9th Information day of CEDRE / 9ème journée d'information du CEDRE
Paris, 6-10-2003

Le Traitement des Epaves Potentiellement Polluantes
The Treatment of Potentially Polluting Wrecks

Un Programme de Restauration Environnementale 12 Ans Après: le HAVEN

An Environmental Restoration Programme 12 Years After: the HAVEN

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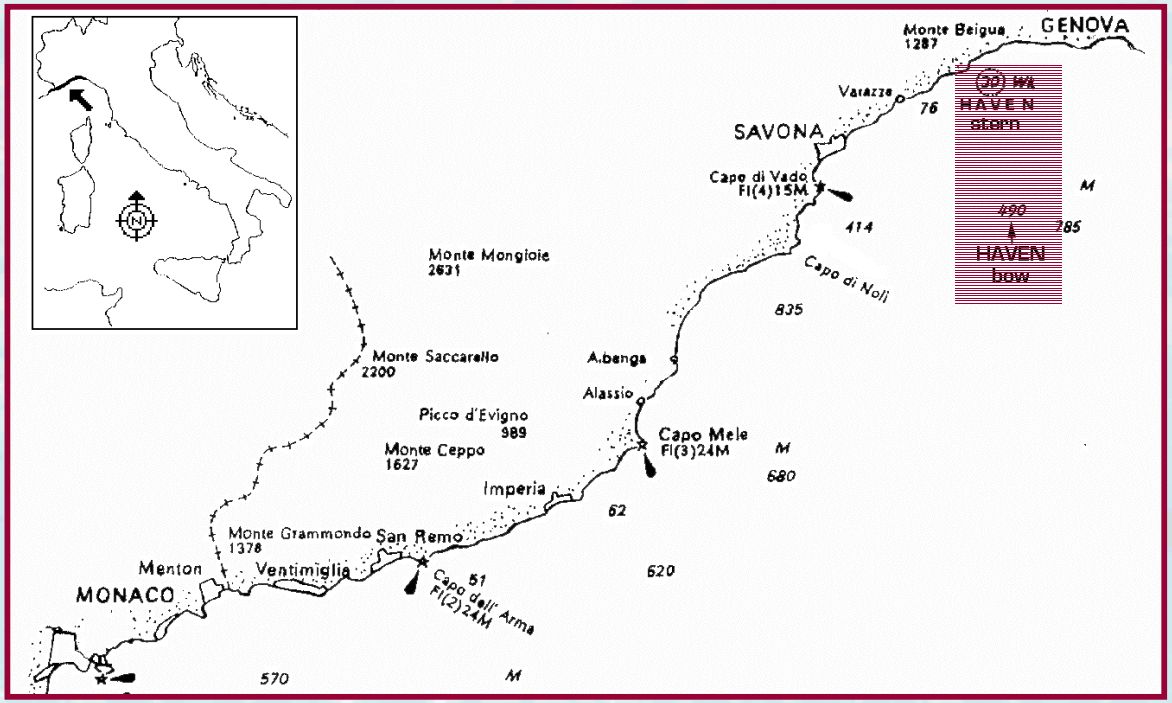


11/4/ '91 Arenzano, gulf of Genoa

Explosion + 70 hour burning

On board:

- 144,000 t of Iranian Heavy crude oil
- 1,500 t of bunker, diesel and lubricating oils

Fate:

- 100,000 t burnt
- 14,500 ÷ 17,000 t evaporated
- 10,000 ÷ 50,000 t sunk
- 3,500 ÷ 5,000 t dispersed at sea
- 3,000 t in the wreck
- 2,000 t collected at sea
- 1,000 ÷ 1,500 t collected on the coast

VLCC HAVEN
(ex AMOCO MILFORD HAVEN)

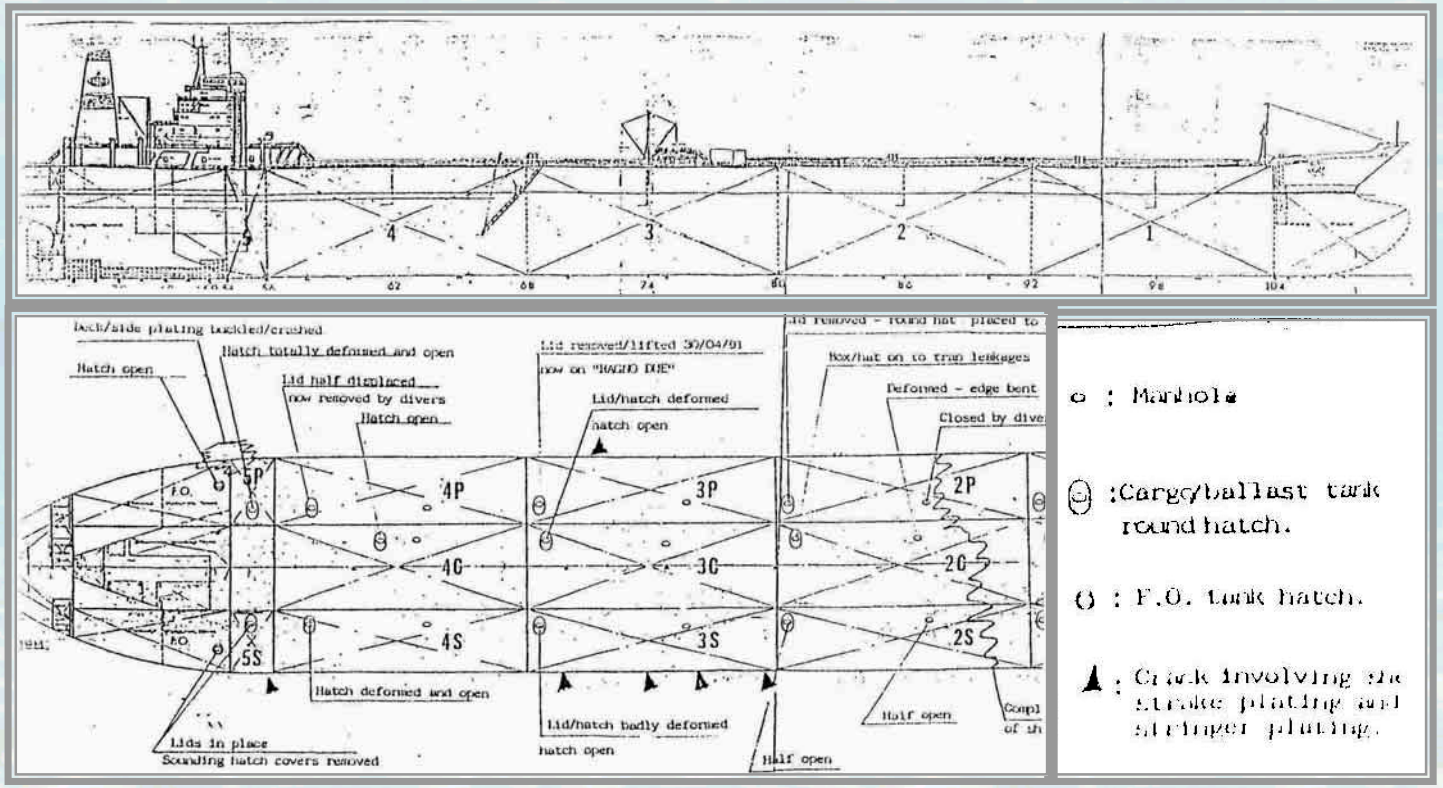
Shipyard: Astilleros Españoles S.A., Cadiz (Spain), 1973

Class: American Bureau of Shipping

Port of Registry: Limassol (Cyprus)

- Overall length: 334 m
- Beam: 51 m
- Upper deck height: 26.19 m
- Draught: 19.943 m
- Gross Tonnage: 109,700 t
- Net Tonnage: 91,988 t
- Capacity (d. w.): 232,164 t
- Dead weight: 35,395 t

VLCC HAVEN

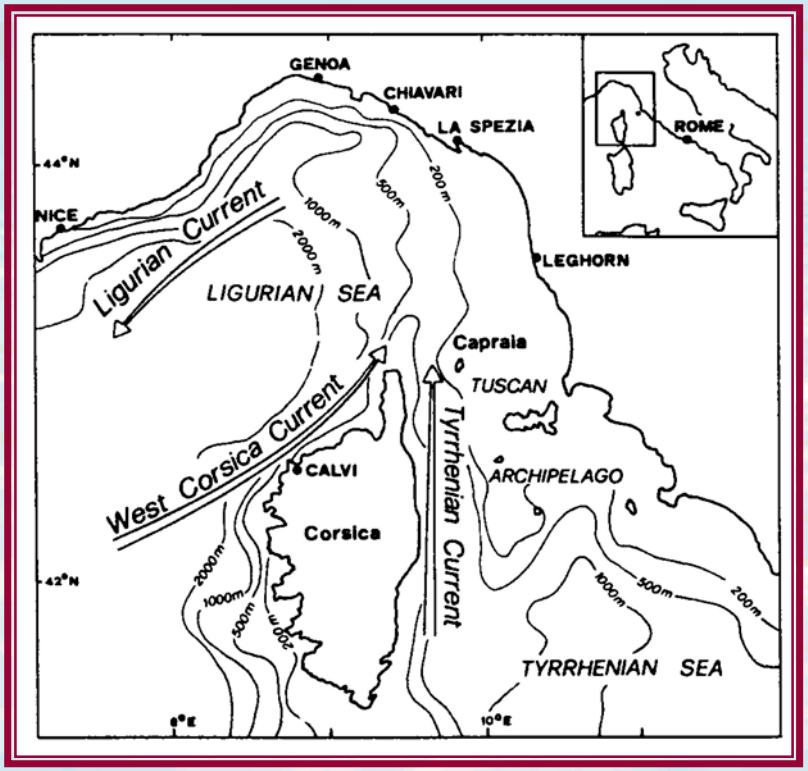


- 13 tanks (3 central, 5 to starboard, 5 to port), total volume 283,626 m³
- Inert Gas System, Crude Oil Washing, Segregated Ballast Tanks (central tank No. 2)
- Engine: diesel, two-stoke, 8 cylinders in line, 3,400 bhp, 103 r.p.m.

Emergency Phase

14th April 1991 declaration of the national state of emergency

- Immediate mobilization of all the available resources
- Intervention of both the Italian and French governmental sea defence organizations as the superficial current, whose direction is south-westward, determined the drifting of the oil slicks towards the French coast



Emergency Phase

- ✓ Clean up of the sea surface
- ✓ Intervention on the main part of the wreck
- ✓ Clean-up operations on land
- ✓ Removal of sunken oil residuals
- ✓ Environmental monitoring
- ✓ Waste disposal

Emergency Phase

While the HAVEN was burning, two important decisions were taken:

- to allow the burning of the greatest part of the spilled oil

- to tow the wreck shorewards

Emergency Phase

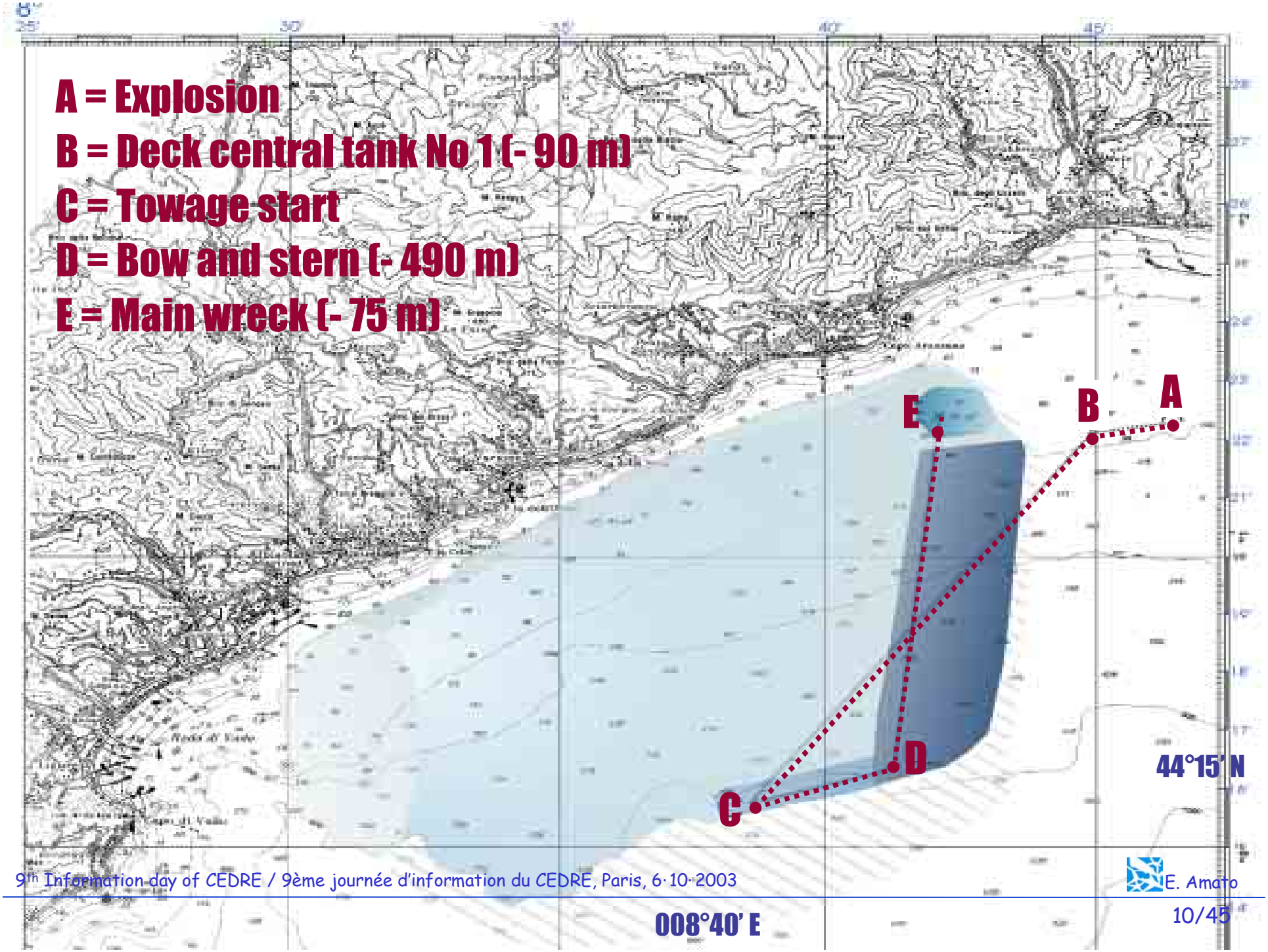
Towage of the wreck shorewards in order to:

- ✓ prevent it from sinking at depths where it would be difficult to take any action
- ✓ contain pollution on the coast

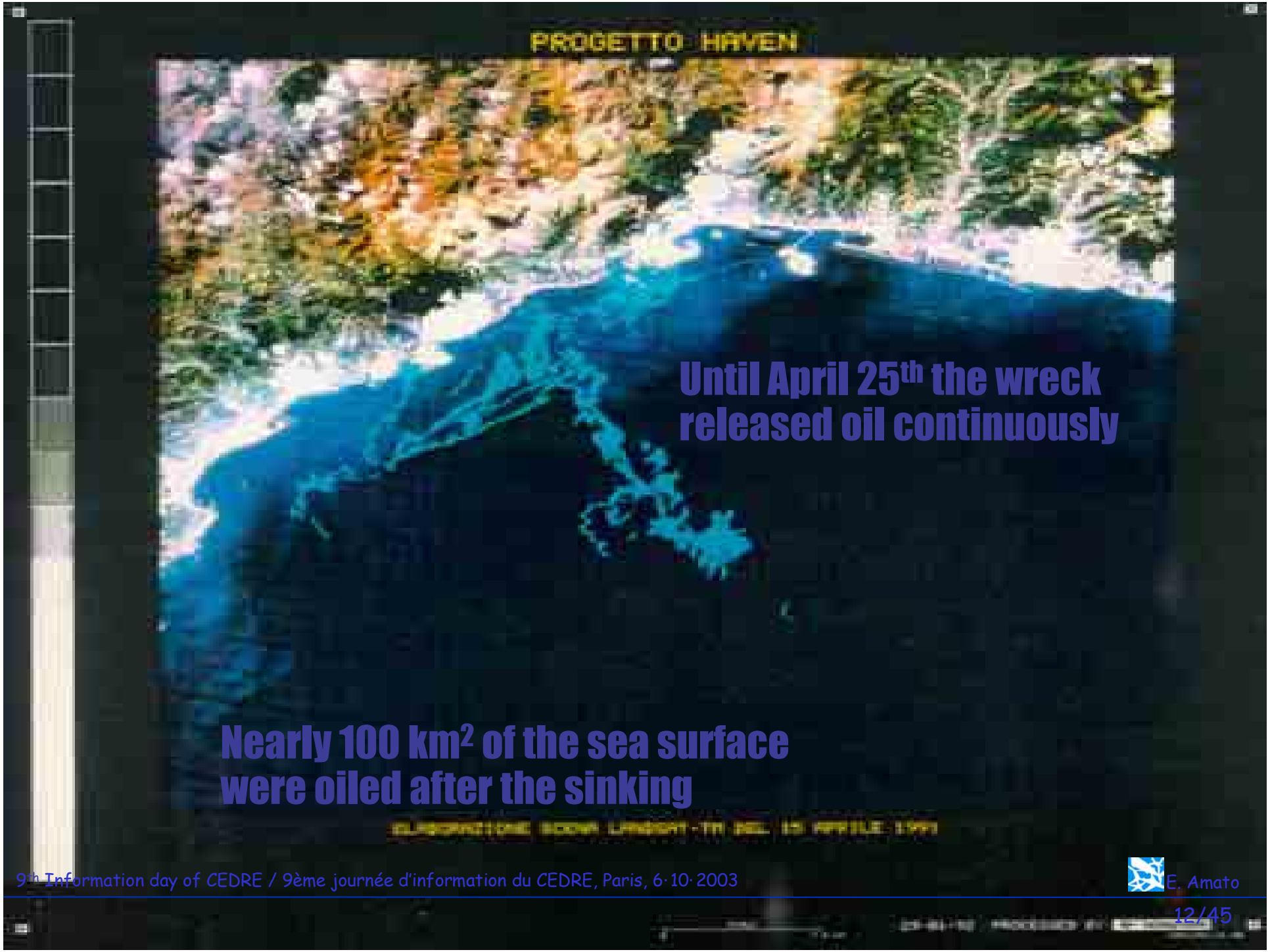
Emergency Phase

Allowing the burning of the spilled oil at sea

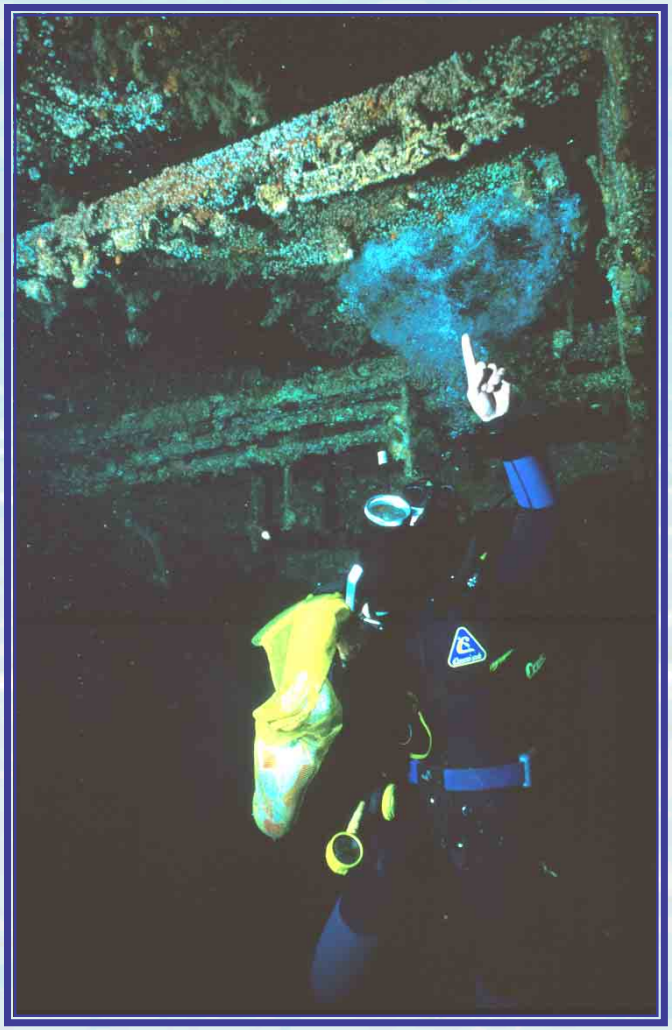
- ✓ In order to contain the spreading of the product on the sea surface
- ✓ Fire was kept in a circumscribed area by means of water-jets


A = Explosion
B = Deck central tank No 1 (- 90 m)
C = Towage start
D = Bow and stern (- 490 m)
E = Main wreck (- 75 m)
E
B
A
D
C
44°15' N
008°40' E

The wreck of the VLCC HAVEN


PROGETTO HAVEN
Until April 25th the wreck released oil continuously
Nearly 100 km2 of the sea surface were oiled after the sinking

Emergency Phase
Intervention on the main part of the wreck



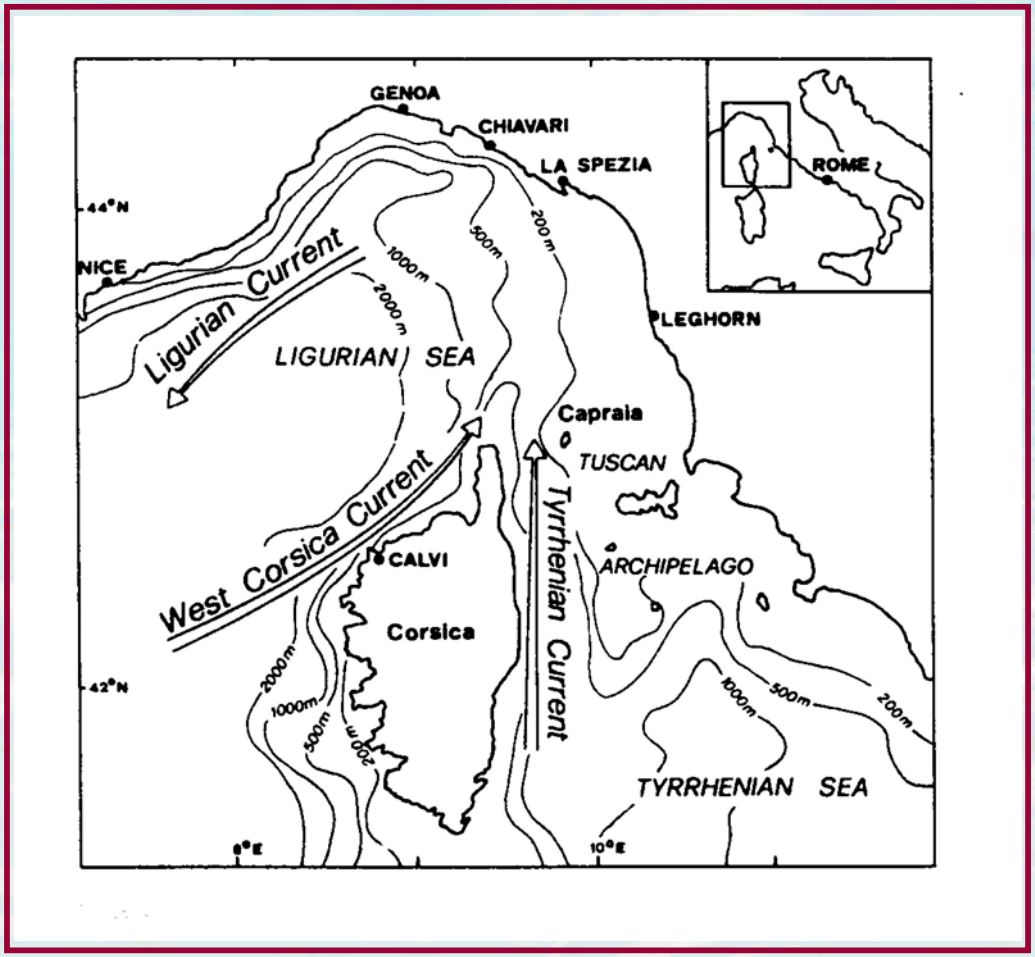
The parts of the wreck dangerous for navigation were removed

Leaking oil was collected through suction devices

Measures were taken to avoid oil spill from the wreck (stern)

Gulf of Genoa
Main Oceanographical Features

- Ligurian-provençal Current
- Narrow Continental Shelf
- Upwelling



Gulf of Genoa
Main Environmental Features

↘ Mediterranean Cetaceans Sanctuary

↘ *Posidonia oceanica* and *Cymodcea nodosa* meadows

ECOLOGICAL EFFECTS

Short-term

Immediate effects

Generally cause the death of the organisms

Long-term

Delayed in time effects

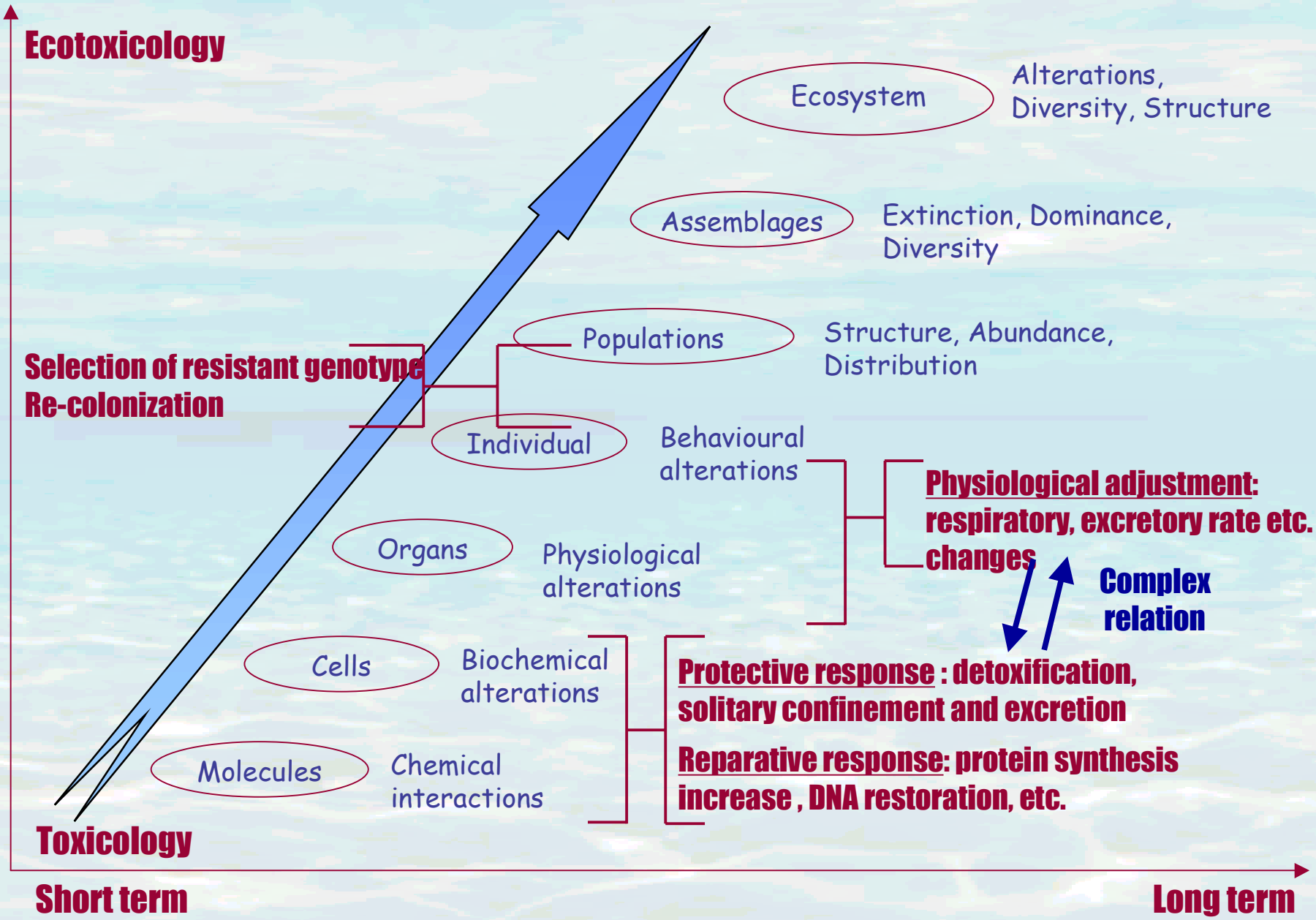
Chronic diseases

Damage to genetic material

Reproductive dysfunction

Physiological alterations

Decrease in biodiversity


Ecotoxicology
Ecosystem
Alterations, Diversity, Structure
Assemblages
Extinction, Dominance, Diversity
Populations
Structure, Abundance, Distribution
Selection of resistant genotype
Re-colonization
Individual
Behavioural alterations
Physiological adjustment: respiratory, excretory rate etc. changes
Organs
Physiological alterations
Complex relation
Cells
Biochemical alterations
Protective response : detoxification, solitary confinement and excretion
Reparative response: protein synthesis increase , DNA restoration, etc.
Molecules
Chemical interactions
Toxicology
Short term
Long term

ECOLOGICAL EFFECTS

Long-term effects

Physical

Physiological

Behavioural

ALTERATIONS in the organisms

Modifications of the ecosystem

Environmental monitoring

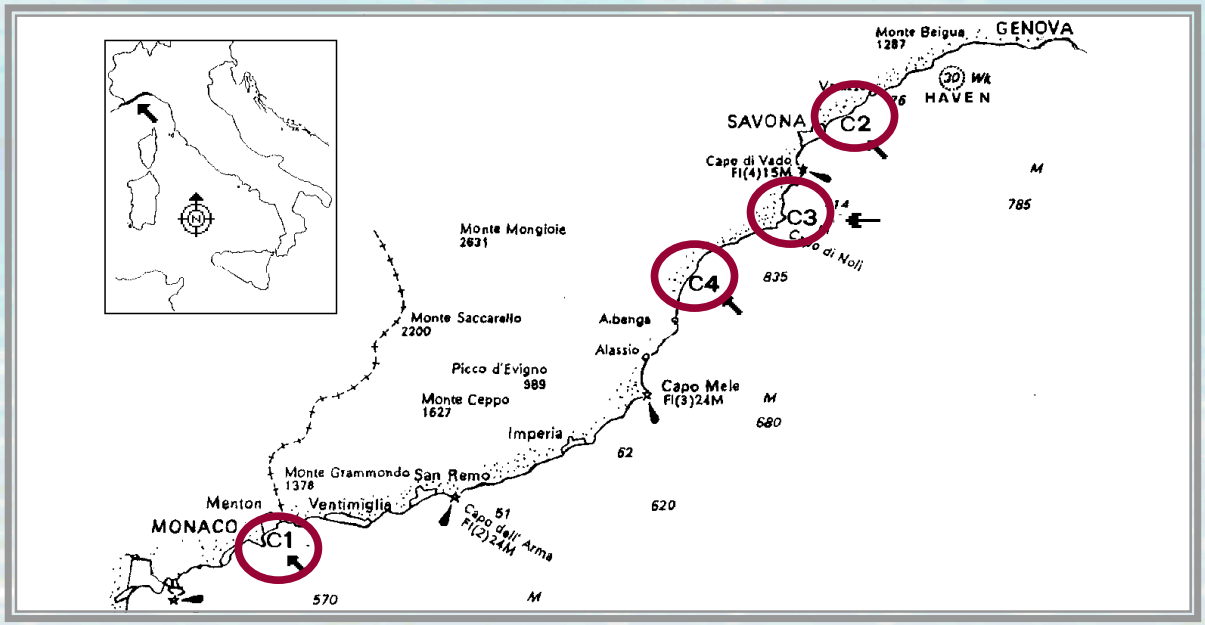
Control and monitoring plan
(carried out by ATI ENI-IRI coordinated by the Civil Protection Ministry)

- Air
- Sediments
- Sea water
- Beach & rocky coast
- Marine fauna and flora

1991-2001: Researches Carried Out by Different Scientific Institutions

- Caging experiments (HAVECO project)
- Surveys by means of ROV and the bathyscaph CYANA
- Studies on commercial fishing
- Mussel watch
- Fouling communities on the wreck

HAVECO project
(April-December 1991)



- Four cages (C1, C2, C3, C4) of sentinel organisms were positioned at increasing distances from the spill

Effects on trawling fishery (1992-1998)

- Beam trawl
- Study area: between Arenzano and Savona

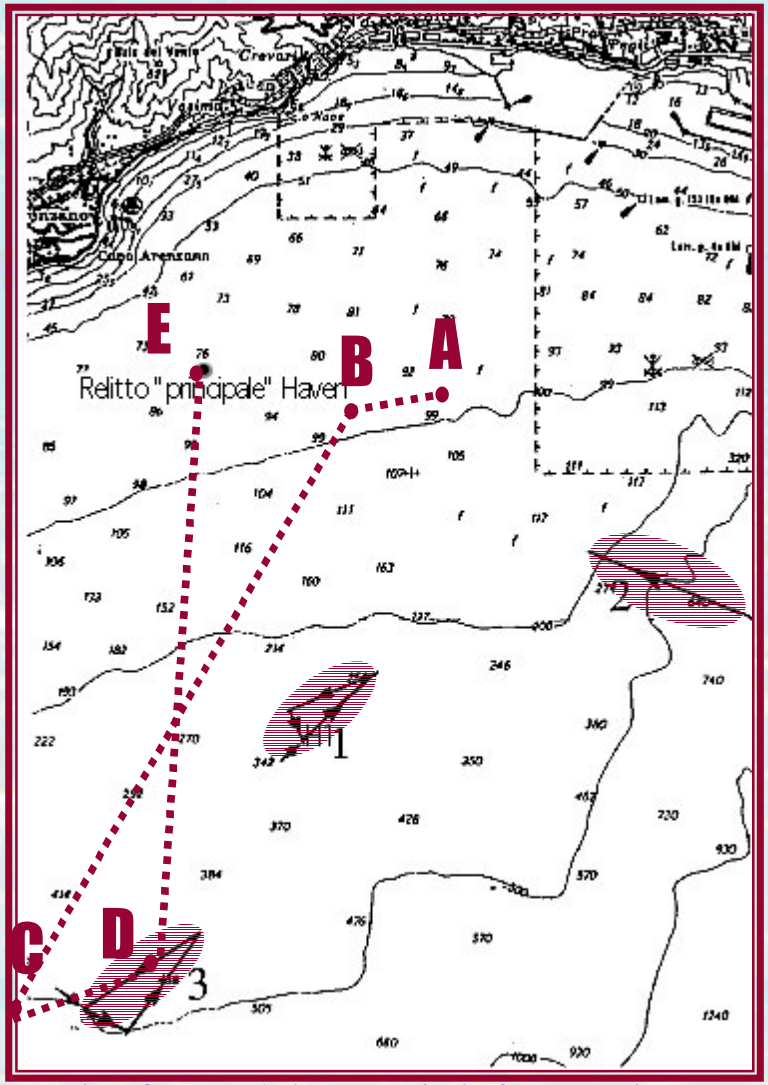
✓ Area of major risk in front of Arenzano

✓ Reduction of the fishing areas and nets damaged by oil residues

✓ Reduction of fish landing. 43% decrease in captures since 1990

LICYA

IFREMER - ICRAM project (September 1994)



Bathyscaph « Cyana »

Aim: to investigate the distribution, morphology and characteristics of some deep tar depositions and to observe *de visu* the associated benthic fauna

LICYA

Deep tar depositions with benthic organisms associated

The sea bottom has assumed the feature of hard *substratum*

Levels of PAHs in sediment cores were determined

Fouling communities

Nine frames of 0.125 m^2 have been positioned on the wreck

Pictures of the frames are taken at regular intervals of time

Mussel watch

Specimen of *Ostrea edulis* were caged at a depth of 40m near the wreck for a 3 months length of time

PAHs levels and stress indexes were measured and compared with those of other specimen collected from a reference site and directly on the wreck

Long-term consequences

The oil residues into the wreck

The burnt oil on the sea-bed

Tar Depositions

Long-term consequence of the accident affecting fisheries and ecosystems

Oil residues into the wreck

Oysters settled on the wreck have shown to be contaminated

Oil leaks have been observed

Oil might be released massively or/and along with the rusting of the wreck

Environmental Restoration according to the Italian Law No 471/1999

"The activities aimed at to eliminate pollutant substances and sources or at to reduce pollutant concentration in soil, underground and superficial waters...
to levels equal or below the acceptable limits"

In 1999, as a consequence of the agreement reached with the IOPCF (Law 239/'98), 16.4 M€ were made available to carry out studies, experiments and restoration interventions

An agreement was signed among the Italian Ministry of the Environment, ICRAM and the Ligurian Region in order to carry out, through public call for tenders, a restoration and experimentation project worked out by ICRAM and validated by the main Italian scientific and technical institutions

Interventions Guidelines

- To minimize the long term effects of the oil spill with regards to the risks posed by the sunken hydrocarbons and to the habitat alteration

- To allow, where is the case, the re-establishment of environmental conditions suitable to the population safeguarding and to the sustainable running of alieutic activities

The ICRAM project indicates the questions that need a response and the objectives to be reached on four topics:

- Removal of liquid oil residuals inside the wreck (1.5 M€)
- Experimental removal of tar depositions from deep sea-bottom (11.8 M€)
- Restoration of *P. oceanica* meadows (1.8 M€)
- Data base, control and monitoring (1.3 M€)

Specific Objectives

- To locate, remove and recycle/dispose the liquid hydrocarbons still in the “main” wreck
- To define quantity and distribution of the oil residues on the sea bottom
- To find out and apply the BAT to carry out the clean up interventions
- To assess persistency, relevance and extension of the environmental noxiousness of the sunken hydrocarbons and efficiency and sustainability of the clean up interventions
- To evaluate the persistency of the damage caused to the seagrass beds as well as the related restoration and protection possibilities

...because

« ...the wreck and the thousands of tons of oil residuals affecting the sea-bottom are likely to be a source of carcinogenic, mutagenic and teratogenic molecules... »

...knowing that

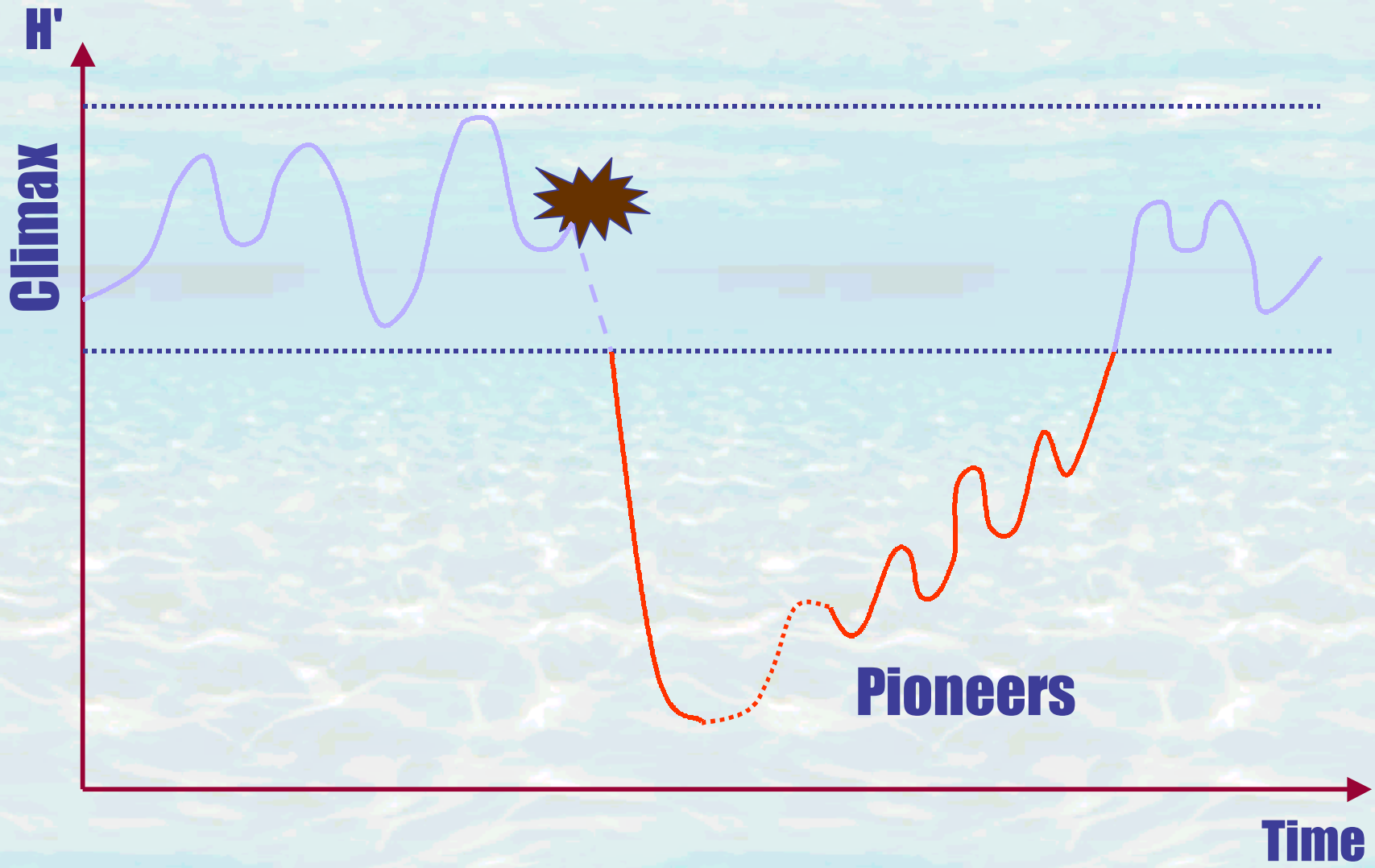
the foreseen restoration and clean up activities imply the availability of knowledge, methodologies and instruments to be adapted or set-up

R&D activities play a very important role

...but also taking into account that

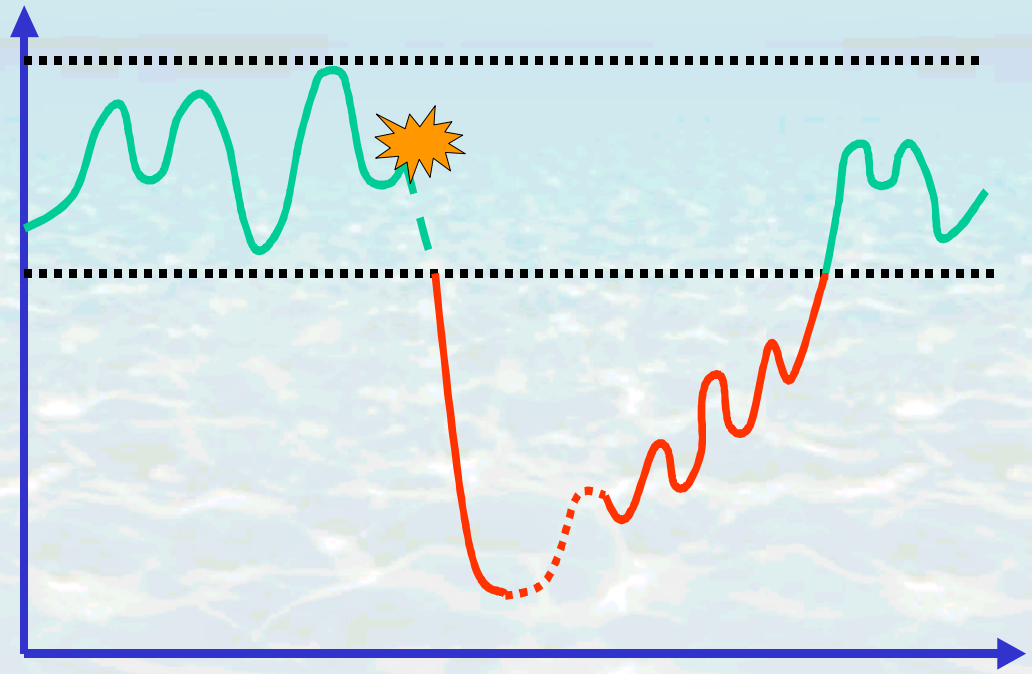
Environmental restoration might never lead the ecosystems back to the previous conditions

Effects of an oil spill on a benthic assemblage



Restoration:

When the affected resources reach the state they should have reached in that moment if no impact, direct or indirect, occurred



This definition takes into consideration the possible natural temporal changes

CLEAN UP PLANNING

Source: Min. Decree n° 471 - 25/10/1999, G. U. Suppl. Ordin. n° 293 - 15/12/1999

1. Characterization

- Collection of Existing Data
- Preliminary Characterization Plan
- Site Characterization

2. Preliminary Project

- Pollutants Analysis
- Available Technologies Screening
- E.I.A. of the Foreseen Intervention
- Validation Test

3. Executive Project

- Detailed work plan and costs
- *Post-operam* Control and Monitoring Plan

Wreck Clean Up Plan

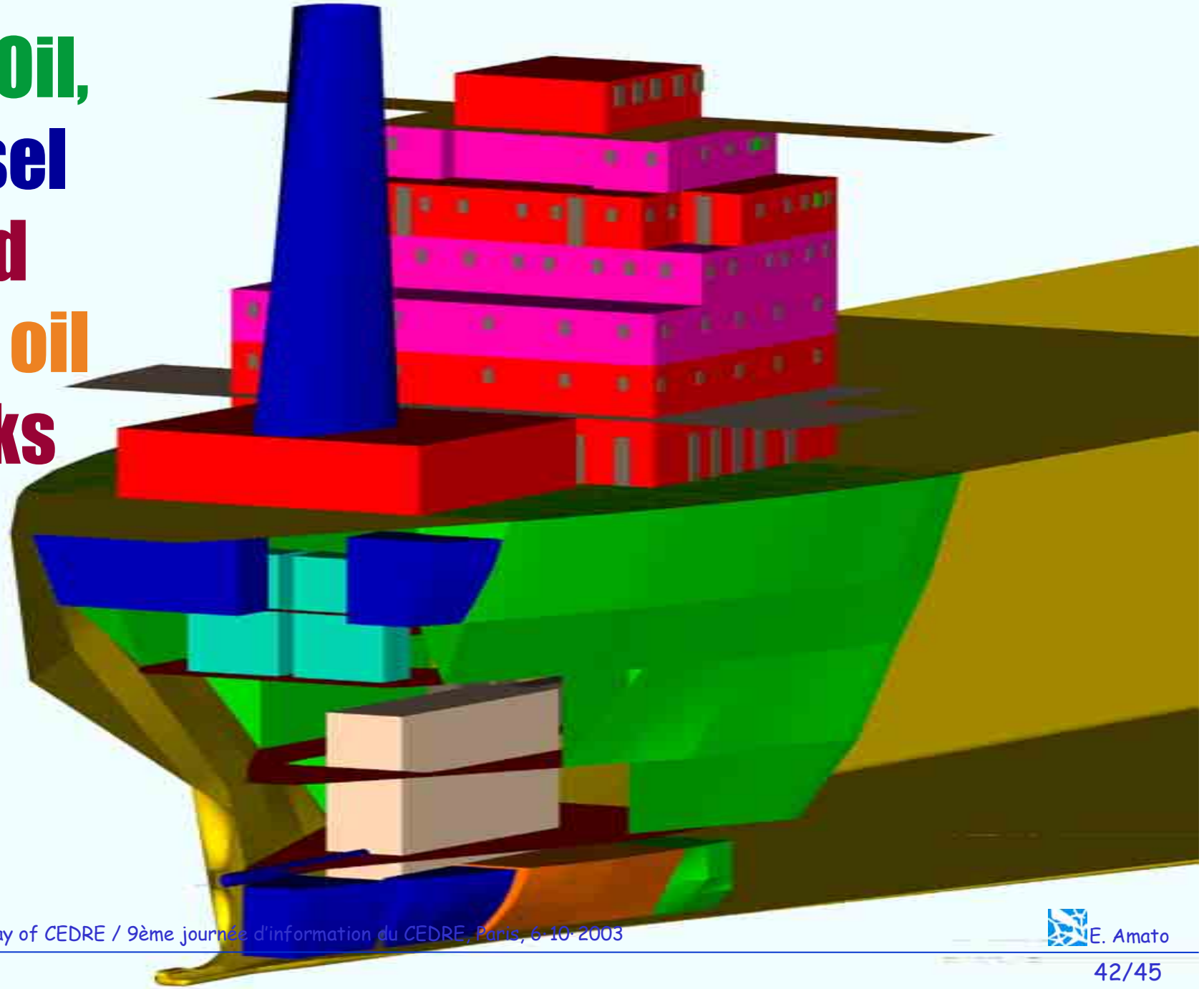
Projecting and Planning

- Problem analysis
- Logical framework definition
- Targets identification
- Strategies and methods choice

Control, Monitoring and Evaluation

- Guidelines
- Indicators
- Evaluators

Fuel Oil, Diesel and Lube oil tanks



Cloudy Water in the Pumps Room
Suspended Solids Analysis

Product	mg/Kg
Hydrocarbons	100.0
Iron	188.6
Aluminium	137.1
Zinc	38.6

Clean up:
up to which point and at which cost ?

Sanitary Risk quantification

RBCA (Risk Based Corrective Action) methodology *

*American Society for Testing and Materials – Standard Provisional Guide for Risk-based Corrective Action – PS 104 – 98, 1998

Precautionary quantification of acceptable concentrations in the site specific exposure pathways

Pollutants quantity which might remain in the wreck with no risk for human health

These quantities are a realistic and pursuable clean up target

The End