The area using the vitality of land plantation as a biological indicator, once a year.

These measures would allow a good general information about the quality of the marine environment of the port area. But to plan a good environmental control, there should be done others analysis. As an example, a study to measure the impact of the ports planning and development activities on the marine fauna and flora can be realised. The result of the study could therewith be a cartography of the area with the “representation” of the different fauna and flora ecosystems existing. Depending on the living species found, a diagnosis about the quality of the habitats could be made, and the measures and the solutions to restore it could be proposed.
Before each development of a new activity, it is necessary to make a mathematical model of dispersion and dilution of the potential pollutants. After these calculations, the results will be

compared to the norms for the protection of the environment. Also, the industrial could know if his firm will respect the environment or not.

There are two strategies of fight against pollution:
- The limitation of the pollutant flows discharged in the environment : the UNE are adopted by the majority of the European states;
- The control of the environmental contamination not superior to the recommended levels is to guarantee of a good use of coastal waters : the OWQ (Mauvais and Alzieu, 1991).

5 MONITORING COSTS

The creation of a 5 hectares “arboretum” with endemic vegetal (14 species) costs around 230,770 EURO for maintenance and new plantations.

The monitoring parameters and then the cost of the port planning and development activity is difficult to evaluate it depends on the nature of the development and ports works involved:

- Embankment;
- Creation of a quay, a wharf, a basin, ...

To create a quay, it needs a mathematical model of the currents way. These calculations cost 22,870 EURO.
The installation of a purification network (drinking water, waste water, driving back station) costs 381,120 EURO.
The building of a reinforcing sea wall costs 457,350 EURO.

6 DEFINITION OF INDICATORS AND CRITERIA : ASSESSMENT / EVALUATION OF MONITORING RESULTS

6.1 Development limits

It is essential to find the right balance between the planned and developed areas, and the natural areas. In fact, it is most important to planed “green” areas between the different infrastructures. It permits to have part of the ports with natural landscape and so the industrial installation will be better integrated in the environment.

An adequate indicator to monitor this activity could be the percent of area planed compared to the natural environment. The percentage of the port area which should stay in a natural state permits to protect a part of the landscape. It is a good balance between the economic development and the protection of nature.

6.2 Environmental indicator

An environmental indicator is:

- Representative of the environmental conditions and the exercised pressures;
- Easy to interpret, able to give the trend;
- The reflect of the environment and human activities modifications;
- Comparable to a threshold.

The approach with fauna and flora gives synthetic data about the state (functioning, dysfunction, biological diversity, abundance) of the environment and the animal and the vegetal populations. But it gives too synthetic data about the pollution through the perturbation of sensible species and the concentration of toxic substances in integrative species (Weber and Lavoux, 1994).

6.3 Organisation of Co-ordination and Environmental Development (OCED)

The OCED allows to the 25 States Member of this organisation to quantify the state of their environment, the pressures which are exercising on it, and the government answers to resolve this problem.
The environmental indicators regrouped by the OCED permit to compare and to measure the differences between industrialised countries.

The performance indicators are objectives, limit or recommended norms of quality and quality scale. They are defined from indicators of pressure, indicators state and indicators of response (Rechatin, 1996).

6.4 Bio-tracers

A bio-tracer is a modification which can be observed and/or measured at the molecular, biochemical, cellular, physiological or behavioural level. It indicates the exposition of an organism to one or more chemical pollutants. There is nearly one bio-tracer for each type of chemical pollution.

The detection of the organisms exposition is generally rapid and permits a diagnostic of the environment state. The measure cost is less expansive because this technique is very used.

The use of bio-tracers as evaluation criteria of the environment quality is based on their capacity to :

- Estimate the distribution of the potential toxic substances in the environment and in the living organisms;
- Put in evidence the organisms answers against the exposition of environment contaminants;
- Establish the cause/effect relations between the pollutant presence and the biological answers;
- Evaluate the exposition consequence for the ecosystem health (Lagadic *and al.*, 1998).

6.5 Uniform norms of emission (UNE) and Objectives of Water Quality (OWQ)

There are two strategies of fight against pollution:

- The limitation of the pollutant flows discharged with the UNE, adopted by the majority of the European states;
- The control that the environmental contamination is not superior of the recommended levels to guarantee the use of littoral waters, with the OWQ (Mauvais and Alzieu, 1991).

6.5.1 The UNE

The European Directive dated May 4th, 1976 classifies the dangerous substances in two categories (see paragraph 1.2.2). The States Member have to take appropriated measures to:

- Eliminate the discharge of substances recognised like toxic, bio-accumulable and non-biodegradable (annex 1 of the European Directive);
- Reduce the water pollution by those ones enumerated in the annex 2 (European Directive).

For each substance, the States Member fix UNE applicable for each industrial branch.

The disadvantages of the UNE are that they do not consider the sensibility of the environment and they are not applicable for the diffuse discharges (Mauvais and Alzieu, 1991).

6.5.2 The OWQ

These norms of quality have to be respected to guarantee the life and the reproduction of the living organisms, the traditional use of the sea (bathing, sailing) and the exploitation of the living resources (non-contamination of the marine food).
The OWQ are function of the uses, they are used like objectives to the environmental management. They are taken in consideration during the fitting-out decisions.

First, it is necessary to determinate the "environmental capacity". This concept was proposed by the Joint Group of Experts on the Scientific Aspects of Marine Pollution ("GESAMP" 1996). The coastal waters have a limited and quantifiable capacity to assimilate the wastes without alteration of resources and their uses (Mauvais and Alzieu, 1991).

7 PRINCIPALS AND GUIDELINES FOR IMPROVEMENT / NEEDS FOR TECHNOLOGICAL INNOVATION

The planning and development activities should always be followed by compensatory measures. Those measures can be done by : creating special areas that would attract birds, rehabilitating the hydraulics works, hollowing the ground, planning the banks in smooth slops, creating sand islands, planting trees, creating a observatory and a scientific follow of birds. The area will have to be forbidden to the hunters and fisherman.

When the planning is done on the port, special prescriptions should be respected:

- The factories will have to place road marking conforming to the rules;
- The unloading of "fine" material will be wet to reduce the flying of particles. For the same objectives the roads of the building sites will also be wet;
- The transport vehicles, the material of handling and the engines on the building site have to comply to special norms;
- The master of the work details the condition of cleanliness to respect. Those conditions specify the state of cleanliness of the vehicles, the road, and if the building site shall be closed by gates;
- The wastes treatment in industries before the discharge in the natural environment, or the use of specialised firms to treat these wastes;
- The equipment of quays with bins adapted for each type of waste.

The planning project has to reserve spaces for the green areas, helping a better integration of the equipment. The plantation will be of two types:

- Along the access road to the terminals, the plantation will be adapted to the local species;
- In the port areas, the species will be more of urban type in line with the ports area species.

Sustainable development is achieved when a port is able to meet its own needs without endangering its future. A situation should be reached where the port can continue to function over the years to come without a negative environmental effect. In terms of action it means a process of change in which the user of resources, the direction of investments, the orientation of technological developments and institutional changes are fully co-ordinated. This balancing process, safeguarding the commercial performance of the port and yet aiming at sustainability in the long term, requires the most attention.

The real power behind the process towards sustainability is the common will-power of participants. The port management should devote effort to making it clear that sustainable development is in the interest of the whole port community and of those dependent on its economic benefits. This latter category is not limited to those actually working in or for the port.

8 ANALYSIS OF TRAINING NEEDS

The port authority should clearly state and teach a global environmental policy with such objectives as to:

- Help the conciliation between the developments of the economics activities and the quality of the environment as the security of the population;
- Listen to the association of protection of nature and the other users of the area;
- Insure a good relationship with the administrations in charge of the environment and the industries as well as the organisms in charge of the water quality;
- Institute a better information about the port planning projects and their impact towards the environment.

8.1 Knowledge of the industrial products evolution

To know well the industrial impacts generated by products, the analysis of the life cycle ("ACV") is necessary. The ACV is an assessment of the matter and energy exchanged between the different compounds and their environment, since the production of raw material to the treatment of industrial and packaging wastes in the end-life time.

The ACV knows a rapid development because of the regulation pressure against the environmental management and the competitiveness of industries for the respect of environment.

The ACV is a tool of environmental evaluation to compare and to improve the firms of production and treatment. It is a mathematical tool and a neutral tool because it does not permit to interpret the results (Rousseau, 1998).

The "eco-stamps" indicate the products which, during their life cycle, induce the less pollution for all the environments.

8.2 Lasting development

The impacts of anthropic activities in the environment are a growing worry for the concerned industries. The environmental management is a tool for the regulation help.

This is the objective of the norm ISO 14,001 about the Systems of Environmental Management (SEM) published in October, 1996. It belongs to the international norms of the series ISO 14,000. The ISO 14,001 norm describes the requirements of the SEM.

The ISO 14,001 is a dynamic method to simplify and to elaborate the development of an adapted environmental politics. It permits to:

- Measure the effects of the activity which have some significant effects in the environment;
- Define the environmental objectives and aims;
- Elaborate some prevention and amelioration measures for a best control of the impacts of the activity in the environment.

The ISO 14,001 norm is based on five principles :

1. Adaptability : the norm is adapted for all the firms whatever their activities;
2. Complementarity : the ISO 14,001 completes the quality systems elaborated yet;
3. Prevention : it insists on the prevention and the capacity of the firm to react in case of accidents, and so to reduce the impact in the environment;
4. Engagement : the certification ISO 14,001 demonstrates the engagement for the constant progress of the environmental performance of the firm;
5. Universality : the ISO 14,001 is valuable at the international rank.

In port management, it appears necessary to get a sound perspective of the role of Environmental Audits (Ruling 1836/93) and of similar tools for environmental management in ports (ISO 14,000). It becomes necessary to prepare and deliver courses and seminars like:

- “Seminar on the European System of Environmental Management and Auditing and its application in the fields of ports”;
- “Designing Environmental Management and Auditing Systems adapted to port sector requirements”;
- “Training for Environmental Auditors specialising in the field of ports”.

The ports have to preserve the environment but to inform and to guarantee to their partners (clients, insurance agents, shareholders, coastal inhabitants…) that this management is effective too.

The community rule Eco-Audit (“EMAS” : European Management and Auditing System) proposes to the ports the definition of a programme permitting a contractual and voluntary engagement for the environmental management.

The Rio summit in 1992 presents the environment like a lasting development. So, it is necessary to research for each project the best balance between the environment, the society and the economy. With respect of rules like the precaution principle and the right of the future generations (Brégeon, 1998).

The steps to respect in an elaboration process of lasting development plans are:

- The identification of the problems to resolve : preliminary study by an environmental-audit;
- The identification of priority problems : to evaluate the physical extent and the impact degree of each problem;
- The analysis of causes and effects : to organise the environmental information around the problems we want to treat;
- The identification of the management modes : procedures linked to the development activities, the regulation, the persuasion, the planning, the research, and the monitoring of the activities and their effects;
- The identification of the administrative procedures necessary to implement the management plan;
- The definition of the geographic area concerned by the management plan (Hénocque, 1997).

9 PUBLIC COMMUNICATION

The public communication done on the port planning and development activities should be realised by the port because this subject is specific for each port.
There should be a good infrastructure to accommodate schools, tourists, future industries. The new techniques and tools can be used like the CD-ROM, the Internet site. The port has to have a data bank accessible to partners, associations of the protection of nature, State services,…

The mediums used for public communication should be films, documentation and scale models of the port. It is important to use regional mediums (TV, radio, newspaper) to inform people living in proximity of the port about the different impacts (noise, view, smell,…). People is more concerned by local information.

The awareness is complementary asset. It can be done by:

- To take over from the operation of national communications;
- To participate at the local campaign;
- To favour the elaboration of an environmental education structure.

Some clef elements of the communication are:

- To modify the comportment of users against the environmental protection;
- To determinate the goal;
- To elaborate a simply and clearly message (crossed symbols for interdiction, several language,…);
- To choose efficacy supports;
- To study the points of diffusion;
- To maintain the supports where the messages are written (Ministère de l'Environnement, 1991).

The public communication in ports should be to do consultation, and environmental impact studies. Consultation should be carried out wherever possible with the actors affected by development proposals, and the environmental impact studies should be undertaken where possible, even if not strictly required under the terms of the EC Environmental Assessment Directive.

The decision 86/85/EEC dated March 6th, 1986 institutes a community system of information to control and to reduce the pollution caused by discharge, in seawater or in intern waters, of hydrocarbons and other dangerous substances. It is modified by the decision 88/346/EEC dated June 16th, 1988.

According to the Directive "SEVESO", the Members States have to collaborate and to exchange information. The public has to be informed about the comportment to adopt in accident case and emergency.

The directive 90/313/EEC dated June 7th, 1990 is relative to access liberty to information in matter of environment.

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LIST OF ACRONYMS AND ABBREVIATIONS

ACGIH	American Conference of Governmental Industrial Hygienists
ACV	“Analyse du Cycle de Vie”
ADEME	“Agence de l’Environnement et de la Maîtrise de l’Energie”
AFNOR	“Association Française de Normalisation”
ANPA	Nationaly Agency for the Environmental Protection-Italy
BDR	Black Distillate Residue
BOD	Biological Oxygen Demand
BTX	Benzene, Toluene, Xylene
CEN	European Normalisation Committee
COD	Chemical Oxygen Demand
CCl_4	Carbon tetrachloride
dB(A)	Decibel averaged with the weight curve A
DBT	Dibutyltin
DDD	Dichlorodiphenyldichloroethane
DDE	Dichlorodiphenydichloroethene
DDT	Dichloro Diphenyl Trichloroethane
DDE	Dichloro Diphenyl Ethane
ECE	Economic Commission for Europe
EMAS	European Management and Auditing Systems
EMEP	Co-operative Programme for Monitoring and Evaluation of the Long Range Transmission of Air Pollutants in Europe
EPA	Environmental Protection Agency
EROD	“Ethoxyrésofurine O-Déethylase”
FMCEA	Failure Modes Consequences and Effects analysis
GESAMPS	Group of Experts on the Scientific Aspects of Marine Pollution
GPS	Global Positioning System
HCB	Hexa Chloro Benzene
HCH	Hexa Chloro Cyclohexane
Hz	Hertz
ISO	International Standard Organisation
IFREMER	Institut Français de Recherche pour l’Exploitation de la Mer
IDLH	Immediately Dangerous to Life and Health
Laeq,Te	Weighted equivalent continuos noise level
LC	Lethal Concentration
LD	Lethal Dose
LEP, d	Personal daily exposure level
LECES	Laboratoire Environnemental de Contrôle et d’Etudes de la Sidérurgie
Ln	Percentile level
Lw	Weekly exposition level
OCED	Oganisation of Co-ordination and Environmental Development
OECD-OCDE	Organisation for economic co-operation and development
OWQ	Objectives of Water Quality
PAH	Polycyclic Aromatic Hydrocarbons
PCB	Poly Chloro Biphenyls
REFIDI	“Résidu Final de Déchet Industriel”
REFIOM:	“Résidu Final d’Ordure Ménagère”
SEM	Systems of Environmental Management

TBT	Tributyltin
TLV	Threshold Limit Values
TSS	Total Suspended Solids
UNE	Uniform Norms of Emission
UNI	Ente Italiano di Unificazione
VOS	Volatile Organic Solvent
vhf	Very high frequency
WAF	Waste Assessment Framework
WDR	White Distillate Residue
WHO	World Health Organisation
ZNIEFF	"Zone Naturelle d'Intérêt Economique, Faunistique et Floristique"
υ	ni
λ	lambda