A GENERAL ENVIRONMENT INFORMATION SYSTEM FOR DECISION SUPPORT DURING MAJOR EMERGENCIES

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Abstract

During a major emergency human life, the environment and/or property are threatened. This paper describes an Environment Information System (EIS) being so general that it may be custom-made to meet the needs for monitoring and prediction purposes of the environment during most Major Emergencies.

The EIS shall meet the need for <u>past</u>, <u>present</u> and <u>near future</u> information on the environment. It forms one of the Work Packages (WP) of the EUREKA project MEMbrain (MEM = Major Emergency Management).

1. Introduction

The Norwegian part of MEMbrain is funded by Ekspomil of the Norwegian Research Council, the Norwegian Industrial Fund and six Ministries of the Government.

The EIS described herein is a general one based on which customized applications can be made to meet many special needs.

MEMbrain

The EUREKA initiative was created in 1985 by 20 European countries and the Commission of the European Community. It seeks to strengthen productivity and the competitive position of industry and national economies on the world markets. The EUREKA framework aims to further European-wide cooperation in advanced technology projects with civilian ends.

To obtain EUREKA status project must meet the following criteria:

- cooperation between participants (enterprises, research institutes) in more than one European country.
- the use of advanced technology.
- the aim of securing a significant technological advance in the product, process and service concerned for which a viable international outlet exists.

MEMbrain is a European project that aims at producing a hardware and a software platform for the integration of decision-support systems in the Management of Major Emergencies. The MEMbrain consortium brings together major actors from six European countries.

Following is a description of the project partners and their contributions:

- Cap Gemini Innovation, France
  - an integrated control and command workstation.
- INERIS (Institute de l'Environment Industriel et des Risques), France
  - reliability, validation and robustness of sensors.

- OCEANOR (Oceanographic Company of Norway AS), Norway
  - integration of heterogeneous environment monitoring systems.

- QUASAR, Norway
  - an evacuation management system as well as a chemical and radioactive substances information system.

- Athens Technology Centre, Greece
  - telecommunication platform

- Instituto de Ciencias de Terra e do Expaço, Portugal
  - modelling of natural hazard

- Risø National Laboratory, Denmark
  - a message management system as well as cooperative training system.

One of the goals is to contribute to a European standard for crisis management. MEMbrain products will be available in 1995.

Potential customers are invited to influence the project products.

The MEMbrain system will be tailor-made to fit scenarios of both natural and technological characters, e.g., landslides, floods, nuclear accident, chemical accident, oil spill etc.

The following functions planned for MEMbrain are non-existent in presently available systems:

- Module for analysis of the major risks in advance of the design of a certain application. Priorities on the use of resources during a major emergency will to a large extent depend on the structure and general risk picture of the application.

- The integration platform will sort out the information that at any time is most relevant to the decision maker. It would be an "overkill" to display to the decision maker all available information.

- The general Environment Information System provides all relevant information on the past, present and future state of the environment. This also includes sensors for monitoring of radioactivity in water. Another feature is that of quick deployment of monitoring on land and at sea by helicopters and/or airplanes.

- Risk may develop differently from that predicted by the advance risk analysis. Therefore risk analyses will be made as the major emergency develops. This forms the basis for priorities on the use of resources to mitigate the consequences of the crisis.

- MEMbrain provides a system for continual monitoring of the situation associated with the application in question. The system is therefore in daily use for monitoring, as well as during the aftermath of a crisis.

- Training and message management are parts of MEMbrain. Experience shows that it is important to transmit messages in a way such that the recipient understands them in the same way as the sender.

- MEMbrain has plans for computerized preparedness plans.

The computerization gives quick, easy and dependable access to such plans. So far preparedness plans exist only in book form.

2. The MEMbrain EIS

The full MEMbrain EIS system deals with:

- Dispersion of pollutants over long and short distances.
- Monitoring of atmospheric radioactivity, toxic and dangerous gasses and traditional meteorological variables.
- Oceanographic information
- Dispersion of pollutants in water over long and short distances.
- Monitoring in water of:
  - Radioactivity
  - Traditional oceanographic variables
  - Algae and suspended matter
  - Oxygen
  - Nutrients.

In this paper we focus on the part of EIS dealing with data from the ocean.

The Use of SEAWATCH in MEMbrain EIS

SEAWATCH is a marine monitoring and forecasting system designed and developed by OCEANOR. After a development period of three years SEAWATCH has become a technically advanced marine monitoring system ready to serve different purposes for real-time data and information from the marine environment.

In MEMbrain parts of the SEAWATCH technology is further developed. This applies especially to:

- Self deployable ocean moorings
- In-situ radioactivity measurements by buoys.
- Accommodate numerical models to facilitate backtracking of the source of potential pollution.
- Improve and simplify all user interfaces.
- Fit EIS system architecture to the general EUREKA MEMbrain integration platform and other products like the Message Management System..

Self Deployable Ocean Moorings

Major Emergencies may take place in areas where no monitoring of the environment is made. The need for data will be very urgent thereby disqualifying deployment from ships. The alternatives are deployment from helicopter or aircraft. Also, the ME may cause radiation doses higher than what is acceptable to humans. This problem can also by solved by deployment from the air. Using parachutes, monitoring equipment can also be dropped over land. Such technology is described [Berteaux, Kery and Walden (1992)]. Further developments are under way at Woods Hole Oceanographic Institution. The first air drop was made by OCEANOR in December 1993, and further work is in progress.

Fig. 1 below shows one prototype of air deployable radioactivity buoy developed by OCEANOR.

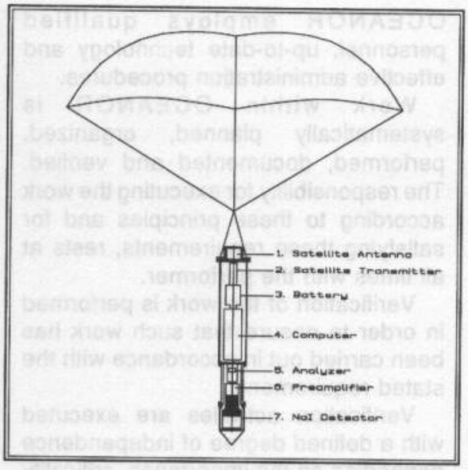

Fig. 1

In Situ Measurement by Buoy of Nuclear Radiation

An example of instruments that are ruggedized to meet the impacts during deployment from aircraft is the radioactivity sensor. The sensor itself is a 3"x3" NaI detector that produces a γ-radiation spectrum. Thereby the different nuclides present can be detected.

To our knowledge no other sensor with similar sensitivity and detection limit is available for serving this task.

A NaI detector is a sensor developed for laboratory use and/or very careful handling in the field. OCEANOR's development has been related to:

- Housing which protects the sensor from shocks and temperature gradients.
- Lowering the detection threshold.
- Reducing power consumption.
- Processor hardware and software to produce a 1024 channel spectrum.
- Linking to ARGOS and Inmarsat satellite telemetry.

Fig. 2 shows a logarithmic spectrum from a situation at 180 Bq/m^3.

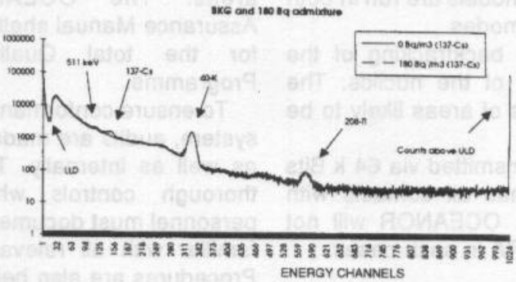

Fig. 2 Logarithmic γ spectrum at 180 Bq/m^3 Ref. 2. cpd=counts per day, BKG=background radiation

3. SEAWATCH Modelling

An important element of SEAWATCH-Europe is the data control, analysis, storage, operational use of numerical models and forecasting. Data received at the SEAWATCH-Europe Center in Trondheim are subject to a data control before it is released for further dissemination and stored in the database. The next step is to prepare forecasts. This is done based on buoy data an supplementary information such as weather bulletins, weather maps, results from numerical models and other data sources. Types of forecasts are algae blooming, currents during marine operations, water level, the haline structure in the water masses and water temperature. Among the users of these forecast are State Pollution Control Authorities and the offshore industry.

During ME situations a special service is initiated, depending on the extent and type of emergency.

This can be illustrated by a nuclear radiation emergency. If unnatural levels are measured, the National Radiation Protection Authority (NRPA) is immediately notified following a thorough control of the data. Then a system of numerical models are run in both hindcast and forecast modes.

The hindcast is for backtracking of the most probable source of the nuclids. The forecast is for warnings of areas likely to be hit by the pollutants.

All information is transmitted via 64 k Bits line to NRPA which has all contacts with media and the public. OCEANOR will not inform others than NRPA in such cases.

4. Data Quality Control

To achieve the required level of quality and to ensure a minimum risk exposure from our activities to personnel and environment, OCEANOR employs qualified personnel, up-to-date technology and effective administration procedures.

Work within OCEANOR is systematically planned, organized, performed, documented and verified. The responsibility for executing the work according to these principles and for satisfying these requirements, rests at all times with the performer.

Verification of the work is performed in order to ensure that such work has been carried out in accordance with the stated requirements.

Verification activities are executed with a defined degree of independence depending on the importance, criticality and complexity of the work in question.

To accomplish this, the OCEANOR Quality Assurance System is developed and implemented throughout the company in order to meet the requirements of NS-ISO 9001. All department managers are responsible for the development, implementation and maintenance of Quality Assurance Program applicable to their respective areas. The OCEANOR Quality Assurance Manual shall form the basis for the total Quality Assurance Programme.

To ensure conformance with the QA-system, audits are made by customers as well as internally. These are very thorough controls whereby project personnel must document that they are familiar with all relevant procedures. Procedures are also being checked.

Working with oceanographic measurements, it is difficult to be completely convinced that the data are 100% correct. The only way in which a customer can be convinced on data quality is by demonstrating for him/her the way data are taken. This means a demonstration of all procedures that the customer is interested in, and a documentation of the fact that all personnel are fully familiar with their procedures and follow them when carrying out their work. This approach, together with quality controls (QC), form the background for assuring that the data holds a certain quality. The quality level of the SEAWATCH data is that of the international standard ISO 9001.

In addition, the extent to which data measured by the buoys are in accordance with parameters obtained by analysis of water samples taken during deployment and recovery of buoys, can be demonstrated for the customer.

As per 15 December 1993 OCEANOR is operating 16 buoys - all not being the SEAWATCH type - in the Barents Sea, North Sea Skagerrak, offshore the Netherlands, Bay of Thailand and the Pacific Ocean.

Onboard all these buoys data are processed hourly, thereby producing parameters for transmission via the ARGOS satellite system. The data is continually stored in OCEANOR's computer. The person in charge of the monitoring projects will normally, via terminals, take a quick look at the data to see that the situation is normal.

However, the main quality control takes place in the forecasting room of OCEANOR daily at 0830 hrs. To make the control there is always one biologist and one meteorologist/oceanographer present, the reason being that the data is of physical as well as biological nature.

The controls concentrate on items like:

- Buoy position
- Light transmittance and oxygen for detection of suspended matter or algae
- Current speed and direction
- Wind speed and direction
- Air temperature
- Air pressure
- Sea temperature also including profile
- T-S profile
- Radioactivity
- Sea surface salinity
- Wave heights and periods
- Wave directions
- Nutrients.

Weather maps - analyzed and in prognosis form - are available to the controllers. For the North Sea, also prognoses of surface currents and sea level by OCEANOR's 3-D model HYBOS are at hand.

The background for validating some of the data is as follows:

- Buoy position shall be within a certain distance of that of deployment.

- At the various sites it is known by experience after some time of measurement that the parameter values have a certain probable range.
- Wind speed and direction are assessed by comparison with weather maps. This also apply to air pressure and air temperature.
- Current speed and directions in the North Sea are compared to values calculated by HYBOS.

- Wind direction is in more than 95% of all cases parallel to that of the high frequent part of the wave spectrum. This correlation is so good that, without measuring wind, the wind direction can be considered as given by that of the high frequency part of the wave spectrum. Having access to weather maps, this is a good basis for controlling the buoy compass.

- When Field Department personnel deploy or service the buoys, CTD profiles are often taken along with water samples. These are also means by which the performance of some of the sensors are validated.

When the daily data controls uncover errors, the Field and Instrumentation Department and the project leader are immediately informed. This non-conformance is communicated in terms of a filled out error form. Action to correct errors in terms of service cruises is normally taken within one week. The actions taken are on a routine basis reported back to the data controllers.

Data Storage

The ARGOS transmitted data are stored using a data base. Case with buoy failure giving rise to missing or erratic data are marked with dummy variables. If only one data point is missing, a linear interpolation is made. This data base works as a backup for data recorded internally by the buoys, if the internal data recording fails, ARGOS telemetered data is used for replacement.

Work on an upgraded database is now under way. Here we will store information related to the data like

- Cruise reports
- Results from analysis of water samples taken during deployment and recovery of buoys
- Etc.

Customers can receive data directly from ARGOS or from OCEANOR's computer. It is only in the latter case they may access quality controlled data. Onboard recorded data or data reports based theron are of course also available to customers of the SEAWATCH-system.

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