



## **EDIOS – WP1 User Involvement**

### **Economic benefits from EDIOS**

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#### **1. Introduction: EDIOS, a gateway to ocean-observing data and observing system management**

The sustainable development and the efficient management of ocean-related activities critically depend on the availability of oceanographic information and data. Shipping, for instance, can save operational costs by a more adequate choice of routes or transit timing and planning. Fisheries management benefits from fish stock assessment, and fisheries can save operating costs if accurate physical and biological information is available. The productivity of fish farming is also sensitive to a number of conditions such as ocean circulation, temperature, quality of waters, etc., and detailed information on such conditions enables farmers to select the most efficient farming sites. The same applies to offshore activities such as gas and mineral extraction, the running of ports, the environmental protection of the seas, the construction of dikes, and many other ocean-related businesses. More generally, the growing concern over damage to the environment, the effects of major climate events such as El Niño Southern Oscillations and of global climate change are now making the need for ocean data increasingly critical. More accurate now- and forecasts are thus an important means to improve marine management and marine activities, to protect environment, and will benefit societies and economies depending on coasts and seas.

EuroGOOS, the European subset of the Global Ocean-Observing System, has the principal aim of facilitating the generation of standardised European products from operational oceanography (forecasts, nowcasts, and hindcasts of physical and bio-geo-chemical states of the seas). EuroGOOS products will be of great value to a number of marine applications.

**The computerised European Directory of the Initial Ocean-Observing System (EDIOS) has been designed as a gateway to EuroGOOS products.**

EDIOS is now established as a result of a 2001-2004 thematic network financially supported by the European Commission. It includes information on the European operational ocean-observing systems (sites and devices) where there are routine, repeated and consistent long-term observations of the marine environmental conditions (e.g. physical, chemical, and biological monitoring programmes), and where the data are made available for use in real-time or near real-time. There are many thousands of installations, platforms, buoys, and measuring sensors in European seas which are providing routine operational data. EDIOS gives agencies and scientists the ability to examine the design and sampling strategy of the existing observing system, and to propose or implement improvements.

More specifically, as an essential component of EuroGOOS, EDIOS assumes major functions:

- it provides metadata (but does not supply users with ocean data);
- it collects the scattered information on ocean-observing sites and devices, harmonises it and combines it in a searchable directory of operational sites and devices currently in use;
- it is designed to facilitate users' access to operational ocean data;
- it will be continuously updated;
- easy access to EDIOS is guaranteed through its placement on the Internet and through a visual user interface that allows users from various backgrounds to extract the information they need, with or without database experience.

The data provided by EDIOS are characterized by parameters on:

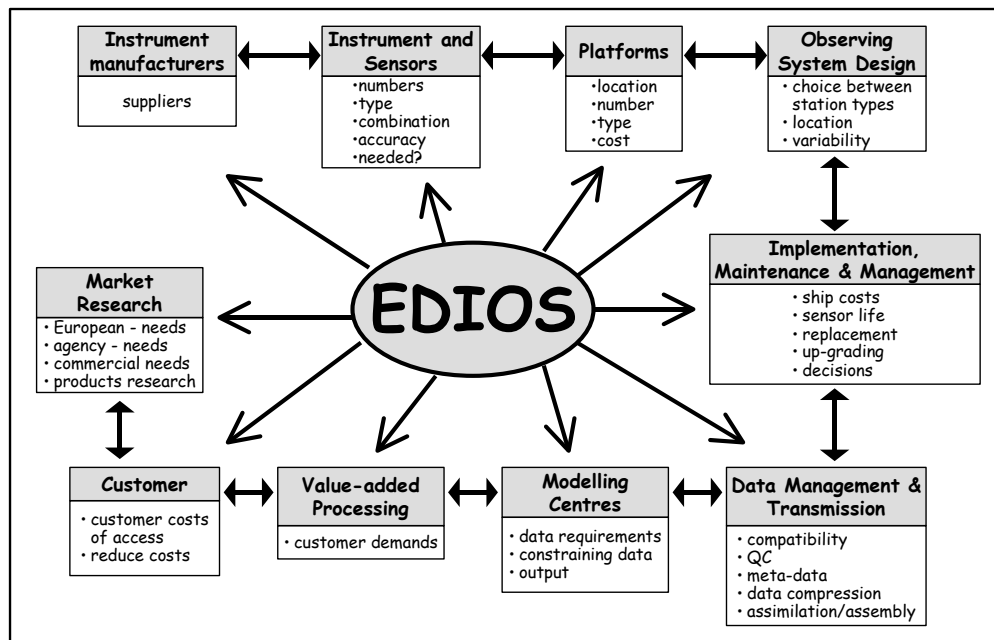
- geographic co-ordinates of observing systems,
- parameters measured and frequency of measurement,
- access to the data,
- technical information of the data collection methods (e.g. instruments, sensors, ships, platforms, nets),
- details on institutes responsible for each instrument or sensor,
- web links with data-holding agencies (NODCs).

The creation and continuous maintenance of EDIOS will incur costs in terms of public expenditure. Its costs would be justified only if they were covered by benefits accruing from the Directory's contribution to the system. Who would be the beneficiaries? Would potential benefits balance costs in the long run? Could public authorities expect a sizeable return for European citizens?

These simple questions can be raised about any R&D project. As far as EDIOS is concerned, they require rather complex answers as many aspects of operational oceanography are supposed to be impacted by the new system. Indeed, EDIOS is not only an additional tool which complements EuroGOOS. As a gateway to European ocean-observing data, it will impact the entire design, functioning and efficiency of EuroGOOS as shown in fig. 1. It will facilitate the access to the system, and so users' ability to have a comprehensive overview of it. It will help to establish a more fluid market through which ocean-observing data suppliers and equipment suppliers will be directly confronted with the users' requirements.

Consequently, the benefits of EDIOS for European operational oceanography will concern every component of the operational system, ranging from instrument manufacturers, design and implementation of the ocean-observing systems, and modelling to value added processing and customer needs.

**Figure 1. Impacts of EDIOS on the Operational Oceanography supply chain and market**



This paper sets out to contribute to the estimation of the long term impacts of EDIOS, in particular its economic impacts (ie costs and benefits). Such estimation is essential as it can provide present

sponsors – namely the EC and European NODCs – with information on the payoffs EDIOS is likely to yield in the long run, and on the specific function of the Directory in the framework of the full ocean-observing system from which it cannot be dissociated.

- The primary task of the paper is to identify the potential users of EDIOS and to estimate their significance in the European economy. This will give a relevant picture to illustrate the extremely varied effects of EDIOS on ocean data demand and supply (section 2 and 3).
- The above-mentioned effects of EDIOS are closely associated to those of EuroGOOS as a whole. It is therefore necessary to estimate the latter: a number of assessments of the effects of various GOOS subsets, in terms of costs and benefits, have been attempted, as shown in the literature; they give an indication of the size of the impacts that EDIOS would contribute to (section 4).
- Finally the paper will consider the specific features of EDIOS, and summarize the various aspects of the Directory's contribution to the ocean-observing system and the change it would bring about in the organisation of ocean data product supply and demand (section 5).

In quantitative terms, an accurate and comprehensive assessment of the future economic impacts of EDIOS would require detailed information on ocean data products, on their impacts on users and customers, and on the development of ocean data markets. It would be overly time-consuming as information is still imperfect in many respects. The scope of the study must then be limited to estimating reasonable orders of magnitude. Qualitative impacts on the ocean data market will be equally important.

## **2. Requirements for operational ocean-observing data**

Identifying EDIOS potential users is critical to appraise the significance of the activities whose sustainability is sensitive to ocean data. Given the Directory's role as a gateway to EuroGOOS, the first and probably major category of EDIOS users is EuroGOOS users themselves: scientists and other personnel of oceanographic research institutes and agencies, environmental and resource management agencies, meteorological offices, as well as data processing businesses, and firms operating in the marine sector.

EDIOS must therefore meet a very wide variety of requirements. Ocean data public supply meets global needs as well as some narrow categories of use for which demand (often for scientific research purposes) is limited and specialised. Academic and research data users are the most vocal and hence the most obvious. They are used to specifying their needs for raw data, and have no need for secrecy. By contrast, most other users are not familiar with raw data, and tend to obtain the information they need from intermediate or value-adding organisations. One such company may obtain data from two or three government agency sources, and generate products which are used by thousands of non-expert beneficiaries.

Such a variety of the needs for ocean data requires that comprehensive information on them be based on reliable surveys:

- The EuroGOOS requirement survey, carried out on a sample of countries, gives details on the European demand for ocean data products.
  - A survey on the US demand from seaside tourism offers specific information on a major sector of applications.
- a) A EuroGOOS requirement survey (ERS) was conducted in six European countries: Denmark, Greece, Italy, Netherlands, Spain, UK (Fischer-Flemming, 1999). This is the most complete contribution which offers an overview of ocean-observing data requirements and thus of most EDIOS potential users. 12 sectors of application of ocean-observing data have been identified:

- Research (all disciplines of oceanography),
- Services (forecasting, consultancy, data processing, insurance, ship related services),
- Energy (offshore exploration, drilling, production, services, offshore energy producing installations),
- Mineral extraction,
- Environment (evaluation, protection, control, disposal, cleaning),
- Seafood (fisheries, fish farming, gear production),
- Defence (military construction, engineering and research),
- Building, construction, engineering (including public works, facility construction and services related to the above sectors, as well as military and scientific electronic equipment),
- Transport and ports (all ports and shipping operations, all transport facility construction, safety services),
- Tourism and recreation,
- Hinterland (agriculture, urban and specific zone management, public health),
- Equipment (all oceanographic instrument design, construction and sales).

12 main sea-related variable groups have been identified as most frequently requested by respondents: surface fields, sea surface topography, upper layer fields, sea ice, ice shelves, icebergs, deep ocean, sea bed, coastal and shelf, bio-geo-chemical, optics, acoustics. Such items as the type of series, geographic coverage, accuracy and resolution, as well as forecast period, are equally covered by the survey.

An important conclusion from the survey is that respondents' interest in marine operational data includes all geographical scales from estuarine to global oceanic, though variables related to coastal and shelf areas are more important to respondents than those in large-scale offshore areas (with the exception of some groups of users). Such diversity in the sectors' requirements is an additional reason for users to need an easy access to the widest range of data, and of their potential interest in a directory such as EDIOS.

- b) Tourism and leisure: a survey of ocean-observing data requirements from seaside tourism was conducted in the US (Altalo, Hale, 2002).

The findings concern only US seaside tourism, but they could be easily extended to the same industry in Europe. A similar diversity in requirements obtains as in the above-mentioned survey. More accurately:

- ocean related factors appear to influence business performance and risk associated to business operations;
- but they are poorly integrated in the business decision making process. The reason is that the industry remains "unstructured and disparate"; requirements for weather, climate, and ocean information (forecasts, historical and real time data) vary largely among the industry sub-sectors.

To conclude on this aspect, requirement surveys help to define the different categories of users. Hence, they help to assess the economic significance of users, as shown in the next paragraph. The surveys also suggest that some of the sectors will have a direct interest in using EDIOS, e.g. scientific research and operational oceanography. Others will have a more indirect interest in the Directory, especially in cases where ocean data are less regularly used in the decision making process: such is probably the case of tourism.

### 3. Economic scale of ocean-related activities

An estimation of the significance of EDIOS potential users' contribution to EU's economy is key to appraising the significance of EDIOS (and EuroGOOS) itself.

To this end, one can refer to several assessments of ocean-related activities at national or EU level: for instance, a study was commissioned by the EC in the framework of the Marine Industry Forum and conducted on the set of European national economies (EU 15 + Norway); national studies were conducted on the UK, the Netherlands, France, Ireland, Canada, Australia (AMISC, 1997; Marine Institute, 1998; Dutch Maritime Network, 1999, 2003; Policy Research Corporation NV & ISL, 2001; DFO, 2001; Michaud et al., 2002; Pugh and Skinner, 2002; Kalaydjian, 2004). An attempt to value marine activities in Europe was also made by Brown (2002).

There is no common definition of "ocean-related activity" in the above-mentioned studies. The term may include a range of activities which slightly differs from the set of categories identified in the ERS (paragraph 2). In terms of valuation, most quantitative studies refer to value added (VA: which is substantially less than the gross revenue, and avoids double-counting) and employment as key figures.

**Table 1. Estimates of the economic value of different potential EDIOS users categories**

<b>EDIOS users – ocean related activities</b>	<b>VA (million euros)</b>	<b>Employment ('000)</b>	<b>Sources</b>
Operational Oceanography and basic scientific research (all disciplines of oceanography)	1,330 o	25 o	EC*: R&D and education
Services (forecasting, consultancy, finance)	4,320	75	EC
Energy production (offshore exploration, energy producing installations, storage, drilling, transport, engineering, consultancy)	6,520	140	EC: offshore supply
Mineral extraction (non-oil & gas material extraction)	450	5	BGS, IACMST: marine sand and gravel extraction
Environmental protection (environmental control and forecast, pollution control, waste disposal, beach cleaning, health, species protection)	N	N	
Seafood (fisheries and aquaculture, excluding fishing gear)	6,700	295	EC: fisheries and aquaculture
Defence (military construction, engineering and research)	1,290 u	35 u	EC: naval shipbuilding
Building, construction, engineering (including public works, facility construction and services related to the above sectors, military and scientific electronic equipment, fishing gear production)	13,480 ?	350 ?	EC: shipbuilding, equipment manufacturing, dredging, maritime works
Transport and ports (including all shipping operations, all transport facility construction, safety services)	30,915	520	EC: ports and shipping
Seaside tourism and recreation	52,640 u	1,315 u	Eurostat, Ifremer: seaside tourism expenditures
Hinterland (agriculture, urban and specific zone management, public health)	65,570	1,470	Eurostat
<b>Total</b>	<b>183,215</b>	<b>4,230</b>	

Figures as of 1997 to 2000, and rounded up. "Total" gives orders of magnitude.

o: probably overestimated; u: probably underestimated; ?: uncertain; N: no available data source.

\* EC (Marine Industry Forum): Policy Research Corporation NV & ISL (2001); data as of 1997.

A tentative evaluation of European ocean-related activities was proposed in a former EDIOS working paper (EDIOS, Nov 2003). Table 1 is a summary of it and displays estimates of the value added produced by various groups of users, and the number of staff. Table 1 is mainly sourced from the study commissioned by the EC (Policy Research Corporation NV & ISL, 2001): though its findings do not cover all sectors of ocean data sensitive industries in Europe, and would need to be updated, it has the merit of having a European scope. Other sources complement Table 1. Overall, owing to the lack of data, a quantitative assessment can only provide an estimate in order of magnitude of EuroGOOS users' activities.

An alternative approach to value ocean resources is to estimate the worth of natural assets, as exemplified in Costanza et al. (1998). The authors' purpose was to estimate the current value of the services provided by different categories of ecosystem, among which the ocean. Ecosystem services are seen as consisting "of flows of material, energy, and information from natural capital stocks which combine with manufactured and human capital services to produce human welfare." This analysis leads to the conclusion that components of the global physical and biological ecosystem, in their present states and with present variability, perform functions which have economic value to the human race. If they did not perform that natural function or "service", or if the function were degraded, we would have to spend money to restore the globe to its present habitable condition. As far as oceans are concerned, such "services" include climate regulation, water regulation (transportation), nutrient cycling, food production, genetic resources, recreation, etc. The value of ocean resources was then defined as the sum of benefits accruing to consumers and producers from the services. It was estimated at \$577/hectare/year, ie more than \$20,000 billion as a whole, which is 63% of the global value of ecosystem services as a result of the vast surface covered by oceans.

Though disputed, such value is high enough to illustrate the significance of ocean environment and resources in economic terms, and the public interest in protecting them and collecting ocean-observing data.

#### **4. Costs and benefits of access to ocean-observing systems**

The estimates of the economic weight of potential ocean-sensitive activities, as shown in paragraph 3, suggest that we are not talking about a meaningless share of the European economy. They show that users' relative economic weights widely vary across countries and industrial sectors.

This approach in terms of users' value added and employment is an option among others to value the expected impacts of an ocean-observing system. The latter can be seen from different angles. The present section addresses a classic one, which is through criteria used to value the benefits of an ocean-observing system as compared to the costs incurred for its development. The valuation often takes the form of a Cost-Benefit Analysis. A number of such CBAs have been attempted to value the impacts of GOOS. Below are three case studies which shed some light on the magnitude of long term costs and likely benefits of GOOS subsets:

- The potential benefits from improved forecast of the ENSO (El Niño Southern Oscillation) climate event<sup>1</sup> were assessed in an economic research programme co-ordinated by NOAA (Weiher, 1999). ENSO may have sizeable economic damages: the entire 1997-1999 cycle caused a loss on the US agriculture ranging from \$3.7 to \$8.2 billion; on the other hand, ENSO allowed the oil and gas sector to save operational costs (through reduced heating in the residential and commercial sectors) estimated at more than \$2 billion.
- Another case study (Kite-Powell, Colgan, 2001) was in the Gulf of Maine, US, exploited by different activities among which five are of major importance: marine transportation, commercial fishing, recreational fishing and boating, search and rescue operations, pollution management (especially oil spill). An observing system of the area, the GoMOOS is operated.

- Adams et al. (2000) focused on the Integrated Sustained Ocean-Observing System (ISOOS), the US component of GOOS. The major input from ISOOS resides in the linkages between different observing systems: applications have access to a much wider range of data.

The three cases differ in nature: a climate event, an observing sub-system limited to a given area, and a global system. a) In the ENSO case, the lack of information makes it impossible to value all of the impacts. The benefits from improved ENSO forecast are estimated at \$540 million/year for agriculture and corn storage, and at \$1 million/year for a northwestern fishery, strongly ENSO sensitive. b) In the GoMOOS case study, potential benefits were estimated at over \$33 million/year, and likely to exceed the start-up and operational costs of the system. c) Costs and benefits from ISOOS were estimated for several weather and marine forecast users. The costs of implementing ISOOS ranged between \$30 and \$100 million/year (as compared to the \$2 billion estimate for GOOS as a whole), whereas benefits from better ENSO prediction were estimated at several hundreds of million dollars (see above).

The above-mentioned quantitative impacts tend to suggest that the long term benefits of ocean-observing systems are likely to be in excess of the long term costs.<sup>2</sup> This does not contradict the assumption made by Woods et al. (1996) that efficiency increase and better management of environment, as a result of the working of EuroGOOS, would create economic benefits in the order of 2-5 billion ECU/year (ie more or less the same amount of euros), which would far outweigh expected investment and running costs.

CBA-based assessments of ocean-observing systems raise several methodological issues (Brown, 1997; Flemming, 1997a, 2001), principally the following:

- market failures, due to non-market values such as those of remarkable landscapes or biodiversity, and to regulatory measures distorting market conditions, limit the scope for applying CBAs;
- the lack of data at international level (the outcomes of such a global system as GOOS would be sensitive to transfers between national economies) as well as for long-term future prospect (GOOS would impact economies in the long run);
- the difficulty in aggregating and valuing ocean related activities, more accurately in estimating their global economic, social, and environmental value.

These remarks suggest that there are two options for conducting CBAs, depending on their scale.

- Limiting the set of beneficiaries to ocean data suppliers and users would amount to valuing the ocean-observing system mainly in financial terms, ie to assessing whether direct users of raw or processed ocean data can afford to pay for the system services or, more simply, whether their profits would balance the cost of the system. Flemming (1999) addressed the issues of broad economic and social arguments as to why an ocean-observing system is required, and of how to measure its impacts: relevant factors of practical importance for properly conducting a CBA are summarized and listed, in particular: a) the extra costs resulting from an upgrading of existing ocean-observing systems or facilities, and the allocation of charge of such extra costs on users and developers; b) the benefits resulting from a more properly planned GOOS, reducing costs, removing redundant instruments or data, and standardizing quality control and data assimilation procedures. The list can serve as a guideline for ocean data related CBAs.
- On the other hand, including in a CBA a range of public goods and services produced by the system, such as public health, biodiversity, or global safety of the marine environment, would broaden the scope of the analysis to the collective benefits of the system for a variety of beneficiaries. This second alternative raises additional methodological problems as to how to assess the collective benefits, some of which being based on non-market values, are difficult to quantify.<sup>3</sup>

CBAs are arguably imperfect and biased. This is the reason why they should be used at a broad indicative level rather than as a strictly controlled and accurate assessment. CBAs are perhaps more

credible when applied to specific industries or specific GOOS sensitive sectors, for which financial and market information is better documented, as pointed out by Flemming (1997b) and Brown (1997).

This remark is illustrated by the approach adopted by Altalo et al. (Dec 2002): the authors value ocean information through case studies on specific businesses (*industry trial approach*) taken in the financial, tourism and construction sectors in different European countries. The aim is, under real operational conditions, to analyse both the impacts of ocean information products on changes in the business model of the firm, and the possible feedback of business efficiency improvement on demand for information products. The impacts are assessed through a set of performance indicators. This approach focuses on the mechanisms through which costs and benefits accrue to ocean information product users and suppliers. The impacts of information products are thereby fully taken on board and not only subject to an ex-ante assumption. The analysis can show how a gradual adaptation of businesses to additional information products is parallel to an increase in demand for such products. On the other hand, the approach is time-consuming as its success depends on a detailed observation of how information products influence the user's business.

## **5. Impacts of EDIOS on ocean data product markets**

As said earlier, the Directory provides a service that cannot be dissociated from EuroGOOS as a whole. It has a function only in the framework of the latter. Through EDIOS the existing operational observing system has been identified and now made available to the public. Thanks to EDIOS, users can be expected to re-organise both their internal structure and their commercial relationships in order to maximise the efficiency of the information surplus offered by the Directory in terms of productivity and transactions. In turn, users' re-organisation will have a feedback on their requirements for EDIOS. The Directory is thus likely to have complex effects which combine both supply and demand. They can be examined on the basis of studies which commonly refer to the notion of "knowledge management" (KM).

### **5.1. General remarks**

Knowledge management refers to a wide range of "organisational practices related to generating, capturing, disseminating know-how and promoting knowledge-sharing within an organisation, and with the outside world, including: organisational arrangements, personnel development and management of skills, transfer of competencies (good work practices), managerial changes and incentives for staff to share knowledge" (OECD, 2003a).

This definition is loose, and the notion of KM does not include any new concept. But KM involves increasingly important management issues for public agencies, administrations and private firms because the outside context is changing: technology, markets, and pressure for more efficiency are key aspects to explain the present interest in this notion. In large private firms, staff are dedicated to finding knowledge management solutions. Public bodies increasingly compete with each other for the use of knowledge-intensive inputs (e.g. researchers) and the provision of knowledge-intensive outputs (e.g. universities) (OECD, 2001).

The reason why KM is of growing concern is that properly managed knowledge resources are a source of innovation capacity (de La Mothe, Foray, 2001, ch. 4 and 12) and of wealth creation. This can be approached through KM users' requirements and objectives, especially in the case of private firms, for which there is an increasing link between competitiveness and knowledge practices:

- generally, there is a link between competitiveness and a more efficient knowledge resources,
- sharing knowledge within the firm is the key to get efficiency gains,
- better managed knowledge resources can save time (and cost),
- competitiveness can be gained through reduced "time to market" for innovative products,
- products can be adapted to more individual clients' needs through more knowledge of clients,
- in public organisations especially, the aim is to anticipate policy needs and policy outcomes,

- in scientific research units of public and private organisations, KM is of course a daily practice.

The motivations for, and the effects of, a better management of knowledge sources were studied by OECD (2003b) through a survey carried out on private firms in four countries: Canada, Germany, Denmark, and France.<sup>4</sup> Some major conclusions can be drawn from this:

- KM practices have spread across the economy;
- They have implications on firms' innovation and productivity;
- Respondents differ in their perception of the impacts of KM practices; but some impacts are seen as essential by most of them; principally:
  - KM practices contribute to increase workers' skills and efficiency,
  - they contribute to adapt products to customers' needs,
  - they help to add new products and services;
- How firms manage knowledge resources depends on their size rather than on industrial sectors.

## 5.2. Impacts of EDIOS

The impacts of EDIOS, as a typical knowledge-based tool made available to industries and scientists, must be approached both in general and in specific terms:

- The general features of KM help to approach the role of EDIOS on the basis of some experiences of similar practice in public organisations and in private firms; this is highlighted by the OECD study (2003b). Indeed, directories such as EDIOS have now become a classic KM option.
- But one must also base the analysis of the specific effects of EDIOS on practical experience of ocean data supply and applications: some documents on this matter are available in studies on ocean data requirements and CBAs.

Basically, the expected effects of EDIOS, as a portal to Europe's operational ocean data, result from more information being incorporated into market relationships between instruments manufacturers, data suppliers and users. The latter are expected to change their market conditions by increasing their knowledge of the internet location of products, about their reliability, continuity, scale, resolution, etc. This is likely to influence market decisions and, in return, public agencies' policy.

Below is a tentative classification of the expected effects of EDIOS from upstream to downstream categories of agents. Illustrative examples are mentioned in italics. Items (a), (b) and (c) refer to the increase in the efficiency of supply. Item (d) refers to the various aspects of users' access to data, efficiency and competitiveness.

### a) Instrument manufacturers: better adaptation to demand

Instruments manufacturers will benefit from EDIOS by improving their marketing strategies through a better knowledge of the requirements of the instrument market.

- *Instrument manufacturers can assess market demand more accurately, and design instruments to meet the widest range of applications.*
- *They can see the total installed numbers and types of instruments, estimate the scale of the market, and plan for replacement of existing instruments.*
- *Instrument manufacturers and suppliers can see what combinations of sensors are most frequently operated together on the same platforms, and therefore provide the most efficient linked packages.*
- *They can see the agencies and operators who have installed sensors of a given accuracy, and design their marketing strategy, or persuade agencies to up-grade to higher standards.*
- *Platform manufacturers can see the exact scale of the existing installed capacity and numbers of platforms of different types. From this they can plan the marketing of improved designs, up-grades, or replacements.*

## **b) Ocean-observing system operators: more efficiency through co-ordination effects**

The ocean-observing system will gain in efficiency through a more rational investment strategy and by decreasing operation and maintenance costs.

- *EDIOS has the potential to further develop and optimize the existing observing system. Groups of numerical modellers, for example, may identify over- and under-sampled areas or observation frequencies which are not suitable for a sufficient description of the prevailing situation or for a forecast. Adjustment of such deficiencies will lead to both a more optimal observing system and a reduction in cost involvement.*
- *EDIOS will help to develop the most cost-effective strategy to collect data for operational products describing the hydrographical situation in European waters.*
- *Analysis of distributions of different types of platform or sensor may reveal discrepancies of technology between institutes or national boundaries which are irrational, and based on historical accidents. EDIOS permits rational decisions on the best technology.*
- *EDIOS will help to improve the daily management of the observing system and response to emergencies.*
- *Where instruments and platforms from different agencies are installed close together, EDIOS permits analysis of the best routine for maintenance visits, equipment replacement, and possibly mounting instruments on joint platforms.*

## **c) Efficiency and quality of ocean data supply**

- *Where multiple different technologies are available for measuring the same variable, EDIOS permits a logical comparative study of which system produces the most cost-effective solution in given conditions at the scale of a regional array.*
- *The classification of measuring systems will set European standards required for a European ocean-observing system. These standards will deal with the formats, scales, units, geographic distribution, type and detail of information on ocean-observing sites and devices stored by national and regional institutions. They will encourage manufacturers and owners of ocean-observing devices to improve their systems.*

## **d) Data managers and users: efficiency through knowledge resources, network effect, attraction effect, and innovation effect**

- More efficient use of knowledge resources: EDIOS will help marine resource users to find the sources generating data relevant to their applications. Knowledge resources will be made available more rapidly and be better adapted to individual needs. This will generally enhance users' adaptation capabilities to environmental conditions.
  - *Potential users can improve their awareness of what ocean information products are available and beneficial to collect. Hence a better exploitation of such products.*
  - *Data bank managers and modelling managers will be able to identify sources of data and improve their services.*
  - *Oil and gas companies can identify sources of marine environmental data, especially physical data.*
  - *Fisheries managers and regulators can locate data for environmental factors influencing stocks.*
  - *The analyses of contamination and pollution can be conducted more quickly.*
- Network effects and attraction effects: the networking capabilities offered to suppliers and users will improve their knowledge of the working of the ocean data market, encourage them to co-ordinate their actions, and contribute to their performance and cost-effectiveness. Efficient networks can attract potential entrants.

- *A compendium of European ocean-observing sites and devices will facilitate collaborative scientific uses of data generated by operational oceanography and thus reduce redundant or duplicate data sampling.*
  - *The resulting cost savings can have the effect of attracting more investigators to study the seas and therefore add to the overall understanding of ocean processes.*
  - *Companies with no previous experience of operational oceanography can review the in situ sector and analyse the opportunities of producing for this market.*
- **Innovation effects:** an increasing number of investigators would contribute to the overall understanding of ocean processes as a result of attraction effects.
    - *A more accurate knowledge of the existing observing system permits the conduct of sensitivity studies on alterations of the design.*
    - *This leads to an improved relationship between the observing system and the design of numerical models.*

It would be interesting to look further into the potential implications of EDIOS. However, the exercise would be confronted with the scarcity of quantitative sources.

- A realistic option would be to conduct a survey of potential or existing users. This could be an "ex-ante" survey focusing on the expected impacts of the Directory and user's motivations, or an "ex-post" survey based on practical experience of real impacts. The two surveys would be necessary in order to compare users' objectives with the benefits obtained.
- Another alternative would consist of a case study on the benefits obtained in a firm or a public body on all aspects of the business plan impacted by the Directory. The exercise could be based on the same approach as Altalo et al. (Dec 2002).

## 6. Conclusion

EDIOS is part of EuroGOOS and cannot be dissociated from it. One must then be careful in addressing the Directory's specific effects, of which this note summarizes the principal aspects:

- EDIOS will contribute to the general impacts of the system. Owing to the lack of data, such impacts can only be estimated. They concern a sizeable share of the European economy: EuroGOOS sensitive activities are important in terms of value added and staff employed.
- The impacts of ocean-observing systems or sub-systems have been studied. The first findings strongly suggest that long term benefits are likely to outweigh the sum of start-up and running costs.
- It is useful to analyse the specific impacts of EDIOS in terms of knowledge management in order to identify the main categories of impacts. However, at this stage, one must limit the scope to a qualitative analysis, pending more experience on the matter. We need more case studies and surveys to underpin and quantify the qualitative remarks gathered in paragraph 5.2. above.

A comprehensive assessment of the overall economic impacts of EDIOS and EuroGOOS would have been a valuable indication to the EC and EU Member States of whether to sponsor the project. Owing to the present lack of data, such assessment would have been too long and costly. In any case, a number of pieces of EuroGOOS are already in place now, and EDIOS is not the least important one.

An economic valuation of the system, as approximate as it may be, is useful information on expected payoffs for the funding organisations. This is why the exercise requires gathering more economic material, especially: (a) at firm level, on the running costs that a public agency or a private company dedicates to the search for ocean-observing information, and on how much the Directory would contribute to increasing the firm's productivity and reliability, and to reducing its business risks, by making the search for ocean information products more efficient; (b) at sector level, on the economic weight of ocean information sensitive industries, and on the potential impacts of the Directory on

users' ocean data requirements. Future detailed assessments will remain justified for new subsets of the system which concern particular groups of users if they are sufficiently documented in financial and market terms.

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## 8. Acronyms

AMISC	Australian Marine Industries and Sciences Council
BGS	British Geological Survey
CBA	Cost-benefit analysis
CSERGE	Centre for Social and Economic Research on the Global Environment, University of East Anglia
DFO	Canadian Department of Fisheries and Oceans
EC	European Commission
EFTEC	Economics for the Environment Consultancy, London
EDIOS	European Directory for the Initial Ocean-Observing System
ENSO	El Niño Southern Oscillation
ERS	EuroGOOS requirement survey
EU	European Union
EuroGOOS	European Global Ocean-Observing System
GoMOOS	Gulf of Maine Ocean-Observing System
GOOS	Global Ocean-Observing System
IACMST	Inter-Agency Committee on Marine Science and Technology
ISOOS	Integrated Sustained Ocean-Observing System
KM	Knowledge Management
NOAA	National Oceanic and Atmospheric Administration
NODC	National Oceanographic Data Centre
PUMA	OECD Public Management Committee
R&D	Research and Development
SOC	Southampton Oceanography Centre
UQAR	Université du Québec à Rimouski
VA	Value added

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## Notes

<sup>1</sup> El Niño is a disruption of the ocean-atmosphere system in the tropical Pacific. It happens when Ocean trade winds die out and ocean temperatures become unusually warm. There is a flip side to El Niño called La Niña which occurs when the trade winds blow unusually hard and the sea temperatures become colder than normal. El Niño and La Niña are the warm and cold phases of an oscillation (ENSO), which has a period of roughly 3-7 years. ENSO has effects on Pacific marine ecosystems and on patterns of weather variability all over the world. Farming, fishing, tourism and other climate sensitive industries can be strongly impacted in many countries.

<sup>2</sup> Other examples seem to bear out the same suggestion. A draft cost-benefit assessment of the NSWQIS (North Sea Water Quality Information System), carried out by CSERGE and EFTEC for the OECD Megascience Forum in 1995, estimated the cost of the system at £31 million/year, and the benefits at £80-172 million/year to come on stream after 15 years. Using the upper bound of benefits would result in a positive benefit minus cost estimate. Using the lower bound would make the latter slightly negative. The estimate depends positively on the lifetime of the system, and negatively on the discount rate.

<sup>3</sup> Some standard methodologies exist and are used to assess the value of products or assets having public good characteristics (i.e. goods of which the cost of provision does not increase much with the number of consumers). The methodologies generally consist in estimating stakeholders' willingness to pay for the conservation or protection of the goods.

<sup>4</sup> The four national studies completed so far covered very different numbers of respondent private firms: 348 in Canada, 497 in Germany, 61 in Denmark, 5100 in France.