

ESFRI LANDMARK MONITORING

**Monitoring Report of
Panel:**

Euro-Argo ERIC

22 May 2023

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PART A – SUMMARY AND RESULT OF THE ANALYSIS

Euro-Argo is the European contribution to the ARGO programme, a global programme contributing to the Global Ocean Observing System (GOOS). With one quarter of the global number of floats deployed, data collected through Euro-Argo have become very central for the study of ocean processes.

The user services are provided by the (global) data assembly centres, which ensure that a quality-assured observational dataset is provided very swiftly to all interested users. The service is excellent; data are easy to access and application methods and software are provided.

The Euro-Argo ERIC was established in 2014 by nine founding members and one observer. Since then, two additional members joined, and one candidate country emerged. This is a sound basis. Euro-Argo is fully operational. The eleven member countries are actively involved in deploying floats and the analysis of the data. The ERIC governs only the central organisation and joint processes of Euro-Argo. While Euro-Argo is a pre-eminent contributor to the in-situ collection of ocean data and hence a key asset for sciences in this area, the programme is also strongly connected to large operational users (Copernicus, Met services). While Euro-Argo monitors the scientific output, its downstream impact may be larger than reported as it does not assess the specific significance of its data in these wider operational frameworks.

The data management strategy appears highly efficient and well-embedded in the European e-infrastructure.

A long-term financial plan for the ERIC is in place. A major issue is, in view of the ambitions of the more demanding OneArgo context, the need for additional funding at national and collective/European (cf. ocean-scale deployments) level. National contributions will most likely not be sufficient to ensure the Euro-Argo operations to the level that is needed.

The risk management is on a small scale but sufficient.

The performance of Euro-Argo is very sound and the seven recommendations articulated in this report aim to provide suggestions that can further strengthen it in terms of scientific capabilities, visibility and recognition.

The development of future cutting-edge scientific capabilities and the further development of its operational support function for societal benefit should go hand-in-hand.

The panel suggests that Euro-Argo keeps its ESFRI Landmark label.

PART B – SCIENTIFIC PART

1. SCIENTIFIC EXCELLENCE

Summary of performance:

Data collected through Euro-Argo have become very central for the study of ocean processes. Euro-Argo is the European contribution to the ARGO programme, a global programme contributing to the Global Ocean Observing System (GOOS). The Global Ocean Observing System is sponsored by the Intergovernmental Oceanographic Commission of UNESCO, the World Meteorological Organization, the United Nations Environment Programme, and the International Science Council. The ARGO programme has been a giant step forwards in the field of ocean observation as near global coverage of measurements (e.g. temperature, salinity) in the upper 2000 m has been achieved. The observations are done with floats released in the ocean. The data from these floats has been used in many important and impactful scientific studies and is also essential to quantify the effects of greenhouse gas emissions on the ocean, for example to determine changes in upper ocean heat content. Furthermore, the data are heavily used in model validation and model initialization and hence important for prediction studies and forecasting.

Euro-Argo has contributed with about a quarter of the total number of floats released and is a mature part of the (now-called) OneArgo programme in which also biogeochemical (BGC-Argo) parameters and deep ocean (Deep-Argo) properties are measured. This is an excellent performance.

Euro-Argo has a strong role in development and innovation towards the upgraded OneArgo network (incl. deep ocean, polar regions, biogeochemistry). This upgrade is relevant for both the scientific and the operational users of Argo data. Euro-Argo is playing an important role in technology development (e.g. hyperspectral radiometers), testing (e.g. of sensors and platforms) and for deploying floats in specific regions (e.g. Mediterranean). It has also shown a swift adaptation to new scientific trends motivating the development of BGC-Argo and Deep-Argo. The Euro-Argo ERIC Science Officer is co-chair of the Argo Data Management Team showing the strong involvement of Euro-Argo in the OneArgo programme.

The user services are provided by the (global) data assembly centres, which ensure that a quality-assured observational dataset is provided very swiftly to all interested users. The service provided to users (free access, connections to Copernicus Marine Services (CMS) and EMODnet) is excellent; the data are easy to access and methods and software are provided to analyse it. The number of users and data access is certainly adequate.

Potential benefits of a more detailed analysis of the Euro-Argo bibliography have been identified (e.g. impact factor, regional and thematic interests, etc.), linking with a deeper socio-economic impact analysis, but Euro-Argo has not yet undertaken this due to a lack of resources.

Euro-Argo is contributing, in the context of EU-funded and/or national research projects, to the technical development and testing of new sensors. While the market for such sensors is quite narrow and there are few companies at global level focusing on these, recent information indicates that for

each of the main parameter sensors, there is more than one global provider company (some of which are based in Europe), so that a modicum of competition is arising.

2. PAN-EUROPEAN RELEVANCE

Summary of performance:

Eleven European countries are member of Euro-Argo and are actively involved in deploying floats and the analysis of the data. Euro-Argo is well-embedded into the European Research Infrastructure ecosystem. The programme has strong connections to the Copernicus Marine Service (CMS) and to meteorological agencies (several of the national contact persons are employed by these agencies).

One candidate member and one founding observer country, which are also involved in deploying floats and the analysis of the data, complete the group of countries involved in Euro-Argo. The Argo data serve users of nearly all European countries. Euro-Argo forms a part of the emerging European Ocean Observing System (EOOS) which serves as an important body to coordinate ocean observation efforts. There are many collaborations of Euro-Argo with other innovation projects and other RIs (ICOS, EMSO), for example regarding standardization of data flows, which appear very fruitful.

Euro-Argo welcomes filling gaps in coverage in European seas, and membership from additional European countries, where there are still many smaller gaps in coverage. However its main goal and main challenge is to secure its global coverage. Participation of more countries in the Euro-Argo programme could enable more collaboration and support the distribution of national float deployments towards global coverage. Permission for deployment of floats is also still an issue.

The stronger EU focus on transatlantic marine research cooperation has resulted in additional project funding, but not to enhanced structural funding. Euro-Argo is associated with the AtlantOS programme that aims at an All-Atlantic Ocean Observing System by 2030, as part of GOOS.

Euro-Argo considers that the only sustainable solution to rising costs linked to the transition to the more ambitious OneArgo programme and the main means to address the inflation cost increases would be to secure a financial contribution from the EU budget, for instance via funding by the operational users of Argo (i.e. mainly the Copernicus programme).

Euro-Argo recognises that it needs to strengthen, both on the scientific and on the operational side, its links with the modelling community. It can benefit from similar developments at the global level. The European efforts towards the development of (a) Digital Twin(s) of the Ocean (DTO) provides strong opportunities to achieve this better interplay between the different branches of ocean science.

3. SOCIO-ECONOMIC IMPACT

Summary of performance:

The analysis provided on the socio-economic impact appears realistic as the impact of Euro-Argo can only be assessed as a contribution to the global Argo International Programme, which was initiated in 1998, and its new development, the OneArgo programme. The upstream impacts (e.g., Argo-float suppliers and, especially, sensor providers) of Euro-Argo are indeed rather limited compared to the situation in the US, where there is a larger market for ocean observation technologies.

There has not been a full impact assessment. The downstream impacts (e.g. use of data in climate models) may be larger than described in the Landmark report. First, reanalysis products, by some considered as ‘observations’ although a model is involved, are very important for assessing the effects of greenhouse gas emissions on ocean physics, chemistry and biology. Second, many of the biases in climate models have been established by comparison of model results to Argo float data. Projections from these models form one of the aspects for policy making on handling climate change. Finally, the impact of having Argo floats in specific areas on forecasting and climate modeling is most likely higher than addressed in the material provided. The rationale that the quality of many downstream services depends on the data available from Euro-Argo is convincing, but has not been exhaustively documented.

The societal interest for, and the significance of, the role of the ocean and seas for Europe has increased significantly in recent years. The positioning of Euro-Argo within the context of the development of the European Ocean Observing System (EOOS, see above Pan-European Relevance) may fall outside the scope of this Landmark Monitoring process; it seems however clear that the chances to continue to secure Euro-Argo, in a OneArgo perspective, as a preeminent research infrastructure for ocean processes is also strongly bound to the EU-level efforts to enhance the European capabilities to observe, in-situ as well as from remote sensing, the physical, chemical and biological ocean processes and how they change in a rapidly changing global climate.

[The ESFRI Forum may wish to consider this broader strategic function of Euro-Argo in its final report.]

4. USER STRATEGY & ACCESS POLICY

Summary of performance:

The (free) availability of the data through CMS and EMODnet has made access of the data to users very easy and attractive. The data are also accessible through a number of web services in many of the commonly used formats (e.g. NetCDF).

The GitHub platform 'euroargodev' is really excellent. This collaborative platform allows code hosting, sharing and development, but also networking and discussion among the Argo users' community and beyond. It provides much useful material and is well structured with (links to) tutorials, jupyter notebooks, many other software tools, and creates a very low barrier to use the Argo float data.

The community of users is estimated to be very large as many PhD students in oceanography will have worked with Argo data, including Euro-Argo data. The use of these data is also stimulated in many courses in universities (both at MSc and PhD level).

The usefulness of the biennial Science Meetings, where scientific results are presented, can be questioned as a means to collect information on user needs related to Euro-Argo.

The ERIC as such does not have an extensive user strategy, although it organises science meetings every two years. Argo at global level undertakes large surveys to obtain user feedback.

The Euro-Argo Implementation & Sustainability Plans 2024 - 2028 was developed thanks to the H2020-funded Euro-Argo RISE project, where the questionnaire used to gather the information on the specific requirements of the Euro-Argo ERIC user community is described. However this document does not explain if e.g. potential business or new public service users would be interested in use or cooperation (e.g. sponsorship of big companies and foundation such as Bill & Melinda Gates and their Ocean Innovators initiative) with the Landmark. To attract new users, it would be good to use co-creation approach (to discuss with the potential users/partners and step-by-step develop joint activities based on their needs and Landmark capacities).

Euro-Argo ERIC recognises the importance of user community enhancement and the relevance of KPIs in this domain. However, due to the restricted role of the ERIC and the restrictions experienced on available resources (both in the ERIC and in the operators in member countries), the ERIC considers itself unable to set KPIs for interaction with user communities.

[R1] It is recommended that, in line with its own strategy, the ERIC and the Euro-Argo bodies where it works with its European operators:

- examine how they can actively engage with a broad(er) possible user community (e.g. through sessions at major conferences such as EGU), beyond the audience reached by their biennial own science conferences;
- keep the matter of interaction with user communities in Europe under review in order to obtain, between ERIC and the group of national nodes, relevant information from the user communities' evolving interests and needs, possibly also in the form of a management indicator (Euro-Argo ERIC + members' operators contributing), and attribute sufficient resources to this.

5. E-NEEDS

Summary of performance:

The data access management of Euro-Argo (also connected to that of OneArgo) is excellent and the data management strategy appears highly efficient and well-embedded into the European e-infrastructure.

The data-quality procedures are very well designed and there are two global data centres GDACs (one in Europe) which synchronise data daily. All procedures are well documented and software to process the data is available through the GitHub site 'euroargodev'. Data have a DOI and so are citable (and findable) in scientific papers and reports. The FAIRness of the data has also substantially increased through the ENVRI-FAIR project.

The enhancement of visualisation capabilities is on the list of further developments, but with so many (free) Python/Julia tools available nowadays, this does not need to be a high priority issue.

It was further clarified that, thanks to several redundancies, the whole system has very little vulnerability to contingencies. Developments are planned to provide a better user experience, while keeping and even improving safe-keeping of the data system:

- The data volume represents 2 Tb of data, that are mirrored on both US-Godae and Ifremer GDAC plus monthly snapshots archives.
- The GDAC and upstream processes that feed the GDAC also have redundancies that are described and qualified through the ISO9001 P14 process. The upstream processes are running on virtual machines, and several physical machines are in-use and are redundant. In addition, the machine room is made redundant in another building at the Brest Ifremer site. Finally, there is a safe-keeping recording in the Nantes Ifremer site (300 km away).
- The use of a cloud solution to hold the GDAC is something planned for the medium term. It consists in developing a container, validated in Ifremer own cloud facilities, that can be then uploaded on public cloud structures (e.g. NCEI, EOSC). These structures have framework agreements with cloud-providing companies (such as Google, Amazon, Microsoft for NCEI or Google, D4science, CESNET for EOSC). The container can be uploaded in several cloud structures and/or moved if necessary.

Data use is facilitated through several layers of 'help' tools, both at Argo and Euro-Argo level.

<p>[R2] As Euro-Argo is working with a growing and unique set of data it is recommended that the RI continues to work on further reduction and elimination of vulnerabilities in their total e-infrastructure system.</p>

PART C – IMPLEMENTATION PART

6. STAKEHOLDER COMMITMENT

Summary of implementation state:

The Euro-Argo ERIC was established in 2014 by nine founding members and one observer. Since then, two additional members joined, and one candidate country emerged. This is a sound basis. Outreach to possible new members is suggested. Two additional members (Poland and Denmark) will join Euro-Argo soon.

Other countries (Portugal, Belgium, Sweden, Turkey) have a scientific community, which is interested but the challenge is to get the formal commitments from ministries. Euro-Argo representatives cited competition with other ERICs, who are in essence competing for the same budgets of the particular member states. EuroGOOS ARGO Task Team was established to provide for coordination between the ERIC and non-member institutes/countries (exchange of expertise, advice, communication with Euro-Argo governing bodies).

Euro-Argo has a two tier membership structure – members (formal commitment and payment of membership fees), observers (formal commitment but lower membership fees and no voting rights). Additionally, the ERIC cooperates with observers to keep in touch with interested stakeholders from non-member/observer countries.

The Landmark very convincingly and frankly admits that despite being a strategic component of the development and implementation of several key European policies, Euro-Argo largely relies on the in-kind contribution of volunteering European countries through their national Argo programmes, complemented by project-based EU funding which, by definition, is limited in time and not renewable.

This review is to the scientific functions of Euro-Argo, i.e. the Landmark Monitoring is not considered to have a mandate to address the issue of the role of Euro-Argo within a sustained European Ocean Observing System (EOOS). It can be observed however that EU institutional users such as the Copernicus Marine Service (CMS) or the European Marine Observation and Data Network (EMODnet) are not supporting Argo activities financially. Furthermore, the Landmark indicated the fact that in Europe, the ratio of research-based Argo funding versus operational funding is 75 % and 25 %, respectively, while, in the USA, the ratio is reversed. In this context, the major challenge of Euro-Argo ERIC is not only the sustainability of its operations itself, but it has also impact on the approach taken, which uses project call opportunities rather than one of a long-term strategic research infrastructure operation with enough sustainable funding.

The financial sustainability of Euro-Argo programme and its expansion into the measurement of new ocean variables is however a major issue for its sustainability. On the one hand, the prices of floats are rising per se due to inflation, on the other, their new capabilities (of measurement) demand yet another price increase. In the future, the financial demands will be raised by 100 % (from 6 mil EUR/year to 12 mil EUR/year) or even by far more if OneArgo is implemented at full scale.

[R3] It is recommended that other funding opportunities; such as the EU structural funds, be examined and where applicable utilised to a higher degree, especially in the countries with such opportunities,

e.g. potential new member countries. This will help to strengthen the membership of Euro-Argo in relevant Euro-Argo countries, though not the ERIC directly.

Definitely public (governmental) funding is crucial for the Euro-Argo, however above mentioned opportunities should be tried or at least credibly explained why it is not possible to use it and thus justify governmental costs to taxpayers.

7. CURRENT STATUS AND PLANNING

Summary of implementation state:

Euro-Argo ERIC is fully operational. Continuous upgrades to the floats are envisioned (see comments on financial sustainability). It does not require large buildings or very expensive pieces of equipment which need to be periodically upgraded. Floats are deployed and usually lost at sea at the end of their life cycle; hence, the decommissioning of equipment is not relevant (see environmental impact section).

Euro-Argo is part of the global ocean observing system. Argo is part of the Global Ocean Observing System (GOOS), a programme co-sponsored by WMO and IOC (Intergovernmental Oceanographic Commission of UNESCO). The Landmark points out that its data centres are designated by Governments of Member States of the Intergovernmental Oceanographic Commission of UNESCO (IOC) to provide access to- and stewardship for all oceanographic data, including Argo data, worldwide. However, formal interconnections to global initiatives are missing and especially towards UN IPCC, UN IPBES and perhaps to the World Meteorological Organisation - WMO (apart from the Landmark data provision via GTS (Global Telecommunication System) operated by WMO). In fact some national bodies/countries are active in these international fora, not Euro-Argo.

[R4] It is recommended to establish formal connections of Euro-Argo to global initiatives to increase the global visibility of the RI and its impact. As was presented by the ERIC a pilot action is part of a newly funded Horizon Europe project. These activities shall continue in the future as well.

These international connections can be achieved also in cooperation with other ERICs from the environmental domain.

8. GOVERNANCE, MANAGEMENT & HUMAN RESOURCES POLICY

Summary of implementation state:

The ERIC statutes are in place, stipulating the proper governance of Euro-Argo with the Council (meeting twice a year), Management Board (meeting three times a year) and Programme Manager.

The Euro-Argo community is organised in an informal way. The contributions from the ERIC members towards the ERIC (e.g. number of floats to be provided each year) are only stipulated in the Scientific and Technical description of the infrastructure (part of the statutes). Since the ERIC establishment these initial commitments have not been reviewed.

[R5] It is recommended to put the ERIC, in this next phase of development where it needs to address a number of significant challenges, on a more business-like footing by making a stocktaking exercise and proper planning of in-kind contributions of individual countries or introducing service level agreements with Euro-Argo services providers.

Euro-Argo ERIC is a very small entity with only a handful of employees. Human resources policy seems to be implemented and working.

The Gender Equality Plan is developed and quite substantial resources committed (the GE Officer is expected to dedicate half a person/month per year on gender-related activities). Given that Euro-Argo has no direct means to influence which users use their data and other tools, it is not in a position to work on a gender-sensitive approach to user access.

9. FINANCES

Summary of implementation state:

A long-term financial plan for the ERIC is in place. An increase in the very modest budget is suggested, which will result in increasing the membership fees of the member countries (currently at 30.000 EUR/year) and the need to attract additional project funding from the European Commission. The increase in fees is not yet agreed by the members.

However, a major issue is the need for additional funding at the national level, which often depends on project funding bases which are limited in time. The introduction of new capabilities of floats (BGC floats) put additional pressure on budgets (six times as costly as core floats and 50 % more costly than deep ocean floats). At the same time Europe is expected to keep to its commitment of providing 25 % of the floats globally. In the long term, national contributions will most likely not be sufficient to ensure the sustainability of the Euro-Argo operations to the level that is needed and has to be complemented by other funding.

[R6] As the use for operational purposes - used by various national and European agencies, such as the Copernicus programme - of Euro-Argo data also benefits from the advances made of the Euro-Argo capabilities developed for research purposes, Euro-Argo is recommended to negotiate with them to provide financial support and how to best fit their needs and improve their services (e.g. additional coverage in certain regions). This is, so far, an untapped funding opportunity that shall be seized by Euro-Argo. It is recommended that discussions, mainly with the Copernicus programme, should be established.

The annual accounts are properly audited (external accounting firm) and approved by the Council.

Organisation of centralised procurement of floats is a very valuable activity that provides for circa 50 floats to be bought in cooperation with the national institutes.

10. RISKS MANAGEMENT

Summary of implementation state:

For a small organisation like Euro-Argo the risk management is on a small scale but sufficient.

The data collection is the most precious asset of the Euro-Argo ERIC and is well secured by the data centres (DACs) in France and UK which received UNESCO label and/or ISO-9001 certification. (See also section 5 above)

11. ENVIRONMENTAL / ENERGY POLICY

Summary of implementation state:

[R7] Euro-Argo is aware of the environmental impact of its activities and is recommended to keep looking more carefully into them in the future, namely to the recovery of floats.

The initial activities of setting up a dedicated webtool for recovery of floats (<https://floatrecovery.euro-argo.eu>) is promising, making the floats to be recovered visible.

Power supply is not a major issue of Euro-Argo.

By having European capabilities to monitor the ocean, including Euro-Argo, actors with maritime activities have the capability to use this relevant environmental information for their environmental and energy management, which is for the benefit of the seas and oceans.

PART D: KPI

KEY PERFORMANCE INDICATORS (KPI)

Summary:

The selected KPIs are credible and aligned with the mission of Euro-Argo. They fulfil the RACER criteria and are monitored already for several years.

For some KPIs, the information pertains only to the ERIC in the strict sense (performance of Euro-Argo HQ), while for others (e.g. number of deployed floats), it covers the entirety of Euro-Argo “network” (ERIC + national operators).

The ‘end-to-end’ Euro-Argo ERIC performance depends on the operation of the ERIC staff as well as of the entire network. This network should not only be relied upon for the operational side (preparation and deployment of floats).

[R8] So it is recommended that Euro-Argo investigate whether additional ‘network performance indicators’ (ERIC + network of national nodes) could be beneficial in addition to those already in use.

Especially in relation to the knowledge of, and interaction with, the user community, an ‘ERIC only’ approach appears to be too restrictive (see section 4 above with its recommendation).

In relation to the KPIs for the dimension Scientific Excellence, this monitoring clarified that:

- On average about 22-30% of the Argo-related scientific articles has a European first author and Euro-Argo uses, on top of information from a global bibliometric study, input from Euro-Argo national representatives (provided in their annual national reports) to document the use of Argo data by scientists in Europe. In this process, it is not possible to differentiate between data used from observations by ‘European’ (Euro-Argo) and ‘other’ (other Argo contributors) floats. The relevance of Euro-Argo ERIC for European scientists in this field is strong.
- The percentage of scientific papers by a principal investigator from an Argo contributing institute has decreased in recent years, which indicates that the relative uptake of data outside the group of contributing institutes is rising. Euro-Argo sees an opportunity to start tracking this process also at the European level, as it could lead to identifying main beneficiaries which are as yet not institutionally linked to Euro-Argo.

PART E: ADDITIONAL INFORMATION

ADDITIONAL QUESTIONS, DOCUMENTS, HEARINGS, ON-SITE VISITS

Summary:

Not Applicable.

FURTHER COMMENTS

Additional comments on the monitoring process as such:

The Landmark reported within the agreed deadline. The report was accompanied by a set of clear additional documents. The external experts provided their appreciated reports within the agreed timeframe. The Monitoring Panel distilled nineteen questions for further clarification from their first analysis of the materials provided. These were addressed in a clear manner by the Landmark at an online meeting on 4 April 2023. The online meeting was also an opportunity for a short bilateral interview between the panel and the Chair of the Euro-Argo Management Board, Ms Birgit Klein from BSH, Germany.

Through the initial contacts it was established that there was no strong need for a site visit to the Euro-Argo HQ in Brest, France; the Euro-Argo team provided additional means for getting to know them better (short CV profiles, videos) at the occasion of the 4 April meeting.

The Monitoring Panel considers that the whole process of this Landmark monitoring has gone very smoothly. The Panel wishes to extend its thanks to the whole team of Euro-Argo ERIC and all others who helped in preparing the materials for this process.