

## ***Interactive comment on “Assessing economic impacts of environmental research infrastructures: overview of methodological tools” by Régis Kalaydjian***

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Received and published: 9 November 2019

Response to RC1

General comments

1. Comment 1

The main focus of the paper is on operational applications of ENV RIs. How can the paper better address basic research and education applications? How can the dual use nature of ENV RIs (basic research and operational uses) be better taken into account in the paper ? It would be useful to consider subdividing ENV RI costs between research

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and education costs and operational costs.

Response to comment 1

The focus of the paper is on the economic impacts of ENV RIs through operational uses (monitoring and forecasting). But research and education applications are considered essential by the scientific community, in particular the Argo community. They must be given attention, first, by specifying, in the introduction and in the section on downstream impacts, the role of scientific research in the data supply chain ; second, by using information from the literature on RI impacts on research and education, and indicators used to quantify these impacts.

Regarding Argo specifically, the operational and research domains are complementary: Argo contributes to providing scientists with key data for research and education purposes, e.g. for ocean modelling and reanalysis. Ocean models are also used for monitoring and forecasting. E.g. scientists insist that Deep Argo will reduce the uncertainty in the rate of deep ocean warming, thus in future sea level rise projections.

Subdividing ENV RI costs between research costs and operational costs faces a difficulty. For an ENV RI such as Argo, research is not only a data user. Ocean models are developed by scientists, using observations from Argo and the other observing systems. Ocean models are then used both for research (ocean analysis) and for monitoring and forecasting. Research therefore contributes to operational uses. So ENV RI costs cannot be easily subdivided into costs for research and costs for operational applications.

Changes in manuscript

In the introduction and the downstream impact section, stress the significance of research and education as a user of ENV RI products. Mention quantitative indicators proposed in the literature to assess the impacts of RIs on research. In the description of Argo, mention the contribution of research to the development of marine services.

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## 2. Comment 2

The CBA discussion lacks a stronger and more comprehensive conclusion and recommendations of the best approaches to CBA for Argo.

### Response to comments 2

Conclusion on section 3 must be strengthened by building on a classification of the four examples of CBA, depending on their geographical scope and on the set of environmental information users involved. The CBA examples also differ with regard to the description of users' behaviour toward improved information (i.e. how they adapt their own business strategies to improved information). Classifying CBAs according to these features helps to address the question of CBA for Argo.

CBA for Argo : Argo is a component of the GOOS and contributes to improving ocean models. A CBA of Argo would therefore differ from the CBA examples given in the paper. The latter apply to the general impacts of entire observing systems, while the former would assess the impact of improved ocean information, starting from a baseline (no-Argo) scenario with an existing observing system. So the CBA examples assess the impact of the existence of an observing system, while a CBA for Argo would assess the impact of an improvement of an observing system.

Technical studies have been published on the use of improved ocean information, partly based on Argo observations, to support agriculture stocks and crop management, responses to oil spills and marine pollution, and search and rescue : the impacts that are described are not quantified in monetary terms. I failed to find any publication on a CBA of Argo specifically.

### Changes in manuscript

After subsection 3.3.1, make a summary highlighting the main features of the CBA examples (spatial scale of observing systems under analysis, characteristics of data users). After the summary, add a new subsection to address the issue of CBA for

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Argo.

### Specific comments

Certain specific comments concern unclear explanations, sentences, figures or tables, and about missing elements. The best response is to make the appropriate corrections. Other specific comments (below) require responses and corrections.

## 3. Comment 3

Page 2, lines 13-17 and page 4, line 14 : the uses of data from ENV RIs are not limited to forecasting or operational applications but also include data archival for long-term studies.

### Response to comment 3

Comment 3 is linked to comment 1 and refers to the research purposes of ENV RI data products. Indeed, the data from ENV RIs are a major source of information for research.

### Changes in manuscript

In the introduction, mention data management and long-term studies as essential components to study the downstream impacts of ENV RIs.

## 4. Comment 4

Page 3, line 23 : analyzing Argo's economic impacts in isolation does not capture the full upstream and downstream benefits from the combined applications of observing systems.

### Response to comment 4

A summary must be added and include this comment. Argo is used to illustrate the organization of the supply chain and give an order of magnitude of costs. Upstream, downstream and feedback impacts, as they are described in the paper, are not ana-

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lyzed for Argo separately.

Changes in manuscript

In section 2.1, add a summary on Argo explaining its complementarity with other observing networks. Upstream and downstream impacts of ocean observing systems are therefore wider than those of Argo, taken separately.

5. Comment 5

Section 3.1.3 and Figure 1 : purchase costs are mentioned but maintenance costs are not. Figure 1 does not include contributions of the deployment and maintenance industry, including ships and remotely-operated vehicles, inter alia.

Response to comment 5

Indeed, it must be made clear that upstream impacts include deployment and maintenance costs. The Argo cost report referred to in section 2.2 includes these costs.

Changes in manuscript

The description of upstream impacts and the related figure have to be revised accordingly, as explained in the above response.

6. Comment 6

Page 8, line 13 : instrument inventories are discussed but infrastructure costs are not. These are high however.

Response to comment 6

It is true that infrastructure costs are not mentioned in the section on upstream impacts. Instrument inventories are used as an example of how purchases can be derived from available data on the stock of material. The objective is methodological.

Changes in manuscript

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Mention infrastructure costs in the beginning of the section. Explain that instrument inventories (section 3.1.3), if available, are an example of how to obtain periodical purchase values.

7. Comment 7

Section 3.2.1 : KPIs are not limited to the small set mentioned in the paper. Different ENV RIs use very different KPIs, notably research specific KPIs.

Response to comment 7

It is indeed important to mention research related KPIs. Note that the KPIs discussed in subsection 3.2.1 are related to the performance of the observing system as a primary data acquisition system. Research, as a primary and processed data user, operates downstream of data acquisition and quality control. So we are not talking about the same segment of the supply chain. Research performance is partly driven by observing system performance.

Changes in manuscript

Mention the significance of research performance indicators in the introduction and in the section on downstream impacts.

8. Comment 8

Page 14 : section 3 lacks a stronger conclusion and recommendations on an approach to CBA for Argo.

Response to comment 8

See response to comment 2.

9. Comment 9

Page 3, line 24, and Figure 5 : indicate in Figure 5 which parts of the system are government owned or private. Indicate which parts of the public and private sectors

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incur costs or produce benefits which are accounted for in the CBA discussion.

Response to comment 9

Figure 5 must be clarified and simplified. Public and private entities can be indicated. The examples of CBA used in section 3.3 discuss costs and benefits to society, in other terms : a) costs covered by public funding, so principally the costs incurred by public entities ; b) benefits to environment sensitive activities (private businesses or public coastal agencies and authorities). Figure 5 must give these indications ; section 3.3 must also clarify the cost-and-benefit question.

Changes in manuscript

Modify Figure 5 accordingly. Clarify the cost-and-benefit question in the beginning of section 3.3.

10. Comment 10

Tables 1 and 2 : simplify Table 1 and remove blank cells ; update Tables 1 and 2.

Response to comment 10

Table 1 must be simplified. The comparison between EU and US costs is difficult because of a dissymetry between certain countries in terms of available data. So the US column must be removed. Workforce number must also be removed as it concerns Euro-Argo only.

In terms of updating figures, Table 1 relies on a report published by the AtlantOs project (probably the only attempt to propose harmonised Argo cost figures for all participant countries). More up-to-date figures are included in the report but, given reliability issues, it is preferable not to use them.

Table 2 data would also need updating ; unfortunately, I failed to find an update of the study. However, this table is presented for methodological purposes : the idea is to show a type of survey which can be carried out to classify and analyze different

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categories of RI suppliers.

Changes in manuscript

Simplify Table 1, remove the US column, change title.

11. Comment 11

Many English mistakes in the text.

Response to comment 11

The text is being edited. However a small number of expressions used by scientists cannot be changed, e.g. "nature run".

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Interactive comment on Geosci. Commun. Discuss., <https://doi.org/10.5194/gc-2019-14>, 2019.

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