3rd Periodic Technical report of ENVRIplus project

Project Number: 654182

Project Acronym: ENVRI PLUS

Project title: Environmental Research Infrastructures Providing Shared Solutions for Science and Society

Funding Scheme: Research and Innovation action

3rd Periodic Technical Report Part B

Period covered by the report:

from 01/01/2018 – 31/07/2019

Project coordinator: Werner Kutsch, Director General of ICOS ERIC, (werner.kutsch@icos-ri.eu)

Project website: http://www.envriplus.eu

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 654182

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Declaration of the Project Coordinator

I, as the coordinator of this project and in line with the obligations as stated in Article 20.3 of the Grant Agreement declare that:

- The attached periodic report represents an accurate description of the work carried out in this project for this reporting period;
- The project (tick as appropriate):

  ✓ has fully achieved its objectives and technical goals for the period;

  ☐ has achieved majority of its objectives and technical goals for the period with very minor deviations.

  ☐ has failed to achieve critical objectives and/or is not at all on schedule.

- The public website, if applicable

  ✓ is up to date

  ☐ is not up to date

- To my best knowledge, the financial statements which are being submitted as part of this report are in line with the actual work carried out and are consistent with the report on the resources used for the project and applicable with the certificate on financial statement.

Name of the Coordinator: Werner Kutsch

Date: 30.09.2019

1. Explanation of the work carried out by the beneficiaries and Overview of the progress

Overview of the project

Environmental Research Infrastructures (RI) provide key tools and instruments for the researchers to address specific challenges within their own scientific fields. However, to tackle the grand challenges facing human society, scientific collaboration across the traditional fields is necessary. The Earth system is highly interlinked and the area of focus for environmental research is therefore our whole planet.

RIs also represent significant investments from the Member States and the European Union and their competitiveness is crucial for the innovation potential, resilience and attractiveness of the environmental research in the European Research Area.

ENVRIplus was a cluster project supporting a development and integration of the major European Environmental and Earth System RIs. The project supported creating more consistent products and services, making it possible for scientists to address cross and multidisciplinary environmental and societal challenges. Additionally, by co-designing common solutions technical and policy issues, ENVRIplus increased the cost-effectiveness and accessibility of the environmental Research Infrastructures.

Collaboration within the ENVRIplus enabled the multidisciplinary Earth system science across the traditional scientific fields, which is so important in order to address today's global challenges. The cooperation helped to avoid the fragmentation and duplication of efforts, making the Research Infrastructures' products and solutions easier to use with each other, improving their innovation potential and cost/benefit ratio of the Research Infrastructure operations.

ENVRIplus was driven by 3 overarching strategic goals:

1. Enabling cross-fertilization between Research Infrastructures
2. Implementing innovative concepts and devices across Infrastructures, and
3. Facilitating research and innovation in the field of environment to an increasing number of users outside the Research Infrastructures.

The work in the ENVRIplus project progressed in one Management and 18 Research and Innovation Work Packages. The Work Packages were further organized under six conceptual Themes.

1. Technical Innovation
    - WP 1 – New sensor technologies: innovation and services
    - WP 2 – Metrology, quality and harmonization
    - WP 3 – Improving measurement networks: common technological solutions
    - WP 4 – Joint operations across the Research Infrastructure domains

2. Data for Science
    - WP 5 – Reference model guided Research Infrastructure design
    - WP 6 – Research Infrastructure data identification and citation services
    - WP 7 – Data processing and analysis
    - WP 8 – Data curation and cataloguing
    - WP 9 – Service validation and deployment

3. Access to Research Infrastructures
    - WP 10 – Governance for sustainable and adjustable access to Research Infrastructures
    - WP 11 – New Concepts and Tools for Physical Access

4. Societal Relevance and Understanding
    - WP12 – A Framework for Environmental Literacy
    - WP13 – Developing an Ethical Framework for Research Infrastructures
    - WP14 – Citizen Observatories and Participative Science

5. Knowledge Transfer
    - WP15 – Training, e-Learning and courses
    - WP16 – Staff Exchange

6. Communication and Dissemination
    - WP17 – Coordination of Research Infrastructure communication, development and implementation of the ENVRI Strategy

- WP18 – Dissemination, Liaison and Collaboration

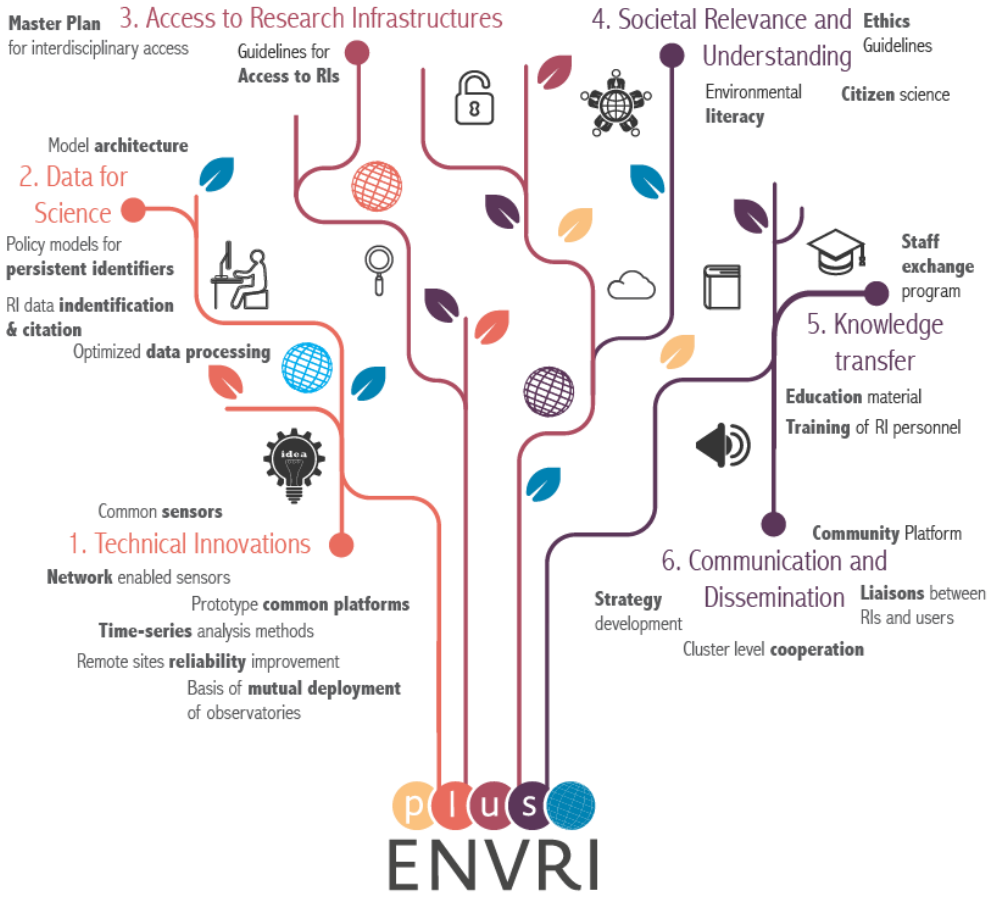

Figure 1. Products and services that were being developed within the six Themes of ENVRIplus.

Means of operations

The work was initiated during the project's Kick off meeting organized in Helsinki in May 2015. Most of the work packages started their activities immediately after the project started.

Besides the Kick off meeting, project management (WP19) organized five consortium meetings called ENVRI weeks during its first and second reporting period. There were three ENVRI weeks organized during the third reporting period. These are described below:

- 6th ENVRI week was organized in Zandvoort, Netherlands, May 14-18, 2018,
- 7th ENVRI week was organized in Riga, Latvia, in November 5-9, 2018, and
- 8th (FINAL) ENVRI week was organized in Helsinki, Finland, March 25-29, 2019.

ENVRI weeks were organized twice a year in order to bring the entire environmental Research Infrastructure community together and to have all the relevant events at one place. ENVRI weeks therefore hosted the project (Theme/WP/Management) related sessions, as well as sessions and workshops organized for the external audience, reaching beyond the project's consortium. Such events proved to be very efficient in terms of saving the time and resources of the project partners, but mostly for its ability to bring the critical mass of people together.

Besides the ENVRI weeks, WP18 together with the Project Coordination, organized a huge final dissemination event in Brussels. The main goal of this event was to:

- Promote the main results achieved within the project;
- Promote the benefits of RI clustering;
- Promote the role of in situ RIs in the international landscape.

The event is described in more detail within WP18 report.

Besides these physical meetings, the project partners worked together and communicated through the internal communication channels offered by the Management office. Such means included virtual meetings, use of mailing lists and internal project management system (see Task 19.3: Project Internal communications for more details).

Overview of the Progress M32 – M51

The main focus of the ENVRIplus project during its last reporting period was on finalizing the work that has been initiated during the previous two periods, making sure all the products, tools and services are delivered by its end. The end was initially scheduled for month 48, i.e. April 2019. There were, however, several reasons why the project consortium applied for an extension. Besides tasks that could not be achieved for different reasons in the given time, such as Methane observation cruise in the Baltic sea (WP4), or the further work on the joint ENVRI strategy (WP17), there were tasks going beyond the original Description of Action, suggested by the project Reviewers. These activities were seen as very beneficial, but could not be implemented in the original time frame of the project. The final dissemination event in Brussels is a good example of such activity, and it had a huge impact on the dissemination of the project's results. The extension was approved by the European Commission (EC) and allowed the project to continue its work until month 51, i.e. July 2019.

In the technical innovation, the above-mentioned Black sea methane cruise was organized, combining four RIs and coupling different methodologies for quantifying marine methane transfer from the sediment to the atmosphere. This use of multidisciplinary facilities from different RI improved not only the scientific understanding, but also acted as a key test for the jointly developed instrumentation. In addition, the reports on common evaluation of use of unmanned vehicles, and on sensor enabled embedded processing were finalized. The joint technical and policy developments in the field of metrology were also finished, and implemented in several RIs, a more concrete strategy for collaboration with satellite data providers were delivered, and joint remote energy testing site was made operational along with the relevant documentation. The technical joint operations also created a new OpenDAM open interface between proprietary observation sensors and data collecting.

A lot of work has been done for developing good practice guidelines to challenges on proper data citation and data publishing, leading to strong improvements at existing and new systems at the corresponding repositories. Technology for scientific data analytics and infrastructure optimization was developed, released and tested through a series of use cases. The work during this period has demonstrated clearly the close relationship between curation, catalog and provenance and the need for tight integration across these functionalities. Relating WP8 results to the WP5 reference model and architecture has been a significant piece of work. The Science Demonstrators implemented during this period serve as proof or evidence that the Theme 2 services can bring added value for supporting ENVRI community to deliver scientific research.

There has been a huge progress in work on the common access policies to the infrastructures. During the RP3, four strategic deliverables were submitted by WP10 providing guidelines and master plan to facilitate and encourage access to RIs, as well as describing the performance criteria for open access and listing the performance indicators. RIs now have a general strategy for flexibility and sustainability of access they can implement in a way it addresses their own specifics and fits best to their own users. In addition, a final call for multidisciplinary access to RIs funded eight projects, that has demonstrated clear added value to ENVRI community, beyond the limits that a single environmental RI could ever achieve. The experience and findings gathered through the organization of this type of access are summarized in the final WP11 deliverable.

The 4th theme, focusing on the Societal relevance and understanding, the work on building the new ENVRI RM module to characterize 'societal relevance' of RIs with respect to published Grand Challenges systems was finalized. A white paper on general guidelines, recommendations, and best practices on communication and decision-making under uncertainty for environmental hazards and natural disasters was also delivered and well promoted. Thanks to the Ethical Label Template and Ethical guidelines for the RIs, the RIs are more aware of the ethical issues applying to their research activities as well as the management of an RI. The work in this theme also facilitated the exchange of information and knowledge regarding the citizen science activities, allowing them to quickly identify and address frontier issues for both citizen science and environmental science in general.

Training activities have been numerous, especially those focusing on soft skills of the RI management. In collaboration with the RI-Train project, the RI senior management was trained to improve their managerial and leadership skills. They were also taught how to build a sustainable governance and funding for their infrastructure. Communications specialists working in different RIs received two full-day lessons focusing on efficient tools and strategic approach towards the communication activities.
Additionally, a joint staff exchange programme has been a successful way to distribute knowledge across the RI domain. The findings gathered through the organization of the personnel exchange were synthesized in the report suggesting how can such service be sustained by the RIs in future.

Communications of the project and community building activities continued to be strong, with a visible social media presence, and very active participation in major environmental conferences, organizing sessions and highly impactful booth activities. The final dissemination event in Brussels nicely presented the top achievements of the project to a wide range of stakeholders. Strategic level collaboration in the ENVRI cluster have led to a stronger cohesion of the cluster. A special BEERi WS kicked of the work on ENVRI sustainability, new vision statement and other strategy issues and identified the steps forward regarding the common future path for the ENVRI community. The RIs agreed on how to structure their cooperation and common activities in a formalized way in future.

Moreover, the feedback collected through ENVRIplus was included in the ESFRI Landscape analysis, which stated that ENVRI community is perceived to be a good instrument to drive strong messages from the environmental RIs.

Summary of deliverables

The project delivered 57 deliverables during this reporting period. The deliverables are shortly summarized below.

WP	Del Ref Number	Del Number	Title	Lead Beneficiary	Nature	Due Date	Actual Submission Date
WP12	D12.1	D49	Report describing the relation between challenges of human systems and environmental information generated in RIs as documented module of the ENVRIPLUS Reference Model updated based on the experiences from Tasks 33 and 34	EAA	Report	30 Apr 2018	
WP14	D14.9	D64	Summary report of WP14	EMSO ERIC	Report	30 Apr 2019	
WP17	D17.6	D95	White paper on further integration of RIs in the environmental field including recommendations on co-locating research sites on national and international level	ICOS ERIC	Other	30 Apr 2019	
WP3	D3.2	D12	New set of standards for the qualification of instruments towards extreme conditions	CNR	Other	31 Oct 2017	02 Aug 2018
WP14	D14.8	D63	Collection Training sessions/presentations	MBA	Websites, patents filling, etc.	31 Dec 2018	02 Aug 2019
WP17	D17.3	D75	Landscape analysis of the environmental RI community in Europe	UHEL	Report	28 Feb 2019	03 May 2019
WP8	D8.4	D34	Interoperable cataloguing and metadata harmonisation for environmental RIs: prototype	IFREMER	Demonstrator	31 Oct 2018	05 Dec 2018
WP15	D15.5	D69	EeTP E – Learning, description of implementation of new functionalities	UNILE	Report	30 Apr 2018	05 Jun 2018
WP10	D10.1	D41	Guidelines on access to Ris	CNR	Report	28 Feb 2019	05 Mar 2019
WP10	D10.2	D42	Master plan to facilitate and encourage access to Ris	CNRS	Report	30 Jun 2019	05 Mar 2019
WP10	D10.3	D43	Description of performance criteria for open access and list of performance indicators	CNRS	Report	31 Oct 2017	05 Mar 2019
WP9	D9.2	D38	Service deployment in computing and data e-Infrastructures Version2	EGI.eu	Demonstrator	31 Aug 2018	05 Sep 2018
WP13	D13.2	D53	Template of the Ethical lab for deliverables and its adoption	INGV	Report	30 Apr 2018	06 Aug 2018
WP8	D8.2	D32	Data curation in system level sciences: prototype and deployment	NERC	Demonstrator	31 Oct 2018	07 Nov 2018
WP8	D8.6	D36	Data provenance and tracing for environmental sciences: prototype and deployment	EAA	Demonstrator	31 Oct 2018	07 Nov 2018

WP12	D12.4	D94	Prototyping a distributed site catalogue	EAA	Report	30 Apr 2019	09 Jul 2019
WP11	D11.2	D46	Plan for sustained multi-year planning of oceanographic vessels for the environment European RIs	IFREMER	Report	31 Oct 2016	12 Jan 2018
WP7	D7.2	D28	Interoperable data processing services for environmental RI projects: prototype.	CNR	Demonstrator	31 Oct 2018	12 Nov 2018
WP11	D11.3	D47	Whitepaper on improving access across to RIs disciplines	INRA	Report	31 Aug 2018	14 Aug 2019
WP3	D3.1	D11	Report on application of energy-unit in extreme environments and communication to SMEs	CNRS	Report	30 Apr 2019	14 Mar 2019
WP15	D15.2	D66	Materials from the second time-series conference including tutorial and hand-book on the second time- series conference	CNRS	Websites, patents filling, etc.	30 Apr 2019	14 May 2019
WP1	D1.1	D1	Roadmap for the emergence of European industry providers and market landscape analysis	CEA	Report	30 Apr 2017	15 Oct 2018
WP13	D13.3	D54	Ethical Guidelines for RIs	INGV	Report	31 Oct 2018	18 Feb 2019
WP4	D4.4	D18	Report on intercalibration with Green repeater initiative	IFREMER	Report	31 Oct 2018	18 Jun 2019
WP1	D1.3	D3	Final prototype of ARGO float with pCO2 and pH launched	EURO-ARGO	Demonstrator	31 Jan 2018	19 Jun 2019
WP1	D1.5	D5	Report on opportunities and applications of unmanned observatories for usage across RI	CNR	Report	30 Apr 2019	19 Jun 2019
WP1	D1.6	D6	Results and recommendations from the comparison exercise of sensor embedded processing practices	CNR	Report	30 Apr 2018	19 Jun 2019
WP11	D11.4	D48	Report on interdisciplinary integration capacity, end-user needs TNA implementation requirement and added-value for the scientific community	CNRS	Report	30 Apr 2019	19 Jun 2019
WP1	D1.7	D7	Report on technological choices for dense networks of small sensors	IFREMER	Report	31 Oct 2018	20 Jun 2019
WP16	D16.2	D72	Synthesis report on staff exchange and how this service can be sustained by RIs	UniHB	Report	28 Feb 2019	21 Mar 2019
WP2	D2.1	D8	Report on standardization in RIs and tree of metrology references (from international reference labs to RI collected data)	CEA	Report	31 Oct 2018	22 Jul 2019
WP3	D3.4	D14	Report on improved robustness in extreme conditions	CNR	Report	30 Apr 2018	22 Mar 2019
WP14	D14.7	D62	Citizen observation training program, training delivery and evaluation, and impact assessment report	MBA	Report	31 Dec 2018	23 Jul 2019
WP9	D9.4	D40	Serving key data service stakeholders and policy initiatives version 2	LU	Demonstrator	28 Feb 2019	24 Jul 2019
WP1	D1.2	D2	Specification report of common test protocols and inter-comparison methodologies	EURO-ARGO	Report	31 Oct 2017	25 Jul 2019

WP13	D13.4	D55	Contents for Websites, social media appearance, printed matter on ethical & societal issues for general public	ETHZ	Websites, patents filling, etc.	30 Apr 2019	26 Jun 2019
WP3	D3.5	D93	Demonstrating robust data provision - data transmission and near real-time QC - employing a use case in a remote ocean region	UniHB	Demonstrator	30 Nov 2018	27 Jun 2019
WP17	D17.1	D73	Report of domain WGs on domain-specific development needs and actions	UHEL	Report	30 Apr 2018	27 Jun 2019
WP17	D17.4	D76	Summary report on policy communication actions	CNR	Report	28 Feb 2019	27 Jun 2019
WP12	D12.2	D50	White paper on general guidelines, recommendations, and best practices on communication and decision-making under uncertainty for environmental hazards and natural disasters	ETHZ	Report	31 Dec 2017	27 Mar 2018
WP6	D6.3	D26	Report on identification and citation service case studies	LU	Report	28 Feb 2019	28 Feb 2019
WP4	D4.2	D16	Achievements report on open interdisciplinary case studies highlighting the common operation of networks	INRA	Report	31 Oct 2018	29 Apr 2019
WP17	D17.5	D77	ENVRIPLUS sustainability plan	UvA	Report	30 Jun 2019	29 Apr 2019
WP4	D4.3	D17	Reference document for methane harmonized monitoring	INGV	Report	28 Feb 2019	29 Jul 2019
WP10	D10.4	D44	RI strategy for flexibility and sustainability	CNRS	Report	30 Jun 2019	29 Jul 2019
WP17	D17.2	D74	Updated version of the ENVRI strategy	FMI	Report	30 Jun 2019	29 Jul 2019
WP18	D18.4	D81	Synthetic report on best practices of linking RIs and societal needs, economics and policy	INRA	Report	30 Apr 2019	29 Jul 2019
WP18	D18.5	D82	Developing a common approach to fostering innovation partnerships between the environmental RI s and the private sector	EMSO ERIC	Report	30 Jun 2019	29 Jul 2019
WP19	D19.7	D90	Final DMP	UHEL	Report	31 Dec 2018	29 Jul 2019
WP5	D5.3	D21	A definition of the ENVRIPLUS Semantic linking framework at conceptual and formal levels.	UvA	Other	30 Apr 2018	30 Apr 2018
WP6	D6.2	D25	A report on negotiations with publishers, providers of existing data citation systems and other scientific organisations on implementing a global data citation system.	LU	Report	30 Apr 2018	30 Apr 2018
WP8	D8.5	D35	Data provenance and tracing for environmental sciences: system design	EAA	Report	30 Apr 2018	30 Apr 2018
WP18	D18.3	D80	Report on user community workshops	UvA	Report	28 Feb 2019	30 Apr 2019
WP2	D2.3	D10	Harmonization strategy report toward support to space mission and assimilation systems based on RI data	CNR	Report	31 Mar 2019	31 Jul 2019

WP19	D19.2	D85	Overview report of all annual meetings, General Assembly and Steering Committee meetings	UHEL	Report	30 Apr 2019	31 Jul 2019
WP7	D7.4	D30	Performance optimisation services for environmental ESFRI projects: prototype	UvA	Demonstrator	31 Oct 2018	31 Oct 2018

Summary of the project milestones

The project achieved 3 Milestones during this reporting period. They are shortly summarized below.

MS number	Milestone Title	Lead Beneficiary	Delivery Date
32	Ethical Consensus guidelines report plan	UvA	30 Apr 2018
33	e-Training material and TEDlike seminars 14	UNILE	31 Aug 2018
21	Training course for teachers delivered	INGV	01 May 2018

1.1 Objectives of the Project and Progress beyond State of Art

The overall objectives of the project as described in the Description of Action document:

The objective of ENVRIplus was to provide common solutions to shared challenges for European Environmental and Earth System RIs in their efforts to deliver new services for science and society. ENVRIplus brought together the current ESFRI roadmap environmental and associated fields RIs, leading I3 projects, key developing RI networks and specific technical specialist partners to build common synergic solutions for pressing issues in RI construction and implementation. ENVRIplus was organized along 6 main objectives.

In the following section, we summarize the key progress achievements in each of the main objectives, derived from the explanation of work part (section 1.2) of this document.

1) Improved the RI's abilities to observe the Earth System, particularly in developing and testing new sensor technologies, harmonizing observation methodologies and developing methods to overcome common problems associated with distributed remote observation networks;

- The ENVRIplus Methane scientific cruise has been undertaken in the Romanian sector of Black Sea coupling different methodologies for quantifying marine methane transfer from the sediment to the atmosphere. Twenty scientists from four different research infrastructures (RI) in Europe (EMSO, ICOS, ACTRIS, and EuroFleets) combined their forces for this expedition;
- The socio-economic impact of RIs and their contribution to innovation in Europe and globally were outlined in one document;
- Opportunities and applications of unmanned observatories for usage across RIs were explored and described;
- Usage, deployment and best practices of sensor web enabled networks were investigated and the results and recommendations were documented;
- Documents demonstrating robust data provision, reporting the improved robustness in extreme conditions and describing the set of standards for the qualification of instruments towards extreme conditions were developed;

- The development of a prototype pCO2 profiling float, a measurement of a crucial interest for all the marine domain RIs, has been completed.

2) Generated common solutions for shared information technology and data related challenges of the environmental RIs in data and service discovery and use, workflow documentation, data citations methodologies, service virtualization, and user characterization and interaction;

- Reference model was further refined and promoted among other communities;
- Identification and citation in environmental RIs were highlighted, available technologies were reviewed and common services for these operations were developed;
- The awareness was raised around publishers, providers of existing data citation systems and other scientific organisations of what environmental and climate research infrastructures view as essential identification and citation-related services that are required in order to reach the ultimate goal of a "global data citation system";
- Three use cases related to data citation were organized. The cases illustrated, in their own ways, the tight connections between Identification & Citation and the other "pillars" of research data management practices, such as Cataloguing, Metadata management, and Provenance.;
- Innovative solutions and approaches aiming at enhancing the data processing practices currently in place in each RI were suggested;
- The technology for scientific data analytics and infrastructure optimization were developed and released and the exploitation of this technology was supported by several use cases;
- A lot of work was done towards improved data curation and cataloging. The work is described in two deliverables on Data provenance and tracing for environmental sciences: system design, prototype and deployment;
- Nine science demonstrators were implemented in order to validate the results of the ENVRIplus Theme 2 developments by showcasing software deployments onto computing and data infrastructure and through investigating how to operate developed services within RIs.
- A book summarizing the Theme 2 findings will soon be published by Springer.

3) Developed harmonized policies for access (physical and virtual) for the environmental RIs, including access services for the multidisciplinary users;

- A set of guidelines and a master-plan to facilitate open access that can be directly implemented by the RIs was delivered;
- A wider-scope governance strategy describing which performance criteria for open access and list of performance indicators together with the principle options for developing an adequate and sustainable access cost model at individual RIs was described;
- Through the organization of multidisciplinary access programme within WP11, ENVRIplus was efficient in promoting the mobility of environmental researchers and fostered international collaboration. The requirements and multidisciplinary criteria have achieved a synergistic approach for advancing the integration of research activities across environmental domains at the RI and facilities and for pushing multidisciplinary collaboration among the scientific user communities world-wide;
- The ENVRIplus pilot programme has been very successful in implementing the multidisciplinary access programme and supporting high-quality projects. They were a first step towards cutting-edge research at the interface of different environmental domains. During the third reporting period, seven out of twelve projects have been supported.

4) Investigated the interactions between RIs and society: Find common approaches and methodologies how to assess the RIs' ability to answer the economical and societal challenges, develop ethics guidelines for RIs and investigate the possibility to enhance the use Citizen Science approaches in RI products and services;

- A prototype that provides a centralized interface for searching across multiple site catalogues was developed. It covers the fundamentals of interoperability, aggregating site information and the implementation of a prototype for a federated catalogue connected to three selected catalogue systems.
- White paper on general guidelines, recommendations, and best practices on communication and decision-making under uncertainty for environmental hazards and natural disasters was also delivered and well promoted.
- Task 12.1 finalized the work on building the new ENVRI RM module to characterize 'societal relevance' of RIs with respect to published Grand Challenges systems and submitted deliverable D12.1
- Ethical label was developed, giving essential information about the ethical and social implications of the RI's output; The Ethical guidelines were as well developed, as a

result of an extensive survey of relevant literature produced by scientific and professional organizations, institutions, and bodies focusing on applied ethics for research and other professional activities conducted by RIs.

- The work in this theme also facilitated the exchange of information and knowledge regarding the citizen science activities, allowing them to quickly identify and address frontier issues for both citizen science and environmental science in general.

5) Ensured the cross-fertilisation and knowledge transfer of new technologies, best practices, approaches and policies of the RIs by generating training material for RI personnel to use the new observational, technological and computational tools and facilitate inter-RI knowledge transfer via a staff exchange program;

- The objectives of developing and delivering adequate training materials for fermenting the understanding and use of the ENVRI RM has been achieved;
- Successful development, population and the maintenance of the Virtual Training platform for the use of environmental RI products;
- Successful organization of two summer schools;
- In collaboration with the RI-Train project, the RI senior management was trained to improve their managerial and leadership skills. They were also taught how to build a sustainable governance and funding for their infrastructure. Communications specialists working in different RIs received two full-day lessons focusing on efficient tools and strategic approach towards the communication activities. The trainings has introduced the RI leadership to RI-Train training program and reminded the benefits of such trainings for a successful management of an infrastructure;
- Serious Gaming was further developed into 4 topics (Biodiversity and Ecosystems, Hydrogeological Risks, Computing Environment and Marine Science) including the development of game guides for the teachers and the students, as well as the demo of the Serious Game and the complete Serious Game for each topic. The game was promoted at several events. The winners of the serious game were awarded during the 7th ENVRI week and Final dissemination event in Brussels;
- Successful organization of a training of Secondary Schools teachers to use the ENVRIplus e-learning platform;
- A third Time-series conference was organized I January 2019 I Tromso;

- Synthesis report on staff exchange and how this service can be sustained by RIs was delivered.

6) Create an RI communication and cooperation framework to coordinate activities of the environmental RIs towards common strategic development, improved user interaction and interdisciplinary cross- RI products and services.

- During the 3rd reporting period, the single (ecosystem) domain analysis, developed by WP12, was widened to the atmospheric and marine domains and mapped the core competences of the domains, sites, existing collaborations, synergies, and joint services. This resulted in to D17.6 providing an integrated overview on the ENVRI landscape by exploring possible scenarios for reinforced cooperation between RIs;
- BEERi members have agreed on several elements that help in building and implementing the new strategy for the ENVRI community. They agreed on a vision statement for the future that describes how European environmental RIs contribute to the society and what the community wants to be and achieve within the upcoming decade;
- The visibility of ENVRI community has been further improved, especially thanks to joint RI communication activities (e.g. open ENVRI community meeting and joint booths at several conferences);
- The RIs agreed on how to structure their cooperation and common activities in a formalized way in future. They agreed to initiate planning for a legal body taking up a few common tasks, but proceed through a step-by-step process. The process resulted in joint work on the required legal arrangements and a business plan underpinning the common ENVRI activities for the upcoming years;
- As for sustaining individual results (tools, services, documents) the sustainability plan revealed that quite some project partners are committed to sustain produced project results. The ENVRI community will build on their plan for a common organization as basis for sustaining other results.

1.2 Explanation of the work carried per WP

WP1 New sensor technologies: innovation and services

WP leader: Laurent Delauney (laurent.delauney@ifremer.fr)

WP participants: IFREMER, EURO-ARGO, CNR, CNRS, FZJ, INGV, UniHB, INRA, EAA, MBA, PLOCAN, CEA, GEOMAR.

Introduction

The scientific observations made in the RIs rely on measurement instrumentation. High performance instrumentation development is a highly innovative domain, intensive and extensive parameters ranging from atmospheric concentration and column amount of trace gases and aerosols to ocean salinity to Earth crust motions. While technologies evolve, only a few fundamental physical principles underlie all measurements. There is ample opportunity for collaborative work across disciplines to share development and application efforts and generate innovation. The objectives of this WP were the following:

1) Consolidating RI requirements for new sensors and the associated market
2) Defining common approaches for sensor requirements across disciplines
3) Defining modalities for use of common technical unmanned platforms and application
4) Promoting the use of Network-enabled sensors across the RIs

Task 1.1 – Emerging technologies, emerging market: fostering the innovation potential of research infrastructures

Over the final reporting period the participants (CEA, CNR, FZJ, Euro-Argo) consolidated the achievements of the *1st EU Environmental Research Infrastructures – Industry Joint Innovation Partnering Forum* held in Grenoble during the 4th ENVRI week and completed the analysis of emerging environmental observations technologies (sensors and platforms) that could be of reciprocal interest for RIs and industry, and that represent a natural way to foster a linkage that helps to develop all their market potential.

- CEA has mobilized and coordinated a network of ENVRIplus internal experts to assess the future development of new technologies, products and services for the needs of research infrastructures. CEA has designed the research and completed the

writing of the deliverable based on expert assessment and inputs gathered after the Grenoble industry forum (that took place in 2017);

- FZJ contributed significantly to the discussion on potential industry partners who provide relevant measurement technology to the RIs and should be included in the market landscape analysis of the environmental research infrastructures, and provided input to Deliverable D1.1 "Emerging technologies, emerging markets: Fostering the innovation potential of research infrastructures";
- CNR(SIOS), (a) continued dialogue with the identified Italian companies for atmospheric domain (mainly those with experience and activities in extreme environments). Aim in the future is to connect them to specific actions and services promoted by the ENVRI Innovation-Cooperation Officer Network (cfr. D18.5). It also (b) foster innovation issues in the frame of SIOS also considering the need for polar regions to improve observation techniques to reduce footprint of pristine environment and increase monitoring capabilities. CNR (SIOS) continued to promote the connection of ENVRI community with metrology community in relation to the target to develop new standards, in this way helping to connect activities of WP1 and WP2;
- Following the collaboration set up with two European private companies as a result of the 2017 ENVRIplus Industrial Forum, the Euro-Argo Eric has pursued its development of innovative capabilities for profiling floats, being able to better assess the technological and scientific outputs of pCO2 and pH sensors for biogeochemical applications. In particular, fruitful collaboration on calibration and validation of data has been achieved with the XYLEM Aanderaa SME, leading to a successful completion of the prototype development undertaken in the task 1.2 of the present work package.

Significant results

Deliverable 1.1 is an important document that contribute to highlighting the socio-economic impact of RIs and their contribution to innovation in Europe and globally.

Deviations, reasons for deviations and corrective actions (short paragraphs foe reach deviation)

Delay in writing D1.1 has been recovered and the final deliverable has been delivered.

Task 1.2 Common methodologies for inter-comparisons and joint field tests

This task relies on the implementation of two use-cases, one more specific to EURO-ARGO expertise - instrument development in the Marine domain for measurement of pCO2/pH in the oceans, one at the boundary of EURO-ARGO fields concerning the lidar and light measurements in the atmospheric domain.

use case 1 - case of carbon-dioxide marine measurements

This final reporting period was devoted to the achievement of the development of the pCO2 profiling float prototype. Successful integration was provided by the Euro-Argo Eric partner Ifremer for the build of the float in late 2017, and several actions have been held by the Euro-Argo Eric staff for the full assessment of the prototype use.

A complete series of test was performed in the Euro-Argo ERIC facilities for the engineering validation: (1) test in a pressure tank with a true mission simulation to verify the design of the hardware and software configuration, followed by a long lasting (two weeks) testing in pseudo-real conditions in the Ifremer's seawater basin. As a result, the prototype float has reached the technical and scientific requirements allowing a deployment for a true validation in open ocean.

In September 2018, a field campaign has been organized jointly with CNRS and UPMC University in the Ligurian sea and the prototype float has been deployed during one week in the DYFAMED scientific area. Euro-Argo ERIC staff has organized the logistics of the cruise, performed the at sea deployment and recovery and processed the data. The achievement of this cruise allowed to finalize the deliverable D1.3 describing in details the development of the prototype and the first technical and scientific results.

A second field campaign has been organised in June 2019 off the French Brittany coast in collaboration with the local university for a final validation of the pCO2 data. The prototype is at sea at the present time, and will be recovered in autumn 2019.

Based on the experience gathered with the development of the pCO2 prototype, measurement of a crucial interest for all the marine domain RIs, the work on the deliverable D1.2 has been finally been possible within an ENVRIplus community collaborative effort. This deliverable describes the various and different requirements for the marine observation networks, a key issue for completing any common intercomparison exercises.

Significant results

- The development of a prototype pCO2 profiling float has been completed, and the corresponding deliverable D1.3 delivered in 2019;

- The deliverable D1.2, thus delayed to the end of the period, has been finally delivered in July 2019.

Deviations, reasons for deviations and corrective actions

The two deliverables D1.2 and D1.3 where both pending with a significant delay from the expected delivery date. These documents were strongly dependent on the result of the complex prototype development and the schedule of the field campaigns, which are hardly organised in a short-term period, as they need a heavy logistics, ship time opportunity, suitable equipment on board for inter-comparison and validation, and staff availability. By the end of the project, the Marine domain collaboration has proven that efforts are still to be pursued for a better integration of cross-networks measurements, and significant discussions have started in order to continue the collaborative effort after the ENVRIplus project.

Task 1.3: New common observation prototyping: the case of drones

Task 1.3 aimed to investigate the usage of unmanned marine and aerial vehicles in the participating RIs alongside the light-weight payloads that are carried by such vectors. The task aimed to investigate perspectives and best practices for drones and payloads usage as well as an exchange of knowledge between RIs, especially between marine drones operating ones and aerial drones operating ones.

During the last reporting period CNR finalized the development (started in 2017) of a prototypal low-cost payload to measure air quality from drones. The payload measures both meteorological parameters (T, RH, air pressure) and various pollutants and gaseous compounds (CO_2, CO, NO_2, O3, PM 2.5 PM 10) and easily fits to any rotary wings unmanned aerial vehicle.

The payload has already undergone multiple test campaigns in Tuscany, Italy as well as two endurance tests in Svalbard, Norway. One of these campaign (with the first version of the prototype) was presented as a poster to the 2018 EGU conference in Vienna, Austria (during the last reporting period). The payload has been loaded on multiple CNR platforms: one propriety of CNR IBIMET (for the Tuscany campaign) and one propriety of CNR ISSIA (for the Svalbard campaigns). The Svalbard campaigns were especially fitting for the purposes of Task 1.3 since they employed at the same time a marine drone and an aerial one for investigating vertical profiles both in the air and in the water in front

of an arctic glacier that would have been too dangerous to approach with a manned mission. The campaigns were a great proof of concept regarding the possibility to exchange knowledge and equipment between different research institutes operating different kinds of drones.

The coordination between RIs initiated within the previous periods of the ENVRIPlus project allowed to exchange ideas between drone-employing RIs that have been finally condensed in the ENVRIPlus deliverable D1.5 "Report on opportunities and applications of unmanned observatories for usage across RIs" that, albeit delayed, allowed to define a state-of-the art regarding the usage of both marine and aerial drones in the participating RIs.

The deliverable detailed the main normative constraints influencing the usage of drones across RIs as well as sketching a potential framework on which to structure a future European transnational access platform allowing the various RIs to have access to an unmanned platform of choice for specific mission objectives.

All the participants to Task 1.3 actively contributed to the ideation and writing of D1.5.

Significant results

- "Exploitation of an Unmanned Aerial Vehicle to characterize the air-sea interface near glacier fronts in the Arctic Region", Ferretti R., Caccia, M., Odetti A., Ranieri A., Carotenuto F., Zaldei A., Bruzzone G. (2018), Geophysical Research Abstracts, 20, EGU2018-6573;
- Deliverable 1.5 "Report on opportunities and applications of unmanned observatories for usage across RIs".

Deviations, reasons for deviations and corrective actions (short paragraphs foe reach deviation)

Delay in writing D1.5 has been made up and D1.5 has been delivered.

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Task 1.4: Network-enabled sensors

Task 1.4 aimed to investigate usage, deployment and best practices of sensor web enabled networks. The task investigated sensors standards, interfaces, maturity and shortcomings of sensor networks, especially the ones composed by large number of miniature sensors.

During the last reporting period CNR ANAEE condensed the experience and knowledge gathered in the previous ENVRIPlus periods in the deliverable 1.6 “Results and recommendations from the comparison exercise of sensor embedded processing practices.” D1.6 detailed the state of the art for low-cost dense sensor networks with a programmable microcontroller unit as well as the main communication standards and the main shortcomings pertaining the usage of these kind of sensors. The deliverable included also the expertise from the other RIs especially regarding the usage of marine sensors.

CNR ANAEE also continued its development of sensor meshes, low-cost sensor networks where each node shares gathered data by short-range transmissions. This allows the data stream to jump across sensors up to a father node that has full web-enablement and can transmit data over the net up to a main database. Node redundancy (i.e.: the ability of each node to intercept the data stream across multiple neighbouring nodes) make the system robust do failures in the field and allows it to be deployed in areas where no internet connection is available. These first prototype are to be deployed as monitoring networks for agricultural areas, but the underlying concept can be translated for the necessities of many other RIs.

Significant results

D1.6 “Results and recommendations from the comparison exercise of sensor embedded processing practices”.

Deviations, reasons for deviations and corrective actions (short paragraphs foe reach deviation)

Slight delay with the delivery of D1.6.

WP2 Metrology, quality and harmonization

WP leader: Vito Vitale (v.vitale@isac.cnr.it)

WP participants: CNR, EURO-ARGO, CNRS, IFREMER, FZJ, INGV, NERC, UvA, EAA, UiT, EuroGOOS, UNITUS, CEA, NILU

Introduction

An overarching objective of WP2 was to address, in a broad sense, the crucial issue of data heterogeneity. Harmonization of the heterogeneous data flowing from research infrastructures (RIs)/networks is important to:

- assure our capability to obtain a correct picture of actual status and trends of the Earth system;
- enable the unbiased usage of data series in modeling studies;
- increase integration of ground-based observations with space-born ones and allow RIs/networks to meet needs of satellite users.

Data flowing from observation networks has to be harmonized in a scientific and metrological sense: improving comparability through RIs and traceability to standard (SI) units and metrological norms; developing new standards when necessary; harmonizing calibration procedures; developing cross-domain methodologies for an analysis of ino-mogenous time series. WP2 aimed to produce significant advances on these topics, mapped the landscape across RIs and increased awarness of the above mentioned topics, shared experience and best practices, and last but not least, developed concrete actions for specific cases/parameters.

Three broad topics were addressed in WP2: metrology and traceability (task 2.1, task lead CEA [ICOS]), “handling” of heterogeneities in data series (task 2.2, task lead INGV [EMSO], and enhancing use of RIs for satellite validation and services data transmission (task 2.3, task lead CNR [ACTRIS]).

Specific objectives of this WP were:

- Address the needs for standardization of measurements and methods across the RIs;
- Develop new services to promote use of heterogeneous time series produced by RIs;
- Develop new services to meet requirements for using heterogeneous networks for satellite validation.

During this reporting period (RP3), substantial progress was made on all of the WP activities, and expected results were achieved. In addition to activities related to each of the three broad topic, cross-RI discussions, involving all partners, took place at the ENVRI weeks during 2018 and 2019, related to interactions across all of Theme 1, with a particular focus on a legacy perspective, and on the sustainability of WP2 achievements after the end of the project in the frame of the Theme 1 activities. WP lead reviewed the deliverables and ensured a homogenization and sharing of information across Theme 1.

Task 2.1: Metrology & national Institutes-standards

The work performed under T2.1 resulted in the production of D2.1 "Report on traceability and standards in Environmental RIs".

D2.1 is a report on metrology standards and practices at use in research infrastructures participating in ENVRIplus. It also identifies metrology needs, providing relevant concrete test cases where metrology developments are being made. Section 1 of the report identified a list of the parameters common to at least 3 RIs. These parameters were the focus of the metrology gap analysis. Section 2 describes metrology practices with core parameters measured by the research infrastructures that can serve as a basis for an exchange of good practices across ENVRIplus. The associated quality assessment and quality control procedures were also described in detail. Section 3 gives a panorama of the existing institutional metrology: BIPM at the global international level, EURAMET in Europe and new initiative in the frame of WMO called the GCOS Surface Reference Network (GSRN). The section ends with a general assessment of the traceability to standards in the RIs of ENVRIplus.

Based on the funding opportunity and the gap analysis made in the project, several concrete testcases (described in section 4) were initiated or further promoted, where metrology improvement relevant to ENVRIplus RIs are being developed via dedicated projects. The list includes: a new WMO standard for eddy covariance (EC) measurements, standards for carbon dioxide in air, Seawater acidity measurements, Black Carbon measurements and standards, and radon measurements.

Information, analysis, best practices and recommendations reported and summarized in D2.1 are the result of a very large amount of activities and actions developed by involved partners along the whole project. Below is the list of the most significant developments:

Constitution of a metrology network;

Organisation of meetings to liaise with National Metrological Institutions (NMIs):

Workshop on Global to Urban Scale Carbon Measurements at BIPM (July 2015) HIGHGAS project meeting, coordination NPL/UK.
Arctic metrology workshop, April 2015, Torino, Italy
EURAMET's 10th General Assembly, 23rd to 27th May 2016, Oslo, Norway
A dedicated session with NMIs at the International Conference on Metrology for Meteorology and Climate - MMC 2016, Sept 26 to 29 in Madrid, Spain;
Survey activities and analysis of results, aiming at mapping the landscape of the ENVRIplus RIs with respect to traceability to standards and SI units, needs of RIs for standardisation, and NMI involvement in the RIs. We were able to involve 11 RIs pertain to all domains. With respect to correlation of observations a set of 15 common parameters were identified. Extensive interviews were conducted with metrology contact points in various RIs.
Support for the test case presented in the report
Metrology lab test esp. concerning water vapour correction when measuring GHGs.
The activities during RP3 devoted to improve ENVRI RIs operations with respect to metrology and traceability issue include:
the calibration chamber for IAGOS water vapour and temperature sensors was extended with a cryogenic dew/frost point hygrometer and equipped with novel control electronics. The implementation of a traceable temperature sensor which is calibrated against a reference temperature is ongoing. New calibration references for relative humidity and temperature will be included during the current revision of the standard operating procedures.
in frame of SIOS, the work to realize a metrology lab in the Arctic, thanks a cooperation with with INRIM (Italian metrological Institute) and METEOMET project (http://www.meteomet.org/) was completed. The metrology laboratory is now fully operational and allows the calibration of temperature and pressure instruments, the characterisation of sensor dynamics, and the evaluation of influence of real environmental conditions on the values measured there. Future implementation plan includes an extension of the calibration capabilities to more parameters as well as to evaluate the measurement uncertainties for radiation measurements in addition to metrological parameters.
in the frame of ACTRIS, NILU helped to connect the ENVRI community and the CEN/TC 264/WG 32 working group on "Ambient air – Particle number concentration", and the EURAMET EMPIR metrology project AEROMET. In the reporting period, CEN/TC 264/WG 32 finished its work on the technical specification for "Determination of the particle number size distribution of atmospheric aerosol using a Mobility Particle Size Spectrometer MPSS", while AEROMET project has assessed the quality of commercial MPSS instruments,

as well as the quality of novel methods for online observation of the elemental composition of atmospheric aerosol particles. Both observations are relevant for the air quality measurements.

Significant results

- Implementation of the ENVRIplus metrology concepts and recommendations for the quality control of the IAGOS relative humidity and temperature measurements;
- Deliverable D2.1 - Report on traceability and standards in Environmental RIs;
- Consolidation of a metrology network connecting metrology focal points in different RIs;
- Implementation of an Arctic metrology lab at Ny Alesund (Svalbard).

Deviations, reasons for deviations and corrective actions

No significant deviations from the Work plan.

Task 2.2: Heterogeneity in time series, innovative user services

Work in this task ended as scheduled, i.e. before the beginning of this reporting period. Most important deliverable within this task - D2.2 - Methodology report for handling of data heterogeneity, was released in summer 2017.

During RP3, partners involved in this task, and in particular the task leader, continued the activity with the aim to refine the developed procedures, to increase the number of test cases and to identify requirements to realize a service potentially useful and portable to other RIs.

At the time of the deliverable release, tests to assess suitability of methodologies to detect heterogeneities in Earth science domain (based on the Probability Density Function (PDF) of the Power Spectral Density (PSD) computed on the time-series) to time-series in different domains (marine, atmospheric, Biodiversity), were based on a limited number of cases. So, during this third report period, efforts have been done to add a couple of more test cases: the atmospheric parameters from ACTRIS and the humidity time series from IAGOS.

In addition, from the perspective of the Project legacy, a possibility to implement a service developing basic processing tools for time-series in different domains and possible requirements for this have been analysed in detail. At the moment, the service is imagined to be hosted/operated in virtual environments (i.e. cloud), which can be a very helpful option in assisting data managers in the regular Quality assessment/ Quality Check procedures and support scientists in accepting/discarding /correcting the results.

Significant results

- two additional test cases for developed procedure

Deviations, reasons for deviations and corrective actions

No deviations from the work plan.

Task 2.3: Observation continuum: enhancing use of RIs for satellite validation from and to assimilation and services

The main purpose of Task 2.3 was to describe the state-of-the art of the Research Infrastructures, both in the atmospheric and marine domain, especially with respect to a validation of the satellite measurement and for the data assimilation into numerical forecast models.

The deliverable related to this task, D2.3, in which the status of each RIs as well as concrete examples of developed activity are reported, due at the end of spring 2018, was postponed to the end of the project to give more time to the atmospheric and marine domain to develop respective use-cases. About 10 RIs, four atmospheric and six from marine domain, were involved in the work and provided information on respective activities for validation of the satellite measurements and for data assimilation into numerical forecast models. The results of the workshop "ENVRI meets COPERNICUS" held in Prague, 16-17 November 2016, were used to address the deliverable outline and work during this final part of the project.

Given the fact the atmospheric domain RIs were established independently, the workshop decided to focus on in-situ needs of Copernicus in relation to atmosphere and climate change monitoring, with a particular attention on the challenge of data harmonization, intra and across RIs, for the calibration and validation of selected upcoming Sentinel and ESA Earth Explorers satellites. The Copernicus Atmosphere Monitoring Service (CAMS), one of the six services that make up Copernicus, being the natural counter-part of atmospheric RIs. As the others, CAMS services are based on a judicious combination of satellites Earth observation, in-situ (non-satellite) data and modelling.

In this respect, as part of the work:

- ACTRIS made (and continue to put) a lot of efforts in providing harmonized and in metrological sense scientifically significative high-quality observational data of aerosols, clouds optical and microphysical properties, trace gases concentration. All these will be available for a satellite validation and analysis of the COPERNICUS needs;

- the existing applications of IAGOS data to the validation of spaceborne sensors were reviewed and summarized and a future plan for satellite validation activities was developed. The IAGOS contribution to D2.3 will form the nucleus of a future IAGOS white paper on the use of IAGOS RI Data for Satellite Calibration / Validation Activities;

- the atmospheric component of ICOS contributed to the goals of this task, reporting about and sharing experiences on its active participation to the Copernicus Atmosphere Monitoring Service (CAMS) activities thanks to two specific contracts: CAMS84 and CAMS26.

  CAMS operational services include:

  (a) greenhouse gas surface flux inversions for CO2, CH4 and N2O, allowing the monitoring of the evolution in time of these fluxes;

  (b) Climate forcing from aerosols and long-lived (CO2, CH4) and shorter-lived (stratospheric and tropospheric ozone) agents.

  In the frame of CAMS84 and CAMS86 projects, ICOS observations are used for the verification and validation of the CAMS global and regional forecasts and near-real-time analyses of global atmospheric composition and air quality. Atmospheric measurements of GHG are also used to validate and reduce uncertainties in the climate models. Potentially, such observations could also be directly assimilated in the global forecasting system. In the near future, consolidation and improvement of reliable preparation, transmission and quality control of near real time atmospheric ICOS data shall be performed for CAMS and other potential users.

Marine domain followed a different approach, with respect to atmospheric domain, to demonstrate an added value of the satellite products. Participating RIs concentrated on two user-cases: chlorophyll-A, and BGC-Argo float. Results, experience, best practices as well as the limitations and challenges are extensively reported in D2.3.

With respect to marine domain, research infrastructures such as EuroGOOS contributed to the operation of COPERNICUS Marine Environment Monitoring Service (CMEMS) as well as to operation of the COPERNICUS Emergency Monitoring Service (CEMS), through a broad range of activities, which included: identification of the priorities, enhancement of the cooperation and promotion of the benefits of operational oceanography to ensure sustained observations made in Europe’s seas underpinning a suite of fit-for-purpose products and

services for marine and maritime end-users. In the same framework, Euro-Argo ERIC is now the single most important in-situ observing system for operational oceanography. Its main focus is on maintaining the global array of measurements which is essential for the long-term sustainability and evolution of the CMEMS. Similarly, the objective of JERICO-NEXT is the strengthening and enlarging of a solid and transparent European network of operational services for the timely, continuous and sustainable delivery of high-quality environmental data and information products related to marine environment in European coastal seas.

The main message that emerges from the work of this task and information provided through deliverable D2.3, is that the benefits of integrating ground-based observations together with the satellite data is bidirectional, as satellite data improve the information at surface and *vice-versa*. For this reason, future strategies should be implemented to establish tight synergies between satellite and ground-based observations.

UKRI worked on deliverable 2.3 chlorophyll-A use case and marine data management landscape including how this fit with the now active ENVRI-FAIR project. UKRI also linked work package 9 sensor web enablement test case and ENVRIplus theme 1 sensor web activity.

Significant results

- Deliverable D2.3 - Harmonization strategy report toward support to space mission and assimilation system based on RI data*;*
- Formulation of a strategy for the use of IAGOS RI Data for Satellite Calibration / Validation Activities which will form the nucleus of a future IAGOS white paper on this topic;
- Workshop contribution: Presentation of joint IAGOS and ACTRIS infrastructure and validation activities in the framework of ENVRIplus at the German National Remote Sensing Validation Workshop, held in Bonn on 28 to 30 May 2018.

Deviations, reasons for deviations and corrective actions

A project amendment organized in the beginning of RP3 allowed to postpone the due date of deliverable D2.3. This deadline extension enabled atmospheric and marine RIs to better develop the planned work and achieve all expected results.

WP3 Improving measurement networks: common technological solutions

WP leader: Helle Pedersen (Helle.Pedersen@obs.ujf-grenoble.fr)
WP participants: CNRS, CNR, UniHB, CEA, IFREMER, INGV, NILU, UNITUS, FZJ

Introduction

The objective of WP3 is to share experience and find joint solutions for field installations, often located in remote areas and in some cases under extreme conditions. Three specific themes are treated in WP3: energy production and storage (task 3.1, task lead CNRS [EPOS]), extreme conditions (task 3.2, task lead CNR [SIOS], and data transmission (task 3.3, task lead UniHB [EMSO]).

Specific objectives of this WP are (See DoA):

1.To review the existing technologies addressing energy production at remote sites, data transmission and adaptation of technologies to extreme conditions used by RIs;

2.To propose innovative solutions including testing of components, subsystems, materials, techniques and dedicated software to improve networking at distributed RIs;

3. Evaluate potential for improved standardization of transmission technologies among RIs and benefits for the cluster.

During this reporting period, substantial progress has been made on all of the WP activities. The transverse activities, which involved all partners, were close to finalization at the end of RP2 through the cross-RI survey. All partners did continue to interact on the survey also in the beginning of RP3. Cross-RI discussions, also involving all partners, took place at the ENVRI weeks, with a focus on interactions across all of Theme 1work packages rather than on WP3 only, including interactions around sustainability of the Theme 1 activities. Most of RP3 activities are consequently focused around the activities of the main partners in WP3. The CEA was strongly involved in review of all deliverables to homogenize and share information across Theme 1.

Transverse activities

Lead and milestone report: CNRS. All RI's and involved organizations contributed.
At the outset of the project (1st ENVRI week), the participating teams decided that the review of existing technologies within the three main themes (energy, data transmission and extreme conditions) should take place through a joint questionnaire, in order to homogenize and optimize the questions and therefore maximize the feedback. During the first periodic report, the questionnaire was public, but few responses were available. The questionnaire remained open into the beginning of RP3, but all the responses (24) were already available at the end of RP2, so the preliminary results presented after RP2 remain valid for the final report of RP3 and shall not be repeated here.
The results were used in two ways: first, each task extracted the information relative to the task activities. Second, a standardized catalogue was made, presenting field installations for different RIs. This catalogue is available to the ENVRIplus community. This catalogue forms stand-alone Chapter B of Deliverable 3.1.

Task 3.1: Enhancing observing capacity from remote sites: improving energy production units

A core activity of Task 3.1 is to set up a test site for evaluation of energy solutions in natural, harsh conditions. Col du Lautaret is located at 2100m altitude in the French Alps and is characterized by substantial amounts of snow and wind. Partners (CNRS - EPOS and ANAEE-SAJF, in collaboration with CNRS - ACTRIS) installed the ENVRIplus energy field test, set up on the technical test platform TETRA dedicated to ENVRIplus, with special emphasis on solar panels and windmills. Figure 1 shows the installation and the main elements tested.

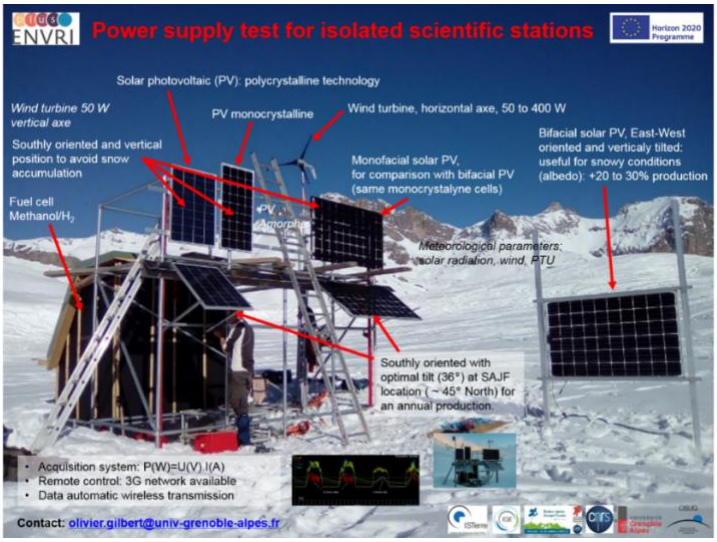

Figure 1. Illustration of the field tests at Col du Lautaret onto the TETRA platform at SAJF.

One (temporary) staff member coordinated all the field activities, with the involvement of additional personnel from CNRS (EPOS, ANAE, ACTRIS) and the University of Grenoble Alps. The field activities were concluded in the first part of RP3 and a major effort was subsequently dedicated to elaborating stand-alone documents that formed D3.1 (see below).
In parallel with the tests under field conditions, CNRS (ACTRIS) conducted technical test on lead-acid batteries in controlled, cold conditions, using a cold climate chamber, with the temperatures down to -50°C. The outcome of these tests is included in D3.1.
In addition to these land-based tests, Ifremer shared information for oceanic observations, through their participation to the autonomous report « Onboard energy of autonomous stations – marine domain» coordinated by Loic Dussud. The document presents best Practices on buoys, profiling floats, gliders, surface unmanned vehicles, long term benthic stations, etc. and is included in D3.1.
Deliverable 3.1 (177p) marks a key achievement of WP3, as it is formed of autonomous chapters that can be extracted and distributed to different audiences within all of the ENVRI community RI's. This is why we here give some details on D3.1. Annex I can be distributed whole or in parts for different purposes. It comprises a general introduction associated with energy production and storage (Chapter A), a catalogue of the energy solutions used across ENVRI RIs (Chapter B, stand-alone), outcomes of energy production and storage (Chapters C and D at the SAJF test site) and Technical Field Recommendations and Summaries (Chapter E). This last chapter is composed of A4 (recto-verso) summaries, one page per type of equipment, that can stand alone as used practical guides for field engineers of different levels

of expertise. The report on On-board energy of autonomous marine stations is included as a substantial stand-alone report, as Annex II.

With the aim to complement Col du Lautaret testing site, creating subsidiary facilities to test technical solutions in more extreme environments, CNR(SIOS), continued to work with the Italian SME company, Wind-Kinetic (http://wind-kinetic.com/) to install solar and wind systems at the ISAC station on the top of Mt. Cimone (Appennine chain - 80 km N-W Bologna) a well as at Ny Alesund in the Arctic. Hardware were prepared at the factory and preparatory work for installation at Mt.- Cimone and Ny Alesund were performed. During summer 2018 wind systems for NYA were sent to the Italian station Dirigibile Italia. Current plan is to complete the implementation of the system in spring 2020.

CNR(SIOS) also continued to work with Arctic portal (https://arcticportal.org/) and the Arctic Council project AREA (http://arcticrenewableenergy.org/) to put our evaluations of solar energy potential in the Arctic determined from a dataset of 20 years at disposal of the Arctic Renewable Energy Atlas.

Significant results

- Finalisation of the TETRA test equipment at SAJF as a sustainable test site which can be used across all of ENVRI RIs;
- Stand-alone reports included in D3.1: catalogue of energy solutions, field guides and outcomes of field and laboratory tests;
- Solar energy potential climatology on Arctic Renewable Energy Atlas

Deviations, reasons for deviations and corrective actions

D3.1 was also be finalized earlier than expected, because the ENVRIplus funding made it possible to proceed the on-site using temporary staff fully dedicated to the ENVRIplus project.

Task 3.2: Testing robustness towards extreme conditions

Task 3.2, coordinated by CNR(SIOS), has two distinct elements. The first one is a review of existing standards for operation in extreme conditions, aiming to prepare an adapted new set of standards for the ENVRIplus RIs. The second one is devoted to develop technical solutions to improve reliable use of instrumentations in extreme environments.

In relation to the first element, the performed work resulted in deliverable D3.2. It was delayed, but the situation was recovered through a revision of the workplan elaborated in RP2 and support from IFREMER. Following the new workplan:

- we reviewed existing environmental design/test tailoring process approaches from the point of view of Environmental RIs in different domains;
- We fixed relevant steps of instrument life cycles in different domains, we selected suitable test-methods and best practices/procedures for 24 "categories" covering a wide spectrum of stress conditions. When appropriate, categories provided by single standards have been merged into a broader category, or new categories and groups of test methods have been created. Scope of this work being to provide building blocks from which RIs engineers could address systematically the qualification problem (tailoring process) and develop for specific case a robust comprehensive procedure (engineering plan);
- we elaborated a set of recommendations as well as we performed an analysis of facilities, testing lab, and services at disposal to qualify instruments to extreme conditions, as provided by the private sector and the public sector, including ENVRI community;
- as final work, we elaborated a sustainable plan through which a dedicated service could be implemented for the whole ENVRI community.

In relation to the second element, the performed work resulted not only in deliverable D3.4, but also in the development of a flexible Programmable Logic Control (PLC)-based system to control and regulate in extreme environments temperature and humidity at which instrument can operate. We focused our efforts on temperature and humidity since these 2 parameters were indicated by answers the questionnaire, as key limiting factors for RIs operating in extreme conditions. With the aim to make the work suitable to as many as possible environmental and operational conditions and to be able to cover different domains, we developed an electronic board and related firmware able to pilot several technical solutions for regulating/controlling temperature and relative humidity inside instruments. In detail:

- we extensively reviewed existing technology to regulate T and RH, selecting for our PLC-based control unit the most suitable to support RIs operations/activities in remote and extreme environments;
- for them we developed a PCL-based control unit/tool, based on two electronic boards (we separated power operations from the more delicate signals/commands handling

and generation as well as data acquisition) and dedicated firmware providing the intelligence to drive each of the three selected technologies. We include in the development capability to control as much as possible thermal gradients inside the heating box in addition to the target temperature;

- we tested in real conditions performances and efficiency of the developed hardware and software. To this scope (i) thermoregulated systems (proofs of concept) have been designed and then in large part realized, and (ii) a test plans has been prepared and in large part implemented. Test results clearly demonstrate capability of our control unit and associated algorithms to control temperature in a very extended range of environmental conditions.

Developed control unit, joint to recommendations and information provided in this deliverable, should enable ENVRI RIs to address, in the right way, issue related to operational temperature control in a very wide spectrum of cases and conditions. In order to demonstrate the need and usefulness of the work we did, and of the PLC-based control unit we developed, we performed a market analysis in relation to thermoregulating systems. Results of this analysis are also provided in D3.4.

Significant results

- Deliverable D3.2 - New set of standards for the qualification of instruments towards extreme conditions;
- Deliverable D3.4 - Report on improved robustness in extreme conditions;
- PLC-based control system for temperature and relative humidity;
- Systems to test control unit in different real conditions and for different regulating technologies (proof of concept);
- Characterization of control unit performances and efficiency in different conditions.

Deviations, reasons for deviations and corrective actions

Delays of D3.2 (expected in Oct 2017) and D3.4 (expected in April 2018). Revised workplans elaborated during RP2 (for D3.2), including support from IFREMER, and RP3 (for D3.4). The deliverables were delivered for D3.2 in August 2018 and for D3.4 in March 2019.

Task 3.3 Robust data provision: data transmission and near real time QC

The aim of this task was to improve and share technologies on near real time data provision and quality control, associated with adequate traceability.
During the 7th ENVRI week, UniHB and FZJ organised a best practices workshop, under the umbrella of the ENVRIplus experience sharing symposium scheme, which aimed at promoting harmonisation of quality control procedures within environmental RIs in different fields. The workshop resulted in a set of recommended actions to be further elaborated within ENVRIplus, ENVRI-FAIR and projects related to The Future of Seas and Oceans Flagship Initiative. These actions included detailed recommendation regarding QC procedures and their lineage and traceability using e.g. the PROV-O standard, minimal flagging schemes as well as handling of raw data and the consideration of community specific best practices.
The overall approach of this task was to promote standardization concepts and to move standardisation closer to the actual hardware, i.e. the sensor or instrument. A special focus thus (UniHB) was on the use of OGC Sensor Web Enablement (SWE) compliant standards and Semantic Sensor Network Ontology (SSNO) compliant ontologies. Both standards ideally shall be used as early as possible within the data acquisition workflow of the related research infrastructures as the effort to include the needed metadata at a later stage calls for an extra effort of data collectors and data management to assign the right information to the related data set. However, the conceived standardization concept employing OGC and SSNO approaches is difficult to implement as typically the manufacturers are using their own proprietary sensor hardware as well as software solutions where any changes are basically impossible. Consequently, no standards supporting, ready-to-use solution for data transmission existed until now.
UniHB CNR as well as FZJ, decided to aim to concretize' the beforementioned standards-based concepts at both software as well as the hardware level.
UniHB developed a hardware prototype, which is capable to support standardised data collection and transmission as a proof of concept. A radically Open Source (both software and hardware) sensor data harmonisation and communication module (OpenDAM, see deliverable D3.5) has been built which will transform manufacturer specific, proprietary sensor output signals into standardised formats and will enable data transmission via the recognized ENVRI transmission methods (see ENVRIplus deliverable report 3.3) in an open, standardized way. This approach allows the use of standards supporting scalable cloud based NRT data quality procedures as demonstrated within the ENVRIplus use case IC_14 (see deliverable D9.2). To support marine domain RIs this module has been robustly boxed in order to survive harsh, marine environments. The work was carried out in close cooperation with a SME from Spain,

SENSORLAB S.L., http://www.sensorlab.es who has been partner on similar tasks in the past. The actual demonstration mission as described in task 3.3 of the DoA (in order to highlight added value and benefits of selected best practices) will be carried out in the area of Canary Islands during the summer of 2019, logistically supported by PLOCAN. A robotic surface drone, the so-called Wave Glider has been equipped with the OpenDAM module with a suite of standard sensors for salinity, temperature, chlorophyll, oxygen, currents and acoustic background signals. With this set of sensors, the Essential Ocean Variables defined by the IOC Global Ocean Observing System will be covered.

FZJ started to contribute to the development of an open source automated QC tool under the lead of the FZJ-JSC (Juelich Supercomputing Centre), which was introduced by Martin Schultz (FZJ-JSC) during the QC workshop in Riga 2018. This automated QC tool will be a milestone concerning harmonization of QC and FAIR principles and will replace the current QC in future.

CNR developed a system for the centralized, automatic and QC analysis of raw lidar data provided by dislocated lidar with different instrumental characteristics. This system generates aerosol optical properties vertical profiles in a fully traceable way. For each lidar products it is possible to trace back to the lidar system operating the measurement and to all the instrumental parameters used to perform the observations. The raw lidar data are transferred by using a web interface (for humans) or by using a specific API (machine to machine transferring protocol). Using the same interfaces, it is possible to monitor the status of the analysis on specific raw lidar dataset and to download and visualize the generated aerosol optical products.

Moreover, technical QC on the aerosol profiling data were designed, developed and tested by CNR. These QC procedures control both the aerosol optical product from both technical and physical point of view. They run on fly during the data submission phase to the database, allowing for an NRT QC on ACTRIS aerosol vertical profiles for the benefit of the ACTRIS RI operators. Solutions like THREDDS have been implemented for robust data transmission of ACTRIS aerosol profiling data for fostering a wider use of the data thanks to high flexibility of this tool in remote data access protocols. Moreover, the ACTRIS aerosol data are made available also by specific flexible and robust RESTful API and web interface as well.

NILU has contributed to this activity with a report on QA/QC documentation needs in ACTRIS, and the way different observational platforms have implemented these.

Finally, a specific web interface has been developed by CNR to make accessible lidar quicklook in NRT (potentially also in RRT). Such lidar quicklooks are generated out of high resolution calibrated lidar quantities calculated by a centralized system automatically.
A continuous sharing of the developed technologies will continue within the ENVRI community also beyond the end of the project.

Significant results

- Summary statement of QC workshop with recommended actions;
- Deliverable D3.5 Demonstrating robust data provision – data transmission and near real-time QC – employing a use case in a remote ocean region;
- Completion of the OpenDAM data transmission module prototype, and associated field tests, including of the standardized OpenDAM sensor data stream into the PANGAEA Spatial Data Infrastructure;
- Development of a strategy on how to make use of the OpenDAM concept for the EMSO ERIC observation systems Further development of an automatic tool for the QC analysis of raw lidar data;
- Further development of NRT QC on ACTRIS aerosol vertical profile database, including development of RESTful API and web interface for the provisioning of aerosol optical products;
- Development of web interface for the provisioning of lidar quicklooks in NRT (and possibly in RRT).

Deviations, reasons for deviations and corrective actions

No deviations from the work plan.

Conclusions

The work programme of WP3 has been achieved, with advances on sharing information on energy production and storage and field installations in remote sites, and on real time quality control. WP3 has benefited from highly competent and open-minded teams. Most deliverables were submitted in a timely manner, and the exceptions (associated with Task 2) were handled jointly between the relevant teams, the WP3 leader, the Theme 1 leader and the ENVRIplus management office.
A constant priority was to produce the deliverables that can, in parts or as a whole, be used in various contexts. Information on software (related to instrumentation) and instrument

developments has been widely shared within ENVRIplus, and one consolidated and one emerging sustainable test sites have emerged.

This is the last reporting of WP3, and an opportunity to summarize the global outcome of WP3. Theme 1, and within that theme, WP3, gave a unique opportunity of engineers working on instrumentation to interact and cooperate across RIs and domain. This is a new activity within the ENVRI community and it was highly beneficial. It demonstrated to the engineers the benefits of cross-domain interaction for issues concerning instrumentation, and the different groups learning from each other's achievements. It initiated discussions between groups who had previously not interacted, and reinforced cooperation across groups that previously only cooperated sporadically. While such activities are not integrated into the ENVRI-FAIR project, there are ongoing discussions within BEERi considereding under which form to continue them in the future.

WP4 Joint operations across the RI domains

WP leader: Jean-Daniel Paris (Jean-Daniel.Paris@lsce.ipsl.fr)

WP participants: CEA, EURO-ARGO, CNR, CNRS, IFREMER, INGV, UKRI, INRA, EAA, MBA, GEOMAR

Introduction

Some important scientific questions can only be answered by clustering the observations of several RIs. More integrated networks also offer potential to increase the spatial coverage of each individual network by putting in common several sites and participate to opportunities launched by international organization and industry. Activities within work package four were developed to work towards networks integration and generation of important cross fertilization across the research infrastructures. The main aim of this work package was the development of common network protocols, designs, deployment of instrumentation, performance of field testing as well as sharing methodologies and protocols through application of different use-cases. The main objectives of this WP were to address strategies for enhancing common RI field operations and to perform 2 proof-of-concept experiments joining expertise from several RIs.

Task 4.1 Deployment and common management of a network of observatories

INRA provided an extensive white paper highlighting the crucial of complementarity and synergistic relationships among environmental research infrastructures (RIs) towards solving complex environmental questions. This paper reveals the need for more improvement of environmental RIs linkages and coordination alongside scientific communities' synergies. This is crucial in order to actively mitigate the risk on ecosystem services, monitoring stressors with the level of accuracy and temporal frequency and finally enhance spatial coverage of current infrastructure to better assess and understand the state of methane sources in the Arctic regions and its influence on global warming. CEA has completed the work to analyze the evolution of the use case on Arctic observation, with special focus on CH_4. This has involved a literature review and compilation and synthesis of recent research aligned with the opportunities offered by RIs. The synthetized results of this task were presented at the last ENVRI week in Helsinki.

The Marine domain infrastructures were involved in exploring the continuity of the Nitrogen cycle measurements from the sea-bottom up to the atmosphere. Unfortunately, this parameter

is not yet measured by the Profiling Argo floats network, and thus the Euro-Argo ERIC activities could not directly enhance the collaborative effort which derived in the organization of a joint field campaign for Nitrogen exploration (e.g. in the Black Sea). Nevertheless, Euro-Argo ERIC staff participated in the discussions around this topic during the ENVRI weeks and, in the meantime, explored the possibilities to measure the Nitrogen concentration in the water column by autonomous platforms in the future.

Significant results

- Collaboration across infrastructures to establish experiments that look at the combined effect of various drivers;
- The importance of multi-factorial experiments to develop an understanding of the effects of multiple drivers and their interactions;
- Increase public awareness of the societal relevance and the long-term importance of CO_2, O_3, CH_4;
- The adoption of low-cost and fast sensors would constitute a valuable effort in bettering our understanding of carbon assimilation in response to environmental stresses thus supporting ozone-risk assessment;
- Creation of the interactive maps.

Task 4.2. Marine-atmosphere common operation of platforms - Case study on methane from seafloor to atmosphere

Methane is a powerful greenhouse gas. Large amounts of methane are generated within the sediment and a fraction of it is discharged in the water column. Only a small fraction of the produced microbial methane can potentially reach the atmosphere and contributing to global warming but this may increase in the future. Previous studies have shown that methane transfer from the sediment to the atmosphere dependent on site and depth. A systematic model remains to be found.

The Black Sea is characterized by intense methane emissions at various depths and is a good candidate for better constraining the fate of marine methane and its input into the atmosphere. In April 2019, the ENVRIplus Methane scientific cruise has been undertaken in the Romanian sector of Black Sea coupling different methodologies for quantifying marine methane transfer from the sediment to the atmosphere. The scientific motivation behind this cruise is to achieve a holistic understanding of the transfer processes involved. Thus, operations combined multiple expertise for measuring concentrations and fluxes of methane in the different

spheres, from the geosphere to the atmosphere. Twenty scientists from four different research infrastructures (RI) in Europe (European Multidisciplinary Seafloor and water-column Observatory- EMSO, Integrated Carbon Observation System- ICOS, European Aerosol, Clouds, and Trace gases Research Infrastructure- ACTRIS, and an alliance of European research fleets- EuroFleets) combined their forces for this expedition. This involved staff and efforts from the beneficiary institutions CEA, Ifremer, GEOMAR, INGV, CNRS. They developed a joint monitoring strategy for methane quantification. Both in situ measurements and onshore analyses from collected samples were carried out.

First, acoustic surveys of the water column over two methane-seep clusters were performed to map their extent and evaluate the release of free methane. Two sites, characterized by multiple gas flares detected during echosounder surveys, were investigated.

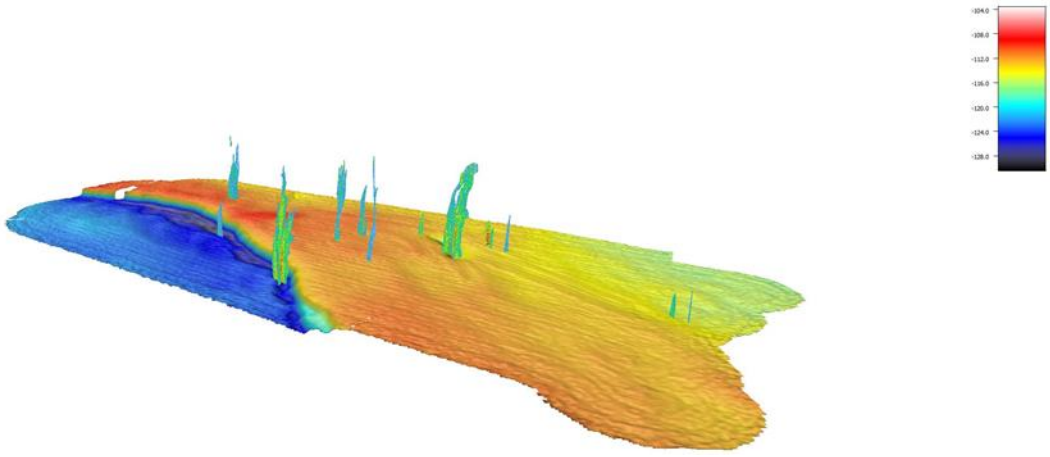

Fig. 1. 3D mapping of the gas flares identified during the campaign from the echosounder EK80.

A seafloor observatory has been deployed close to a selected seep for a five-day monitoring period, and left on the seafloor for long term monitoring after the campaign. Gas-charged sediment as well as seawater over the entire water column have been sampled for laboratory measurements of methane content and isotopic composition. In addition, real-time in situ gas measurements were carried out through the investigated water mass using three different instruments: two in situ spectrometers- the membrane inlet laser spectrometer (MILS) SubOcean [Grilli et al., 2018, Environ. Sci. Technol., 52, doi:10.1021/acs.est.7b06171] and the in situ mass spectrometer (ISMS), and the commercial METS sensor from Franatec. Prior to the cruise, the two Franatec sensors were tested at variable pressures and methane concentrations using a novel high-pressure gas-calibration bench purposely developed for this work within the ENVRIplus project. Simultaneously, continuous measurements of methane

and its main isotopes in the atmosphere were carried out with Picarro analyzers. For the monitoring of the methane emissions in the water column, a seafloor observatory was deployed close to a selected seep for five days.

Overall, there was a good agreement between the in situ measurements of methane using the SubOcean probe and the Franatec sensor. There was also a good agreement between the results obtained from onshore methane concentration measurement at two different laboratories. The major discrepancy was observed from water samples collected near the seafloor where methanotrophy is expected to be more important. Oxygen concentration measured in situ with the ISMS agreed with those measured by the CTD-connected optode. It appears from this experience that the combination of the four RIs is an appropriate cluster to study the dynamics of marine methane from the lithosphere to the atmosphere.

The main outcomes from the cruise can be summarized as follows:

- Methane concentration drastically decreases from the lithosphere to the atmosphere, highlighting its degradation and dispersion along the pathway to the atmosphere;
- The seafloor observatory effectively detects changes in methane concentration over time. In this case, the change was induced by the coring operation, highlighting how sensitive methane emissions are regarding environmental or anthropogenic perturbations;
- The atmospheric measurements show a more important contribution of marine methane to the atmosphere at shallow water depth;
- An in-depth calibration of the in-situ methane sensors is required as function of pressure, temperature and competing dissolved gases which may affecting the output signal.

Significant results

- The Black sea methane cruise has led to outreach and communication by the participating organization and was presented at the Brussels final ENVRI event; see e.g. http://www.envriplus.eu/wp-content/uploads/2015/08/Press-Release_Methane_cruise_ENVRIplus.pdf

Deviations, reasons for deviations and corrective actions

Delay due to the selection of the ship to perform the black sea cruise has led to a late deployment of the campaign. The delay has been compensated by a very fast process of post-cruise analysis of data. This has been ensured by frequent teleconferences and a collaborative meeting at the CEA premises.

Task 4.3 Solid Earth-marine common operation of platforms – benthic stations

CNRS (EPOS) participated in Green Repeater meetings and discussions, and provided expertise for seismological sensors to be used in Green Repeaters and data/metadata formats. CNRS created standardized seafloor pressure, temperature and seismometer data and metadata from the EMSO-MOMAR observatory and provide it to the EMSO-FR data center. It evaluated its availability, accessibility and visibility. Finally, we developed a tool and workflow for the creation of standardized metadata/data from seafloor time-series datasets.

Significant results

- Participation in Green Repeater meetings, evaluation of difference acceleration sensors to use in the Green Repeaters;
- Four years of pressure, temperature and seismometer data put online at the EMSO-FR data center;
- Development of a software suite (obsinfo) for the creation of seismology-standard data (miniSEED) and metadata (stationXML) from seafloor seismology and pressure measurements. obsinfo is Open Source and available online at PyPI and GitHub.

Deviations, reasons for deviations and corrective actions

Not all data put on EPOS-FR site: the seismology data was not easily accessible to seismologists who are used to acquiring their data using standardized web services. We therefore decided to provide seismology data at a site with these web services, with metadata and a link to this data provided at the EMSO-FR website. The *obsinfo* tool was developed for this work (with concurrent EPOS support) and we hope to have the data/metadata online in 2020.

WP5 Reference model guided RI design

WP leader: Paola Grosso (p.grosso@uva.nl) / Zhiming Zhao (z.zhao@uva.nl)

WP participants: UvA, UHEL, EURO-ARGO, EISCAT, CNR, CNRS, IFREMER, FZJ, INGV, UKRI, ETHZ, UniHB, INRA, EAA, MBA, USTAN, EMBL, UCPH, LU, CU, UEDIN, EGI.eu

Introduction

Work package 5 aimed to update and build upon the requirement analysis and technology review already performed in the original ENVRI project to reflect the progress many RIs have made in their architecture design and system implementation, as well as to better reflect the full range of RIs in environmental science. Using the ENVRI Reference Model as a basis, developers working within different RI initiatives can jointly identify operations and services common across RIs, and converge upon standard solutions, significantly improving interoperation within and across domains. An interoperable abstract research environment that can couple those common services with customisable interfaces for specific RIs was designed and prototyped as part of the work package. The objectives of WP5 are:

- To promote interoperability across RIs by providing a novel Reference Model (RM) that should be developed based on the existing ENVRI RM, with consideration of the latest development insights from successful RIs;
- To provide an ontological framework based on the ENVRI RM to describe the requirements and system architecture of RIs, and to link these descriptions with the technologies provided by data and computing infrastructures;
- To provide a design and implementation plan for an abstract yet customisable research environment by engaging RI developers from different domains, in particular via work packages 6–9, and using the updated ENVRI RM.

The work package contained four tasks, the first two tasks finished before this reporting period, and all the rest have finished in this reporting period.

Summary of activity

In this last phase, half of the tasks (T5.1-T5.2) in the Description of Action have already finished. Most of the WP5 activities took place in the context of T5.3 and T5.4. While

supporting RIs for the use cases, we also had some actions that were also related to T5.1 and T5.2. Basically, we:

- Closely interact with the RI developers from different sub-domains, specifically via a number of RI site visits;
- Assisted WP6-9 to further prototype their data management services using reference model expertise;
- refined the RM and OIL-e ontology based on the feedback where necessary;
- documented the technical details learned in the theme 2 in three different forms: a) service portfolio, b) an ontology-based community knowledge base, and c) an open access book (to be finalized and published in Springer).

Task 5.1 Review of existing RIs: requirements, technologies, achievements and gaps leading to characterisation

Duration: M1-M12 (completed)

Some requirements have been revisited via the site visit and technical workshops with SIOS, EISCAT, IAGOS etc. Detailed reports are in the T5.4.

Task 5.2 RI characterisation and ENVRI[PLUS] Reference model

Duration: M7-M30 (active)

Activity

This task has finished at M30. Most of partners spent their resources during that time. Although no explicit activities were planned in this phase, continuation of the work was required to align the reference model (RM) with the architecture developed through T5.4 and resulting in D5.5. We needed to capture accurately or in sufficient detail the required common and cross-cutting services used or desired by the RIs.

CU concluded its participation in ENVRIplus on Month 37 (May 2018). The main objectives of Task 5.2 were fulfilled with the publishing of the updated version of the ENVRI RM, on 30/10/2017. The last months were dedicated to planning of the long-term sustainability of the ENVRI RM and associated materials.

During this period there were no major changes to the reference model, just maintenance and updates in response to comments and feedback. This included, for instance, correcting typos, adding definitions to the vocabulary, adding or correcting bibliographic references, and fixing broken hyperlinks.

A presentation discussing how to align the ENVRI RM with different Research Data Alliance (RDA) proposals was delivered during the RDA Data Fabric Interest Group discussion, at the 11th RDA plenary meeting in Berlin.

The task team also participated in the discussion of the different approaches for the sustainability of the ENVRI RM during the 6th ENVRI week in Zandvoort.

Working more closely (NERC staff for T5.4/T5.5) and CU staff (T5.2) improved the RM so that it reflected the defined architecture (D5.4 and D5.5). The first period project review had also remarked on the divergence and recommended a course of action exactly as already decided within the project and carried out through Period 2 and into Period 3.

ETHZ had a minor role in WP5 during the reporting period. They continued to participate in the discussions in particular with respect to linking relevant issues regarding RI design and architecture between EPOS (Seismology) and ENVRIplus.

Significant results

- The discussion of the ENVRI RM and its alignment to RDA proposals increased the interest of the research community on the use of the ENVRI RM;
- There have been no significant requests for updates and corrections to the current version of the ENVRI RM. The small changes required have been addressed on a case-by-case basis, with voluntary work from CU.

Deviations, reasons for deviations and corrective actions

No deviations from the work plan.

Task 5.3 Semantic description and linking between RI architecture and technologies

Duration: M7-M36 (active)

Activity

UvA lead the Semantic linking task and coordinated the joint activities among EAA, NERC and MBA. With a support from EAA, UvA finalized the development of the ontology of Open Information Linking for Environmental research infrastructure. The ontology can be accessed at www.oil-e.net. Moreover, UvA coordinated the site visits with research infrastructures and organized technical workshops with the RI developers from 15 RIs since 2017. Five visits took place in this reporting period. The descriptions are included in the knowledge base as RDF representations. UvA also prototyped a community knowledge base (kb.oil-e.net).

Coordinating the development of a book for the theme was yet another effort done by UvA. The book is titled: "Towards Interoperable research infrastructures for environmental and earth science: A reference model guided approach for common challenges". The book is a joint effort of many technical partners of the project. The book will be finalized and published by Springer by the end of 2019. All key partners of all RIs joined the writing of the ENVRI Theme 2 book. Last but not least, UvA exploited the ontology in the EU project of VRE4EIC, and mapped it with the CERIF. The QoS, infrastructure descriptions in the OIL-e have been included.

EAA contributed to the development of the ontology of Open Information Linking for Environmental research infrastructure and participated to discussions related to the prototyping of a community knowledge base. EAA instantiated the knowledge base with EUFAR and eLTER RI specific data. Furthermore, EAA organized several semantic workshops together with EUDAT such as the event in Porto as co-located event of the EUDAT conference in January 2018 and the semantic workshop with LifeWatch in Lecce in July 2018. Harmonisation issues using ENVRI OIL-E were presented at RDA Prov WG and RDA VSSIG. Community engagement was started in January 2018 to start an initiative between ENVRI RIs and many others to harmonize observable properties. This lead into the development of a case statement for an RDA endorsed WG (I-ADOPT WG) in June 2019.

MBA Participation in WP tasks/discussions at 7th ENVRI Week.

Significant results

- Deliverable D5.3: a definition of the ENVRIPLUS semantic linking framework
- Co-organisation of semantic workshops (with EUDAT and LifeWatch) and coordination of I-ADOPT RDA WG
- AnaEEThes thesaurus (http://agroportal.lirmm.fr/ontologies/ANAEETHES)

- Pipeline for semantic annotation of relational databases as a service for reusable solution (Service portfolio-C2)
- OIL-e ontology version 2
- Prototype of the community knowledge base

Publications

Paul Martin, Laurent Remy, Maria Theodoridou, Keith Jeffery, Zhiming Zhao (2019) Mapping heterogeneous research infrastructure metadata into a unified catalogue for use in a generic virtual research environment. International journal of Future Generation Computer System [doi:10.1016/j.future.2019.05.076]

Zhiming Zhao, Xiaofeng Liao, Paul Martin, Jordan Maduro, Peter Thijsse, Dick Schaap, Markus Stocker, Doron Goldfarb, Barbara Magagna (2019) Knowledge-as-a-Service: a community knowledge base for research infrastructures in environmental and earth sciences, Workshop on the first IEEE services workshop on knowledge graph as a service (KGAAS), IEEE Service 2019

Liao, X., Bottelier, J. & Zhao, Z., (2019) A Column Styled Composable Schema Matcher for Semantic Data-types, Data Science Journal.

Xiaofeng Liao and Zhiming Zhao(*). 2019. Unsupervised Approaches for Textual Semantic Annotation, A Survey. ACM Computing Survey 1, 1, Article 1 (January 2019), 52 pages. [doi:10.1145/3324473].

Paul Martin, Laurent Remy, Maria Theodoridou, Keith Jeffery and Zhiming Zhao (2018) Mapping metadata from different research infrastructures into a unified framework for use in a virtual research environment, 10th International Workshop on Science Gateways (IWSG 2018), 13-15 June 2018 [http://ceur-ws.org/Vol-2357/paper7.pdf]

Deviations, reasons for deviations and corrective actions

No deviations from the work plan

Task 5.4 Interoperation based architecture design

Duration: M7-M36 (active)

Activity

Although D5.4 (and successive deliverable D5.5) were scheduled in month 18 and month 24, D5.4 was delayed from M18 to M24 and thus aligned with D5.5. The task 5.4 and D5.5 results were utilised in task 5.2 through continued work to ensure the RM relates closely to, and accurately describes in detail, the architecture developed. The development of the ENVRIplus architecture is therefore continuous, and D5.5 at M24 presents then current state of progress at that point in the project. Using engineering and technology viewpoints of ENVRI RM, a conventional architectural design document can be produced.

ENVRIplus is – by its very nature – a heterogeneous distributed network of Research Infrastructures (RI) for providing the advanced environments supporting the environmental scientists. Thus, a key feature of any recommended conceptual architecture for RIs – for their own beneficial utilisation and also for RI interoperation – requires the recommendation of common operations and cross-cutting services allowing the researchers to perform their work effectively and efficiently. In the same time, it should allow the access to RIs other than the one to which they are usually attached in order to encourage – where appropriate – a multidisciplinary research. Identification of computational objects in the RM of the ENVRI project provides a basis; the purpose of WP5 in ENVRIplus is ‘providing a novel ENVRIplus Reference Model which should be developed not only based on the existing ENVRI RM but should also include the latest development insights from other successful RIs’. Thus, a re-examination of the requirements from D5.1 within ENVRIplus (in the production of which UKRI staff was very active) is the start point, wherever possible, for a proper matching with the (developing) ENVRI RM. These common aspects emerge from two directions: (1) the state of the art, which provides opportunities for utilisation in ENVRIplus and (2) the requirements, which provide the specifications of the services and operations needed by the users of the ENVRI RIs. The common aspects form a key basis to be able to achieve the distributed, interoperating architecture recommended for ENVRIplus, providing the RIs with an evolutionary direction allowing the individual RIs to adopt best practice and for them to become interoperable. The development plan provides a stepwise approach to achieve the architecture recommended for ENVRIplus.

The development of the deliverable D5.5 caused intensive internal discussion and exposed varying views within the consortium. The major differences were between the infrastructure providers who wished to have the RIs’ commitment to use their services in a 'silo'

architecture, from user interface through to computing facilities (which precludes to a large extent the primary objective of ENVRIplus for cross-domain environmental research), and the RIs who wished to utilise the infrastructure offerings only when their own computational facilities were overstretched or when a particular service was more effective and efficient than their own - for example EUDAT B2SHARE/B2FIND for curation activity. Furthermore, the EOSC (European Open Science Cloud) ideas were becoming more concrete through the EOSC Pilot project and this resulted in the services approach to architecture being recommended in D5.5. Similarly, D5.5 recommended a layered architecture with defined interfaces thus allowing for component exchange to ensure 'best of breed' services available to the RIs. The development of D5.5 stands upon the requirements and state of the art work done in D5.1. As indicated under T5.2; the RM was not enough evolved to describe the architecture by the due date for D5.5 (D5.2 should have been ready M18 for D5.5 M24), nor was the semantic linking framework of T5.3 (although D5.3 was not due until M36) which itself influenced the evolving architecture after M24. D5.5 work was also closely linked with the WP8 work on the catalog, curation and provenance (although provenance work did not start until after M24); particularly the catalog part, since the catalog provides an 'overview' of what ENVRIplus offers to the end-user.

In general, UKRI staff participated in relevant teleconferences and ENVRI weeks, in using the project management system and in emailing discussions as well as contributing to (and in some cases being the major author of) deliverables.

ETHZ had a minor role in WP5 during the reporting period. They continued to participate in the discussions in particular with respect to linking relevant issues regarding the RI design and architecture between EPOS (Seismology) and ENVRIplus.

INRA participated at the ENVRI week(s) and to international meetings addressing semantics and ecology (“Semantic services in EOSC” Workshop, Porto, Portugal, Jan. 22-23, 2018; International Conference on Ecological sciences, Rennes, France, Oct. 22-25, 2018). INRA developed a generic pipeline for the semantic annotation of resources managed in relational databases. Annotations are realised using the OBOE (Extensible Observation Ontology) extended for the description of AnaEE resources. The RDF (Resource Description Framework) triples produced are used for the feeding of discovery and access portals as well as for the production/identification of datasets.

Together with EUDAT, UniHB has performed a practicability evaluation of the interoperation-based architecture design as proposed in D5.2. This in particular means ICT systems for managing data in an RI as a common RI operation, including curation and provenance and related cataloguing concepts. UniHB has adopted the PANGAEA OAI-PMH interface to provide metadata records for EUDAT's B2FIND catalogue which consequently is available within the EUDAT infrastructure. PANGAEA now provides more than 340.000 metadata records for EUDAT's B2FIND metadata catalogue which demonstrated the canonical cataloguing concept as proposed in D5.2.

EGI participated in the discussion on how ENVRIplus architecture design, ensures the design alingment with the European e-Infrastructures models. EGI also bridged the conversation between ENVRIplus and the EOSC-hub project (started Jan 2018) and contributed to the discussion on how ENVRIplus services can be included in the EOSC-hub service catalogue.

Although the requirement analysis action was completed during the first reporting period. D5.1 has been used as the basis, refined through discussions with use case partners (requirements) and infrastructure partners (technological opportunities), for the work on D5.2, D5.4 and D5.5 (D5.3 being due next period), and has also been referred to when composing other deliverables for the Data for Science theme. During the development, some RIs organized technical workshops with Theme 2 in general to revisit requirements, identify urgent problems, and develop agile cases:

- UvA coordinated the site visits, and engaged the developers from different tasks in the workshops organized during the visits. UvA also exploited the RM and abstract architecture in the different sub-domains, and brought a feedback back to the WP teams.
- FZJ provided required input to the ENVRIplus site visit at the IAGOS data centre in Toulouse which took place 29 to 30 October 2018. FZJ activities presented during this event included the implemented automated near-real-time processing tool for water vapour data, and the conceptual work towards a fully automated data work flow for all sensors operated in IAGOS, based on a relational data base concept.
- CNR(SIOS) contributed to the organization of the Theme 2 technical team visit to SIOS RI in Longyearbyen, 15 to 16 October 2018. During the two days meeting, the ENVRIplus Technical team and SIOS-KC personnel, in particular experts involved in

design and implementation of the SIOS Data Management System (SDMS) had an intensive discussion on data curation, cataloguing, processing, and provenance topics. The meeting also offered the opportunity to discuss future developments. CNR (SIOS) worked to secure that recommendation developed in the frame of ENVRIplus, in particular those reported in D5.5, will drive SIOS in developing data management system. This mainly using them to develop the Italian Arctic Data Center (IADC), planned to be a relevant piece of the whole SDMS distributed system.

- CNR(ISTI) and EISCAT organized a workshop in Pisa to discuss the technical status of EISCAT. Several use cases, e.g., using D4Science to enhance the remote computation required by EISCAT, and automate the legacy scripts in a workflow in the distributed environment, were also discussed in this context. CNR (ISTI) also joined the technical discussion of WP5, in particular related to the ENVRI RM and architecture.

Significant results

- Connection of ENVRIPLUS with SIOS;
- Visit of ENVRIplus Theme2 technical team to SIOS-KC in Longyearbyen;

Publications

Toste Tanhua, Sylvie Pouliquen, Jessica Hausman, Kevin M. O'Brien, Pip Bricher, Taco de Bruin, Justin James Henry Buck, Eugene Francis Burger, Thierry Carval, Kenneth S Casey, Steve Diggs, Alessandra Giorgetti, Helen Glaves, Valerie Harscoat, Danie Kinkade, Jose Henrique Muelbert, Antonio Novellino, Benjamin Gerrit Pfeil, Peter Pulsifer, Anton Pieter Van de Putte, Erin Robinson, Dick Shaap, Alexander Smirnov, Neville Smith, Derrick P Snowden, Tobias Spears, Shelley Stall, Marten Tacoma, Peter Thijsse, Stein Tronstad, Thomas Vandenberghe, Micha Wengren, Lesley Wyborn, Zhiming Zhao (2019) Ocean FAIR Data Services, in International journal of Frontiers in Marine Sciences [doi:10.3389/fmars.2019.00440]

Deviations, reasons for deviations and corrective actions

No deviations from the work plan.

Publications resulting from WP5 activities

Research papers and abstracts

Zhiming Zhao, Margareta Hellström (edits) Towards Interoperable research infrastructures for environmental and earth sciences, a reference model guided approach for common challenges, OA book, Springer. (to be finalized)

Toste Tanhua, Sylvie Pouliquen, Jessica Hausman, Kevin M. O'Brien, Pip Bricher, Taco de Bruin, Justin James Henry Buck, Eugene Francis Burger, Thierry Carval, Kenneth S Casey, Steve Diggs, Alessandra Giorgetti, Helen Glaves, Valerie Harscoat, Danie Kinkade, Jose Henrique Muelbert, Antonio Novellino, Benjamin Gerrit Pfeil, Peter Pulsifer, Anton Pieter Van de Putte, Erin Robinson, Dick Shaap, Alexander Smirnov, Neville Smith, Derrick P Snowden, Tobias Spears, Shelley Stall, Marten Tacoma, Peter Thijsse, Stein Tronstad, Thomas Vandenberghe, Micha Wengren, Lesley Wyborn, Zhiming Zhao (2019) Ocean FAIR Data Services, in International journal of Frontiers in Marine Sciences [doi:10.3389/fmars.2019.00440]

Paul Martin, Laurent Remy, Maria Theodoridou, Keith Jeffery, Zhiming Zhao (2019) Mapping heterogeneous research infrastructure metadata into a unified catalogue for use in a generic virtual research environment. International journal of Future Generation Computer System [doi:10.1016/j.future.2019.05.076]

Zhiming Zhao, Xiaofeng Liao, Paul Martin, Jordan Maduro, Peter Thijsse, Dick Schaap, Markus Stocker, Doron Goldfarb, Barbara Magagna (2019) Knowledge-as-a-Service: a community knowledge base for research infrastructures in environmental and earth sciences, Workshop on the first IEEE services workshop on knowledge graph as a service (KGAAS), IEEE Service 2019

Liao, X., Bottelier, J. & Zhao, Z., (2019) A Column Styled Composable Schema Matcher for Semantic Data-types, Data Science Journal [doi.org:10.5334/dsj-2019-025].

Xiaofeng Liao and Zhiming Zhao(*). 2019. Unsupervised Approaches for Textual Semantic Annotation, A Survey. ACM Computing Survey 1, 1, Article 1 (January 2019), 52 pages. [doi:10.1145/3324473].

Paul Martin, Laurent Remy, Maria Theodoridou, Keith Jeffery and Zhiming Zhao (2018) Mapping metadata from different research infrastructures into a unified framework for use in a virtual research environment, 10th International Workshop on Science Gateways (IWSG 2018), 13-15 June 2018 [http://ceur-ws.org/Vol-2357/paper7.pdf]

WP6 Inter RI data identification and citation services

WP leader: Alex Vermeulen (alex.vermeulen@nateko.lu.se)

WP partners: LU (ICOS), EISCAT, UHB (EMSO), NILU (ACTRIS), CINECA (EUDAT), CNR (SIOS), CNRS (IS-ENES2), IFREMER (SEADATANET), INRA (ANAEE), MBA (EMBRC), DKRZ (IS-ENES2), EAA (LTER)

Introduction

Environmental research infrastructures are often built on a large number of distributed observational or experimental sites, run by hundreds of scientists and technicians, financially supported and administrated by a large number of institutions. If this data is shared under an open access policy, it therefore becomes very important to acknowledge the data sources and their providers. There is also a strong need for common data citation tracking systems that allow data providers to identify downstream usage of their data to prove their importance and show the impact to stakeholders and the public. This work package highlighted identification and citation in environmental RIs, reviewed available technologies and developed common services for these operations.

Task 6.1 Inter RI data identification and citation services

All partners in this work package 6 have been involved in developing good practice guidelines to challenges on proper data citation and data publishing, leading to strong improvements at existing and new systems at the corresponding repositories.

One of the associated problems is citation and provenance information getting lost between publishing portals. Such information loss could be demonstrated while UniHB's PANGAEA metadata has been submitted to provider A (GBIF) which was again submitted by provider A (GBIF) to provider B (EUDAT). As a result, the proper citation of data from PANGAEA got lost for the end user in EUDAT's B2FIND. This example was used and fully described as a contribution to D6.2 and further utilized to improve the overall situation during bilateral negotiation between PANGAEA, B2FIND and GBIF. As a result, PANGAEA's metadata flow was redesigned (see Task 5.4) to deliver metadata for GBIF and B2FIND and to preserve correct data citation there.

As a major demonstration of the publishing of data using strong identification of individual data objects coupled to a citation and data usage tracking system, LU implemented in the ICOS repository the minting of collections and publishing of collections through Datacite. Each collection consists of a set of Data Objects that are all individually identified using

Handle PIDs. Also, each collection receives a Handle PID. Download of a collection triggers the download of all underlying data objects into one packaged data stream and takes care of the download count of all the underlying data objects. The landing page of the collection contains the links to all the data objects and an automatically generated citation, and when a DOI is minted the link to this DOI and its citation. Just like all other data objects in the ICOS Carbon Portal, collections support versioning and the simplified Prov-O provenance scheme. LU also developed user friendly interfaces to the creation and editing of Datacite metadata and the minting of DOIs and the creation of collections and metadata including link to the DOI.

This ICOS use case on (a) data identification and (b) data usage tracking linked to (a) implemented two of three uses cases that have been reported in Deliverable 6.3. MBA contributed there by documenting the use-case looking at data flow from peer-reviewed publications into national and global data aggregators for marine biodiversity data.

With the other ENVRIplus partners in the Data Centre (DC) of the ACTRIS RI, NILU continued its work on implementing data citation services for the ACTRIS data products. Special focus was placed on choosing an approach allowing for accounting of data use with metrics comparable between the distributed DC units within ACTRIS. A corresponding dialogue with the same objective included the other ENVRI RIs in the atmospheric domain (EISCAT, IAGOS, ICOS, and SIOS).

Within the framework of the semantic annotation of AnaEE resources using the extended OBOE ontology, INRA developed a generic (second) pipeline for the production and identification of datasets (service portfolio "C3", https://confluence.egi.eu/pages/viewpage.action?pageId=42305093) from the RDF triples produced by semantic annotation (first pipeline, service portfolio "C2"). The pipeline includes an automated DOI generation service.

A workshop was organised in Hamburg in October 2017 to discuss the needs of the environmental needs on the publishing of data and attribution and citation, provided the necessary input for the formulation of Deliverable 6.2 in this reporting period.

Deliverable 6.2

This deliverable reports the group efforts of Work Package 6 Task T6.1 during M24 to M36 to prepare and initiate a dialogue ("negotiations") with publishers, providers of existing data citation systems and other scientific organisations on raising awareness of what environmental and climate research infrastructures view as essential identification and citation-related services that are required in order to reach the ultimate goal of a "global data citation system".

The activities include creating a network of contacts with a number of actors across the identification and citation landscape, organising a workshop bringing these actors together with ENVRI partners in order to exchange information on current practices, and undertaking a survey aimed at examining the attitudes of relevant publishers and PID, citation & indexing service providers towards citation-related issues identified as important by ENVRI partners.

Deliverable 6.3

This third and final deliverable of WP6, "Inter RI data identification and citation services", provides a summary of three use cases related to data citation: 1) the publication of marine biodiversity data from peer-reviewed journal to EU data infrastructure; 2) the development of a citation and usage tracking system for greenhouse gas monitoring data; and 3) facilitating quantitatively correct data usage accounting. The cases illustrate in their own ways the tight connections between Identification & Citation and the other “pillars” of research data management practices, such as Cataloguing, Metadata management, and Provenance. They also point to the importance of designing and implementing efficient means of harvesting accurate and sufficiently detailed information on various types of usage, and then feed these into analysis tools that can produce suitable impact metrics for a range of different purposes: total numbers of downloads and visualisations of data at the level of a research infrastructure, the demand for near real-time data from a given measurement site or campaign, or the average number of citations in scientific literature associated with an individual engineer.
Furthermore, the cases highlight the need for RIs to engage with both their respective data producers (especially in the case of distributed or extended collaborations contributing their data to a central database) and data end users, and offer support for and also training in best practices for citing and identifying data.

Significant Results

A working implementation of a (versioned) linked data approach for dynamic data citation and usage tracking of highly granular and strongly identified data objects using collections and Datacite DOIs at ICOS by LU;
UNIHB and other partners in Theme 2 established the RDA interest group of PIDs for instruments, whose goal is to design a draft metadata scheme for PIDs for instruments;
LU (ICOS), NILU (ACTRIS), CNR (SIOS) and INRA (AnaEE) implemented or improved significantly the PID and/or DOI minting for data and data collections in their respective infrastructures;

UniHB redesigned metadata workflow at Pangaea to reduce metadata information loss and sustain correct citation information for GBIF and B2FIND;
Community lobbying through workshops and direct contact with citation indexing and data service providers for API access to metadata stores at indexing agencies for ENVRI data repositories;
CNR (SIOS) implemented a Database for Climate Change Tower observations for the arctic compliant with ENVRIplus recommendations developed in WP6;
Submission of Deliverables D6.2 and D6.3.

WP7 Data processing and analysis

WP leader: Leonardo Candela (leonardo.candela@isti.cnr.it)

WP participants: CNR, EURO-ARGO, EISCAT, INGV, ETHZ, UniHB, UvA, DKRZ, UNITUS, CSC, CINECA

Introduction

The overall goal of WP7 'Data processing and analysis' was to provide Environmental RIs with innovative solutions and approaches aiming at enhancing the data processing practices currently in place in each RI. In particular, the activity was organised in two tasks: T7.1 dealing with the delivery of an enhanced version of the data processing facility developed by ENVRI and T7.2 dealing with the development of optimisation mechanisms for computing and storage resources.

CNR-ISTI acted as a work package leader and coordinated the overall activity, e.g., organised dedicated conference calls, participated in the weekly conference calls aiming at coordinating Theme 2 overall activity, organised and chaired the related sessions during the ENVRI weeks.

The major activities performed in the final reporting period include:

- the development and release of the technology for scientific data analytics (T7.1) and infrastructure optimization (T7.2);
- the exploitation of this technology to support several use cases.

Task 7.1 Interoperable Data Processing, Monitoring and Diagnosis

The goal of this task was to develop a data analytics solution suitable for Environmental Research Infrastructures. The activities initiated in the second reporting period were completed in this reporting period. In particular, the data analytics designed in D7.1 have been consolidated and developed, e.g. by improving the mechanisms supporting algorithms integration, fixing bugs and malfunctions. Various versions of the technology have been released by contributing to the gCube technology and the D4Science infrastructure. In particular, the various versions of the analytics technology produced in the period have been included in gCube v 4.10, 4.11, 4.12, 4.13, and 4.14 and made available as-a-Service via https://services.d4science.org/group/envriplus. Software artefacts have been deposited in Zenodo https://zenodo.org/communities/gcube-system.

Several virtual research environments (VRE) have been deployed to facilitate the use and exploitation of the analytics solution from the ENVRI community. In addition to the ENVRIplus VRE presented above, three new ones have been developed to support WP9 use cases: EISCAT VRE for IC_3 "Support EISCAT_3D Users to Reprocess Data Using User's Algorithms" (https://services.d4science.org/group/eiscat), ICOS Eddy Covariance for IC_13 "The Eddy Covariance Fluxes of GHGs" (https://services.d4science.org/group/icoseddycovarianceprocessing), and Particle formation for TC_17 "New particle formation event analysis on interoperable infrastructure" (https://services.d4science.org/group/particleformation).

- CNR-ISTI acted as task leader. CNR-ISTI lead the consolidation and enhancement of the data analytics platform. The beneficiary lead the production of D7.2 and largely contributed to this project deliverable documenting the resulting analytics technology. CNR-ISTI lead the development of all the Virtual Research Environments.

EISCAT focused on the development of IC_3 use case (see WP9). In such context, in cooperation with CNR-ISTI, a dedicated VRE has been developed by liaising with D4Science. Such VRE is equipped with the data analytics solution developed in Task 7.1 and it has been exploited by EISCAT to set up the analytics pipelines for their data.

UNITUS focused on the development of IC_13 use case (see WP9). In such a context, they developed several analytics pipelines by using the data analytics solution and equipped the target VRE with these algorithms.

- All the partners contributed to task discussions, participated in the ENVRI weeks and reviewed the deliverable D7.2.

Task 7.2 Performance optimisation for big data sciences

The goal of this task was to develop solutions for optimisation of e-Infrastructures. The activities initiated in the previous period have been continued and completed in this one. In particular, what was planned in D7.3 has been completed and documented in D7.4. Four main technologies characterised the activity:

- the Dynamic Real-time Infrastructure Planner (DRIP), a microservice suite for planning and provisioning networks of virtual machines and then deploying distributed applications across those networks; DRIP then manages the virtual infrastructure during run-time based on time-critical constraints defined with the application workflow;
- a virtual overlay for Information-Centric Networking realising a Named Data Networking (NDN) based on PIDs;
- a Data Subscription Service, implementing TC_2 where Euro-Argo RI prototyped a subscription service for the data gathered from the Argo float network;
- and Developed core algorithms required for the infrastructure optimization, in particular using the latest Cloud, DevOps, NDN and blockchain technologies.

All these activities demonstrate optimisation of e-infrastructure based on data-driven requirements imposed by scientific applications and are described in D7.4. The software components resulting from these activities have been deposited in GitHub.

UvA acted as a leader of this task. UvA developed DRIP (jointly with the other projects). Moreover, they supported the development of the Data subscription use case, using the infrastructure optimization service in collaboration with CSC (EUDAT), EGI and Euro-Argo. UvA tested the DRIP with the NDN, PID and made one feasibility study on NDN and PID in data infrastructure.

UniHB focused on the IC_14 "SOS & SSN Ontology Based Data Acquisition & Near Real Time Quality Control" use case which built upon an Apache Storm topology as well as the EGI ARGO messaging service. Both services have been improved, adopted and deployed on EGI infrastructures as a test-bed for performance optimisation within near real time quality processing services. In addition, UniHB has evaluated the EGI standard SLA templates which by now guarantee about 80% availability which consequently need to be optimised for such near real time applications within stable, productive systems.

All the partners contributed to task discussions, participated in the ENVRI weeks and reviewed the deliverable D7.4.

Significant results

- D7.2 Interoperable data processing services for environmental RI projects: prototype;
- D7.4 Performance optimisation services for environmental ESFRI projects: prototype;

Technology for data analytics and infrastructure optimization has been developed and made available (via Zenodo and Github);

- Several Virtual Research Environments have been developed and operated by relying on WP7 technology.

Publications

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Vitale, D., Fratini, G., Bilancia, M., Nicolini, G., Sabbatini, S., and Papale, D.: A robust data cleaning procedure for eddy covariance flux measurements, Biogeosciences Discuss., https://doi.org/10.5194/bg-2019-270, in review, 2019.

Yang Hu, Huan Zhou, Cees de Laat, Zhiming Zhao (2019) Concurrent Container Scheduling on Heterogeneous Clusters with Multi-Resource Constraints, International journal of Future Generation Computer System [to appear]

Huan Zhou, Yang Hu, Xue Ouyang, Jinshu Su, Spiros Koulouzis, Cees de Laat, Zhiming Zhao (2019) CloudsStorm: A Framework for Seamlessly Programming and Controlling Virtual Infrastructure Functions during the DevOps Lifecycle of Cloud Applications, International journal Software: practice and experience [doi:10.1002/spe.2741].

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Wenchao Jiang, Yinhu Zhai, Paul Martin, Zhiming Zhao (2018) Structure Properties of Generalized Farey graphs based on Dynamical Systems for Networks, Scientific Reports, volume 8, Article number: 12194 [doi.org:10.1038/s41598-018-30712-2]

Yang Hu, Cees de Laat, Zhiming Zhao (2019) Learning Workflow Scheduling on Multi-Resource Clusters, IEEE international conference on Network, Architecture and Network (NAS), Enshi, China [to appear].

Huan Zhou, Zeshun Shi, Yang Hu, Pieter Donkers, Andrey Afanasyev, Spiros Koulouzis, Arie Taal, Alexandre Ulisses and Zhiming Zhao (2019) Large distributed virtual infrastructure partitioning and provisioning across providers, IEEE conference on Smart IoT, Tianjin, China [to appear] (Best student paper candidate).

Yang Hu, Cees de Laat, Zhiming Zhao (2019) Multi-objective Container Deployment on Heterogeneous Clusters, International workshop on Network aware big data computing, in the proceedings of IEEE CCGrid 2019, Cyprus. [10.1109/CCGRID.2019.00076] Best paper award.

Huan Zhou, Spiros Koulouzis, Yang Hu, Junchao Wang, Alexandre Ulisses, Cees de Laat and Zhiming Zhao(2018) Migrating live streaming applications onto clouds: challenges and a CloudStorm solution, 1st Workshop on Cloud-Native Applications Design and Experience, 11th IEEE/ACM conference on Utility and Cloud Computing, Zurich Switzerland [doi.org:10.1109/UCC-Companion.2018.00075].

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Deviations, reasons for deviations and corrective actions

No deviations from the work plan.

WP8 Data Curation and Cataloguing

WP leader: Keith Jeffery (Keith.Jeffery@keithgjefferyconsultants.co.uk) representing UKRI
WP participants: UKRI EISCAT, CNR, CNRS, IFREMER, INGV, UvA, INRA, EAA, MBA, USTAN, DKRZ, LU, CEA, NILU, CSC, CINECA

Introduction

Overall the WP has progressed its work significantly producing four deliverables. Task 8.1 delivered D8.2 "Data curation in system level sciences: system design" (M42) and Task 8.2 produced D8.4:" Interoperable cataloging and harmonization for environmental RI projects: system design" (M42) were updates of D8.1 and D8.3 respectively. T8.3 produced D8.5 "Data provenance and tracing for environmental sciences: system design" (M36) and D8.6 "Data provenance and tracing for environmental sciences: prototype and deployment" (M42). Most partners were involved in these deliverables although the major responsibility rested with UKRI, IFREMER and EAA respectively.

UKRI is WP leader and so participates in both a management and technical role in all tasks.

Almost all WP partners have participated in ENVRI week organized during this reporting period and other workshops and conferences related to their scientific domains.

The work has demonstrated clearly the close relationship between curation, catalog and provenance and the need for tight integration across these functionalities. Relating WP8 results to the WP5 reference model and architecture (linked back to D5.1 Requirements) has been a significant piece of work.

Task 8.1 Self-adaptable data curation for system level sciences

This task was led by UKRI. The major work was to deliver deliver D8.2 at month 42. Based upon D8.1, this involved an updated review of curation systems and also curation best practice and associated tools. Data curation is commonly the 'Cinderella' of ICT (Information and Communication Technologies). Usually, it receives little attention from researchers or

managers and may be seen as a tedious chore to be done in wrapping up the research activity. Since research may well be continuous, such wrapping up may not occur. In contrast, many important research discoveries have been made by re-working old data and/or by comparison of old data with recently collected data. This is particularly true of environmental sciences where understanding the atmospheric, biospheric, hydrospheric and geospheric processes usually requires long-term observation and subsequent analysis. Furthermore, validation and re-validation of research results requires open and understandable access to the data used in the preparation of the original publication. Data curation is thus an important aspect of ENVRIplus and a key element of the ICT architectural and governance design. Data curation is also integral to research methods (supporting, influencing, recording), workflows and processes and also integrates with all ICT activities through cataloguing and provenance. With an evolving policy of open access to data – as well as publications – and, in time, software developed from the open source movement – curation has become more visible and necessary. D8.2 reviews the updated state of the art and recommends architectural principles to be considered (along with the inputs on other topics) in the final architectural design phases of ENVRIplus although D8.2 at M42 is well after the architectural design D5.5 at M24. It also makes recommendations for best practice.

The atmospheric ENVRIplus RIs agreed to have all their metadata and data accessible through machine-to-machine (M2M) interfaces for both metadata (OAI-PMH for ICOS and ACTRIS, and CSW for IAGOS) and data (OPeNDAP). The EISCAT 3D project is developing data formats for the new radar system. To aid this process we are also converting existing EISCAT data into HDF5 based formats with sufficient metadata.

Task 8.2 Interoperable data cataloguing and metadata harmonisation

This task is led by IFREMER. The major work was to deliver D8.4 at M42. This report describes the technical implementation for a catalogue system in the ENVRIplus framework. After a brief reminder on the general requirements detailed in D8.3, this report provides information concerning the architecture and design recommendations for the implementation of this catalogue system.

The ENVRI RIs of the atmospheric domain (here: ACTRIS, IAGOS, ICOS), have worked on implementing the named metadata and data M2M interfaces for all its data centre (DC) nodes. These are online, or will be shortly as described below. IAGOS participated to the

Implementation Case: IC_8 Catalogue, curation, provenance as a validator for the Atmosphere domain. The ENVRI Flagship data service catalog prototype harvests IAGOS metadata records through the IAGOS CSW service (http://catalogue2.sedoo.fr/geonetwork/srv/eng/csw-iagos?REQUEST=GetCapabilities&SERVICE=CSW) All IAGOS products are now referenced by the flagship catalogue.

EAA contributed to Task 8.2 for the ENVRI Flagship data service catalog prototype. It harvests eLTER metadata records through the DEIMS service. EISCAT demonstrated the use of the Madrigal web services and the EUDAT B2FIND web API to insert EISCAT metadata, visual overview data and URLs to spectral data into B2SHARE.

LU contributed by close collaboration with the ENVRI Flagship Data Product Catalogue development team at the B2FIND group (at DKRZ), with special focus on implementing an interface for harvesting cataloguing information via the ICOS SPARQL Endpoint and contributions to & co-authorship of the demonstrator deliverable D8.4 (M43) ICOS contributed to the ENVRIplus "flagship product" catalogue by listing Near Real Time (automated quality control only) and Level 2 (fully quality controlled and 30-minute aggregated) data set types from Atmospheric, Ecosystem and Ocean observation stations, and one Level 3 (atmospheric modelling output) data set type. In connection with this work, ICOS Carbon Portal also collaborated with the B2FIND team at DKRZ to extend the functionality of our metadata store SPARQL endpoint with a new query template that returns search results in a format compatible with the OAI-PMH metadata harvesting protocol. This contributed to an increase in interoperability.

Cineca contributed to implement and integrate the ENVRIplus catalog using the EUDAT-B2FIND service, operated and maintained by DKRZ. For datasets made available from ANAEE, EuroArgo, IAGOS, ICOS, LTER, EMBRC, EPOS mainly in ISO19139 and Dublincore have been mapped to the B2FIND schema. While for some RIs the protocol OAI-PMH could be used to harvest the metadata, CSW2.0 protocol was also enabled to allow collecting records from the GeoNetworks of SeaDataNet and ANAEE.

INRA participated in management of the AnaEE(-France) metadata records IS (geonetwork implementation, ISO19139 standard) harvested by the ENVRIplus flagship catalog. A first

pipeline was developed for the semantic annotation of relational databases. Annotations are realised using the OBOE ontology extented for the description of AnaEE resources (experimentation on ecosystems). A second pipeline was developed for the production of rich metadata records (ISO19115) and datasets.

INGV contributed to the ENVRIplus flagship catalogue by providing the CERIF metadata catalogue as used in EPOS, as well as sharing the experience gained within the EPOS project related to the metadata conversions to/from several formats in order to harmonize contributions from all the scientific communities involved.

SIOS is extremely interested in cataloguing system for a dynamic management of the large amount of different observing platforms, infrastructures, stations, instruments/sensors, datasets characterising Svalbard research landscape. Even limiting to Ny Alesund, attempt done in the past had not been successful. Based on information provided to Sensor registry user case (TC_4) as example of sensors and hardware manage by a RI in a multi-domain environment, a sample of SIOS station description has been encoded in OGC/SensorML format.

For demonstration purposes, few records were uploaded to a B2FIND test server and indexed for the search. Further enhancements and improvements of the mapping are necessary before the ENVRIplus records will be published and searchable in the productive B2FIND portal.

UKRI staff continued to participate actively in T8.2, surveying emerging and evolving catalog systems and metadata formats used in the RIs leading to the implementation in D8.4 using CKAN (as used in EUDAT B2FIND) and CERIF (as used in EPOS): the former more for discovery and the latter for discovery and contextualisation. UKRI staff - working with INGV staff and others - have extensive experience in conversion of metadata formats to/from CERIF (used as the canonical format because of its richness) thus CKAN can be generated from CERIF and CKAN can be converted to (some subset of) CERIF. UKRI staff working with INGV delivered metadata in the appropriate format for the flagship prototype ENVRIplus common catalog.

Task 8.3 Inter RI data provenance and trace services

EAA coordinated Task 8.3 on data provenance, 2018 was the main year of activity for this task. As part of D8.5 EAA compiled a review of the latest technologies and existing standards, collected data provenance related requirements of the RIs collected and produced an overview of state-of-the-art approaches. As part of D8.6 EAA coordinated the development of the PROV-Template Registry and Expansion Service and the collection of RI use cases to demonstrate the value of the developed service.

UvA joined the development of the provenance service, and contribute a Log conversion template to D8.6. Moreover, the UvA team also developed a tool to visualize the contextual information between provenance and the system logs.

DKRZ contributed to the provenance service prototype with the IS-ENES use case a Python-based provenance tool. UvA contributed a provenance and system log analysis tool. MBA contributed an operational PROV use case and python scripts and tools.

CNRS operationalized the usage of PID services by maintaining and updating a self-adaptable and semantic annotation services (a generic errata services). Any user can identify if the dataset he is using is safe for usage or if a known issue has been flagged. In that case the errata service informs the user of the potential existence of a new version fixing the problem.

The operation and analysis workflow of the legacy EISCAT radars was modelled in collaboration between EISCAT and EAA. This will serve as a starting point for modelling the future EISCAT 3D workflows.

LU contributions included mapping of the needs for collection of provenance information in the ICOS data flow, and performing a corresponding analysis of necessary enhancements to the ICOS metadata model and data processing workflows. LU staff were also involved in contributions to & co-authorship of the deliverable D8.5 (M36) and project-internal review of deliverable D8.6 (M42). Based on the outcomes of discussions with WP8 experts on best practices for implementing well-defined metadata models to support the capture of provenance information from raw data processing, ICOS has been able to make good progress towards realizing a mechanism for automated harvesting of relevant metadata for e.g. Cloud-based Eddy Covariance ecosystem flux data processing & quality control.

UKRI staff participated concerning standardisation (W3C PROV) and being involved and contributing further on work from outside the project on PROV-CERIF mapping and conversion as well as on the use of CERIF itself for provenance, integrated with cataloguing and curation.

Significant Results

- D8.2 which recommended that curation and cataloguing (and provenance) should be within the same system since there is a very large intersection of the metadata involved. Curation metadata is important for assessing availability of assets – including data locality (especially copies or versions or partitions) which may be utilised for improved performance - while provenance information provides a basis for an end-user to assess context (relevance, quality) alongside the discovery of the asset using rich metadata in the catalog. This implies that the metadata model must be a superset (in representation of syntax and semantics) of the metadata models used or planned within the RIs.
- D8.4 was able to demonstrate cataloguing capabilities and a two-pronged approach was adopted. A few records were converted and uploaded from several RIs to a B2FIND test server and indexed for the search. This platform is openly accessible at http://eudat7-ingest.dkrz.de/dataset.
- Separately the EPOS metadata catalog of services was used as an exemplar of the use of CERIF for integrated cataloguing, curation and provenance.
- Work continues with the use of CKAN (as used in EUDAT) and CERIF for the metadata catalog. A prototype has been demonstrated. ENV RIs can now evaluate what is best for their purposes. Various ENV RIs have set up automated routines for harvesting their metadata to the prototype catalog.
- D8.5 and D8.6 recommended use of the W3C standard PROV with the use of templates. Work since M42 has been concerned with how to integrate PROV with CKAN and CERIF; it appears possible with CERIF (based on the CERIF-PROV work initiated outside of the project) but more difficult with the CKAN metadata set as used in EUDAT B2FIND. However, the use of templates and linking appears to be a way forward. This work is ongoing.

Publications

Paul Martin, Laurent Remy, Maria Theodoridou, Keith Jeffery, Zhiming Zhao (2019) Mapping heterogeneous research infrastructure metadata into a unified catalogue for use in a generic virtual research environment. International journal of Future Generation Computer System [doi:10.1016/j.future.2019.05.076]

Elias Khaldi Ahanach, Spiros Koulouzis and Zhiming Zhao (2019) Linking provenance with system logs: a context aware information integration and exploration framework for analyzing workflow execution, 10th International Workshop on Science Gateways (IWSG 2019), 13-15 June 2019

Elias Khaldi Ahanach, Spiros Koulouzis and Zhiming Zhao (2019) Linking provenance with system logs: a context aware information integration and exploration framework for analyzing workflow execution, IEEE eScience conference, poster, accepted

Identification of spikes associated with local sources in continuous time series of atmospheric CO, CO2 and CH4. Atmos. Meas. Tech.. El Yazidi et al, 2018

ENVRI Book
WP8 partners contributed significant effort to this activity. Chapter 7 was edited by UKRI, Chapter 8 by IFREMER and Chapter 9 by EAA with significant cross-contributions from the lead organisations for each chapter and additional contributions from other partners in WP8. Much of this activity was between M36 and M48 and depended on the results from WP8 including deliverables.

Deviations, reasons for deviations and corrective actions

The initially planned late start (M25) of T8.3 made integration with the architecture (D5.5 M24) difficult. However, this was overcome thanks to the flexibility of the T8.3 task leader. Approaches to integrate cataloging, curation and provenance in one architectural environment is ongoing.

WP9 Service validation and deployment

WP leader: Yannick Legré (yannick.legre@egi.eu)

WP participants: EGI.eu, UHEL, EURO-ARGO, EISCAT, CNR, CNRS, IFREMER, FZJ, INGV, UKRI, EMSC, ETHZ, UniHB, INRA, EAA, UiT, UCPH, LU, UNITUS, CEA, NILU, CSC, CINECA

Introduction

The aim of ENVRIplus WP9 is to validate the results of the ENVRIplus Theme 2 developments by showcasing software deployments onto computing and data infrastructure and through investigating how to operate developed services within RIs. WP9 defined two tasks:

- T9.1 focuses on the technical issues of software validation, integration and release management, and of deploying developed results on computing and data infrastructure;
- T9.2 focuses on tracking the actual usability and operationality of the ENVRIplus services, once these are deployed under real world conditions.

Task 9.1. Validation and integration of developed services.

Main activities in T9.1:

During the period Jan 2018 to Jul 2019, T9.1 continued work with the implementation of the community use cases and testing Theme 2 services. As the result, 7 well-developed use cases were selected as the final Science Demonstrators. The Science Demonstrators showcase of service solutions illustrated through prototype implementations, which serve as proof or evidence that the Theme 2 services can bring added value for supporting ENVRI community to deliver scientific research.

The details about the Science Demonstrators and the integration solutions are described in deliverable D9.2 that was completed on time by the end of August 2018. T9.1 also provided Wiki and YouTube videos for each Science Demonstrator.

During 6th and 7th ENVRI weeks, we organised sessions and workshops to discuss these Science Demonstrators and collected feedback from the communities.

We used international conferences, workshops, and working groups (in various organisations and community networks) as vehicles to promote these project results. We have attended RDA, EOSC, DI4R, EGU conferences and gave presentations and posters. We wrote articles for ENVRIplus newsletter issue No.5 and EGI newsletter issue No.32. We also contributed to ENVRIplus Theme2 book and wrote a Chapter on Authentication, Authorisation and Accounting.
T9.1 also created and maintains the Themes 2 Service Portfolio that provides the core repository for all information of Theme 2 services.

Below are the main activities of individual organisations in T9.1:

- EGI led the tasks in T9.1. EGI supported the developments of use case and science demonstrators, providing e-Infrastructure resources and trainings, directly participated the implementation of use case TC_2, TC_17, SC_3. EGI organised WP9 sessions in every ENVRI week to discuss WP9 tasks. EGI also helped to link ENVRI+ to EOSC and organised EOSC session during the 7th ENVRI week;
- UiT - Ongoing work and discussion to integrate and improve data transfer from RIs to workspace. Collaboration with EMSO-ERIC for operation related to RI data;
- UniHB has continued to implement IC_14 which is based on Apache Storm and the EGI messaging server. The Storm topology for near real time quality control has been refined and adopted to the specific needs of the marine community. In cooperation with UvA, UniHB has evaluated the usability of RabbitMQ messaging server as alternative for the ARGO messaging server. Further, a SSNO derived, compact data transmission formats have been developed in order to reduce the data volume and consequently costs for e.g. Iridium data transmissions. For the second WaveGlider demo mission, in cooperation with WP3 a RabbitMQ messaging server has been installed at MARUM servers and the Storm topology has been adopted to support RabbitMQ. A video on IC_14 has been provided as well as some descriptive texts as UniHB’s contribution to deliverable D9.2;
- EISCAT Scientific Association - EISCAT have used the D4Science platform to implement the IC-3 Use Case. A user interface to upload analysis software through the DataMiner interface was developed and a video was made showing the steps of processing. Test software using existing EISCAT data as input was successfully deployed;

- The EMSC has performed some technical experimentation on integration of seismic data to the use case IC_14 (NRT Data Quality control service). However seismic data is high frequency and is not completely adapted to the service;
- The EMSC has participated in the review of the deliverable D9.4, has participated in regular telephone meetings and has attended ENVRI weeks in Zandvoort and in Helsinki;
- CNRS attended the ENVRI weeks;
- IAGOS participated to the Implementation Case: IC_8 Catalogue, curation, provenance as a validator for the Atmosphere domain;
- CSC further developed and supported the piloting of EUDAT Data Subscription Service that is a key component in the TC_2 Use Case "Euro-Argo Data Subscription Service". This service allows researchers to save subscriptions for data matching user-defined criteria, and getting notifications when new data is available. The data subscription was connected to infrastructure optimisation tools from UvA to allow automatic pre-processing of new data according to user defined rules. The work includes implementing standard interfaces to initiate subscription actions, for easier integration to other research infrastructure portals, and designing AAI integrations to Euro-Argo user management system;
- CSC participated actively in all ENVRI weeks during the reporting period including reporting and updating on the progress of the development as follows: Poster and workshop presentation at 6th ENVRI week, workshop presentation at 7th ENVRI week, and as member in panel discussions at 8th ENVRI week. CSC participated in site visit to ACTRIS research infrastructure at Lillestrom, Norway, in January 2019. CSC contributed in preparing the deliverable D9.2 Service deployment in computing and data e-Infrastructures, Version 2;
- ETHZ participated in the WP9 telecons and discussions during ENVRI weeks, in particular linking the experience & developments in EPOS (Seismology) to the ENVRIplus service validation and development activities. They supported the development and finalization of Deliverable D9.2;
- EAA coordinated IC_10 providing the PROV-Template Registry and Expansion Service (PTRES) as a platform to explore the possibilities of PROV-Templates in the context of the ENVRIplus task T8.3. Involved communities were asked to represent provenance specific aspects of their Data Life Cycles (DLC) using PROV-Templates. This way, they could experiment with the PROV-DM as language to express

provenance for their infrastructure and to assess what steps would be necessary to create PROV compliant data out of the respective workflows. The contributors were moreover asked to register their created templates in the prototype infrastructure so that they would become available for inspiration and reuse. Whenever possible, contributors were also encouraged to experiment with the provided expansion functionality and to assess the usability of such a service within their own RI. The collected feedback suggests that the chosen approach is of interest to the community and has a number of advantages, although its use within a production setting would still require specific modifications/extensions of existing workflows;

- INRA and EGI have agreed to test the deployment of the pipeline for the semantic annotation (of relational databases) developed by INRA and proposed as one of the services of the ENVRIplus portfolio (C2). In addition to the evaluation of the deployment ability, the objective is to evaluate the gain of performances offered by the EGI resources, by increasing the number of CPU used and the amount of available memory. The test will also provide information about the cost of access to a remote relational database as compared to the access to a locally hosted database. It has been decided that, as a first step, the modalities for carrying out the deployment test have to be defined using limited computer resources offered by the French grid (France-Grille). As a second step the test will be carried out by mobilizing more resources from EGI;
- LU actively participated in the Task 9.1 related portions of regular WP9 team telcos during M32-M40. The partner actively participated in sessions dedicated to validation and integration of developed services at all ENVRI week meetings during M32-M40;
- UNITUS cooperated on aspects of the ICOS data flow & processing related to Science Demonstrator SD2 (presented in D9.2). They also contributed to & co-authored the demonstrator deliverable D9.2.

Significant results

ENVRIplus Science Demonstrators, Wiki and YouTube Videos were provided:

Science Demonstrator 1: Support EISCAT-3D Users to Reprocess Data Using Users' Algorithms

Author: Ingemar Haggstrom, EISCAT Science Association

Description: a model enables EISCAT scientific researchers to re-process data by implementing and adapting algorithms and parameters from other sources
Integrated Theme2 services: D4Science
Added value to ENVRIplus RIs: a common challenge to many RIs: data is often processed using standard models/methods. But researchers want to use different analysis models, easily modify parameters or algorithms, and collaborate with each other, they need a VRE
YouTube Video: https://youtu.be/YEEMUvnSHUM
Wiki: https://wiki.envri.eu/pages/viewpage.action?pageId=30736974

Science Demonstrator 2: The Eddy Covariance (EC) Fluxes
Authors: Domenico Vitale, Dario Papale, University of Tuscia
Description: a service solution that integrates the gCube service to optimize the processing of EC data based on 4 different processing schemes that executed in parallel mode. The results largely reduce Near Real Time processing time.
Integrated Theme2 services: D4Science
Added value to ENVRIplus RIs: RIs aim at analyzing routinely large amount of data can benefit from the efficiency of parallel computing implemented in the VRE
YouTube Video: https://youtu.be/hod2WksKzV8
Wiki: https://wiki.envri.eu/pages/viewpage.action?pageId=30737048

Science Demonstrator 3: SOS&SSN Ontology Based Data Acquisition and NRT Data Quality Checking Service
Author: Rober Huber (University of Bremen)
Description: allow to submit and publish raw observational timeseries data in common standard formats (T-SOS XML and SSNO JSON) via a messaging API (EGI ARGO) that is used to perform Near Real Time (NRT) quality control procedures by an Apache Storm NRT QC Topology, which publishes the quality controlled and labelled data via a messaging output queue.
Integrated Theme 2 services: Reference Model, Semantic Linking, EGI FedCloud, ARGO
Added value to ENVRIplus RIs: provide a technical solution to a common problem for RIs that data acquisition service (the preparation of data transfer prior to data transmission) are often not yet standardized. This hinders the operation of efficient cross-RI data processing routines.
YouTube Video: https://youtu.be/p3UQZkRRWlw

Wiki: https://wiki.envri.eu/pages/viewpage.action?pageId=30737103

Science Demonstrator 4: Euro-Argo Data Subscription Service
Author: Thierry Carval, Glenn Judeau (IFREMER), Jani Heikkinen (CSC), Baptiste Grenier (EG), Zhiming Zhao (UvA), Spiros Koulouzis (UvA)
Description: allows researchers to subscribe to customized views on Argo data, selecting specific regions and time-spans, and choosing the frequency of updates. Tailored updates are then provided on schedule to researchers' private storage.
IntegratedTheme2 services: DRIP, EUDAT, EGI
Added value to ENVRIplus RIs: to receive regular transmissions of data (in near-real time), directly from data providers is commonly requested; RIs can benefit from the subscription services, e.g., to create more elaborated data products by requesting data from other sources, and can optimise their internal workflows by signing up for automatic updates
YouTube Video: https://youtu.be/PKU_JcmSskw
Wiki: https://wiki.envri.eu/pages/viewpage.action?pageId=30737116

Science Demonstrator 5: Sensor Registry
Author: Justin Buck (BODC); Simon Jirka (52°North)
Description: Common (families of) sensors are used across RIs. It provides a standardised sensor repository to support
Easily discover sensors and their metadata
Sensors and sensor observations discoverable, accessible and usable via the web via standardised services
Seamlessly integrate sensors from one network with sensors from other networks
Tested Theme 2 services: Catalogue, Provenance
Added value to ENVRIplus RIs: The service can be integrated to various types of platforms, deep-sea observatories (e.g., EMSO), marine gliders (e.g., EuroGOOS), solid earth (e.g., EPOS) or atmosphere observations (e.g., ICOS). It can also be used to track usage of specific sensor models (e.g., CO2) across the RI's observation networks.
YouTube Video: https://youtu.be/4QxTZ2iiznk
Wiki: https://wiki.envri.eu/pages/viewpage.action?pageId=30737160

Science Demonstrator 6: New Particle Formation Event Analysis on Interoperable Infrastructure

Author: Markus Stocker (TIB), Markus Fiebig (NILU) Leonardo Candela (CNR), Giuseppe La Rocca (EGI), Enol Fernandez (EGI)
Description: enable the detection and visualisation of particle formation events at the data acquisition station and share the analysis algorithm among researchers
Tested Theme 2 services: D4Science, EGI JupyterLab
Added value to ENVRIplus RIs: a possible architecture of an infrastructure that "transforms data into knowledge". the deep integration of science communities with research and e-Infrastructures
the curation of formal (i.e., machine-readable) data semantics
YouTube Video: https://youtu.be/ra9W7b5DbgI
Wiki: https://wiki.envri.eu/pages/viewpage.action?pageId=30737206

Science Demonstrator 7: gCube-Based VRE for Mosquito Diseases Study
Authors: Baptiste Grenier (EGI); Matthias Obst (Swedish Lifewatch); Leonardo Candela, Gianpaolo Coro (CNR-ISTI)
Description: illustrates how a LifeWatch researcher can easily upload and integrate an R-based algorithm in D4science, making it available to other researches within the VRE. Once published, researchers can discover the algorithm and use it with their own data. It allows to adapt the algorithm and to share improved versions. When processing data-intensive analysis algorithms, the computation can be outsourced on federated resources, such as those provided by the EGI e-Infrastructures.
Tested Theme 2 services: D4Science, EGI, LifeWatch infrastructure
Added value to ENVRIplus RIs: a solution to the integration of community services with VRE and e-Infrastructure services
YouTube Video: https://youtu.be/IBJkSys5tVo
Wiki: https://wiki.envri.eu/pages/viewpage.action?pageId=30737220

Science Demonstrator 8: Dynamic Ecological Information Management System - Site and Dataset Registry (DEIMS-SDR)
Authors: Christoph Wohner (EAA)
Description: DEIMS-SDR (Dynamic Ecological Information Management System - Site and Dataset Registry; https://deims.org) is a web service that allows registering and discovering long-term ecosystem research sites around the globe, along with the data gathered at those sites and the people and networks associated with them. DEIMS-SDR describes a wide range

of sites, providing a wealth of information, including each site's location, ecosystems, facilities, parameters measured and research themes. It aims to be a globally comprehensive site catalogue of in-situ observation or experimentation facilities covering all (terrestrial) biomes and enabling that standardised information to be openly available to science, politics and the public in general e-Infrastructures.
Tested Theme 2 services: Catalogue
Added value to ENVRIplus RIs: an online production service with long- term funding to issues neutral site identifiers, which allow cross-RI site identification
YouTube Video: https://youtu.be/k_25TZzEF1Q
Wiki: https://wiki.envri.eu/pages/viewpage.action?pageId=40861752

Science Demonstrator 9: PROV-Template Registry and Expansion Service (Use Case IC_10)
Authors: Doron Goldfarb (EAA)
Description: PROV-Template is a proposed standard for converting existing process output such as log files into representations following the PROV Data Model (PROV-DM) specification for describing provenance of electronic resources in machine readable, structured form. Besides the potential advantage that existing process implementations can be enabled to generate PROV-DM conforming data without the need to change their underlying codebase, the general notion of using templates for describing provenance traces for recurring workflows can be used to foster interoperability and best practices for provenance data generation across individual communities. Following this motivation, the ENVRIplus PROV-Template registry and expansion service prototype has been designed as public platform for describing, storing and sharing PROV-Templates across members of different RI, including a dedicated Web API for instantiating stored templates with individual data.
Tested Theme 2 services: Provenance, Reference Model
Added value to ENVRIplus RIs: The service enables users from different communities to exchange re-usable templates for describing provenance information about common aspects of their data life-cycles. This will result in more homogeneous representations of provenance information, potentially allowing to trace the genesis of datasets especially in anticipated cases where data products are passed on between different RIs.
Youtube Video: https://youtu.be/dS58qTfscSM
Wiki: https://wiki.envri.eu/pages/viewpage.action?pageId=40861727

- Deliverable 9.2 is submitted on time 10.5281/zenodo.3258529
- A Chapter to ENVRI Book (see e.g. WP5 report) on subject of Authentication, Authorisation, and Accounting

Publications

Koulouzis, S., Martin, P., Zhou, H., et al. (2019). Time-critical data management in clouds: Challenges and a Dynamic Real-Time Infrastructure Planner (DRIP) solution. Concurrency Computat Pract Exper. 2019;e5269.https://doi.org/10.1002/cpe.5269

Koulouzis, S., Carval, T., Martin, P., Grenier, B., Chen, Y., Heikkinen, J., Zhao, Z. (2018). Dynamic Optimization for Time-critical Data Services: A Case Study in Euro-Argo Research Infrastructure. 20th EGU General Assembly, EGU2018.http://adsabs.harvard.edu/abs/2018EGUGA..2016012K
In addition the work has been presented in international conferences, such as EUDAT 2018 conference in Lisbon, Portugal, in January 2018.

Task 9.2. From research to operational

Main activities in T9.2

- LU was a leader of Task 9.2. LU coordinated and participated in all Task 9.2 - related portions of regular WP9 team telcos during M32-M40. LU also participated in sessions dedicated to the “From research to operational [services]” topic at all ENVRI weeks during M32-M40. They developed an interactive on-line tool for service evaluation (described in D9.4) and authored the demonstrator deliverable D9.4;
- EGI contributed to T9.2, participated the discussions about the approach, survey questions, review and contributed to deliverable D9.3, D9.4;
- FZJ provided requested information on automated near real time data processing and provision for D9.3 to the work package leader;
- NILU continued T9.2 work on a service for quantitative accounting of data us, with its first version and approach described in deliverable D9.1. In the reporting period, the approach has been iterated with partners, updated, and prepared for implementation in

the ENVRI-FAIR project. The following further actions have been defined: 1) Implementation of primary data identification at data repositories, 2) Reference implementation for coining collection DOIs containing correct references to primary PIDs of data contained in collection, 3) Community lobbying for API access to metadata stores at indexing agencies for ENVRI data repositories. These actions will be pursued further in ENVRI-FAIR;

- UNITUS – The major effort of UNITUS in the last reporting period, to make the tool operational, was dedicated to the activities needed to process raw data collected by Ecosystem sites having measurement systems with different setup and characteristics respect to those recommended by the ICOS-RI. The format of the input data now allows to process also data not collected under the ICOS framework and this has been a major step in the direction of the interoperability. The management of the data and metadata is not fully implemented and operational. The code will be available on a GitHub repository as soon as the final debug is finished, and in any case before the submission of the final report;
- ETHZ contributed to the discussions and development of Deliverable D9.4;
- CNR(ISTI) focused on continuing the offering of the data analytics platform stemming from WP7 and its exploitation to serve the needs of selected use cases. In particular, this data analytics platform is of primary interest for four cases: IC_3, IC_13, TC_17, SC_3. The development of three cases (IC_3, IC_13, SC_3) started in the previous period and have been continued in the reporting period by counting on the VRE developed by WP7 to showcase the technology. In the reporting period it was decided to develop dedicated working environments for supporting the cases: https://services.d4science.org/group/eiscatfor Use Case IC_3https://services.d4science.org/group/icoseddycovarianceprocessingfor Use Case IC_13https://services.d4science.org/group/particleformationfor Use Case TC_17 Moreover, CNR contributed to D9.2 Service deployment in computing and internal e-Infrastructure version.

Significant results

- Mapping of the data service user landscape (reported in D9.3);

- on-line tool – based on a survey platform – for service validation was developed (D9.4). This tool is likely to be further developed in the framework of the ENVRI-FAIR project;
- primary identification of data in a repository (homogeneous granularity, resolution fine enough to resolve data originator);
- the tool produced in this task and in Task 7.1 will have a high impact giving access to an advanced eddy covariance processing pipeline (the one used in ICOS) to other RIs;
- three virtual research environments dedicated to support selected use cases have been developed.

Deviations, reasons for deviations and corrective actions:

- The final deployment test was delayed due to insufficient staff availability. It is now planned for late 2019 or early 2020 and will contribute to the ENVRI-FAIR activities;
- The demonstrator deliverable D9.4 was delayed due to technical issues with the server platform and software package used for the service evaluator tool. After D9.4 was submitted in M51 instead of M46 as originally planned.

WP10 Governance for sustainable and adjustable access to RIs

WP leader: Paolo Laj (paolo.laj@univ-grenoble-alpes.fr) and Sabine Philippin (s.philippin@opgc.univ-clermont.fr)

WP participants: EISCAT, CNR, CNRS, INGV, ETHZ, INRA, RCN, UiT, FMI, EGI.eu

Introduction

The aim of this work package was to investigate which governance tools are most suitable to facilitate common, fair, and scientific merit based virtual, remote and physical access to environmental research infrastructures and to the data that they provide. Provision of access is a pillar activity of all RIs in ENVRI but the funding of service provision to users via physical and remote access to national nodes of Research Infrastructures is often not sufficiently secured and politically challenging. WP10 starts with consideration that none of the existing ENVRI related ERICs had included other access types than virtual access in their activities, while the physical access to platforms has been central to many RIs during the preparation and implementation phases. Work in WP10 that resulted in 4 deliverables (deliverables D10.1, D10.2, D10.3), has been elaborated through surveys of best practice and governance in the different ENVRIs that indeed confirmed the differences between RIs in access modalities, and the diversity of access strategies, in particular for virtual and physical access, and the experiences and results from the pilot programme for trans-national, multidisciplinary physical access programme implemented in WP11. This WP then discusses the main issues related to the provision of sustainable access to the facilities, resources and services of environmental research infrastructures. Being mostly of distributed nature, environmental research infrastructures need to develop appropriate access funding strategies that allow ensuring the viability of access provision in the long-term. Overall, in WP10, readers will find recommendations aiming at addressing the needs for developing sustainable solutions considering the open access principles, and complement the documents related to the guidelines, governance and management tools prepared in ENVRIplus WP10 for easy, efficient and effective access provision. In practice, based on an assessment of the present access policies, user needs and other requirements imposed by the community, WP10 provides:

- In task 10.1 and 10.2, a set of guidelines and a master-plan to facilitate open access that can be directly implemented by RIs;
- In task 10.3, wider-scope governance strategy describing which performance criteria for open access and list of performance indicators together with the principle options for developing an adequate and sustainable access cost model at individual RIs.

The work has relied heavily on communication and survey between the different RIs with the purpose to get a picture of the existing access policies, the procedures in place or envisaged to select users, the kind of users and their provenance, the specific provisions for the commercial use of data and for the access from private sector users, the specific outreach measures to attract users as well as legal and ethical issues. Findings from WP10 activities will serve in the future as a basis for implementing access at several RIs.

Task 10.1. Develop Guidelines on access to RIs

The overall objective of this task, led by CNR, is to give a set of recommendations to be used as a reference for the Environmental Research Infrastructures when defining data and access policies. This set of recommendations is based on the existing policies in ESFRI and other Research Infrastructures, research institutions and international projects as well as on the current European policies and regulations in place. Information was collected through a survey about the current procedures, modalities, and policies for access implemented within the RIs participating in ENVRIplus: ACTRIS, EGI, EISCAT 3D, EMSO, EPOS, ESONET-Vi, Euro-Argo ERIC, FixO3, SIOS, SOERE ACBB. In deliverable D10.1 – Guidelines on access to RIs (http://www.envriplus.eu/wp-content/uploads/2015/08/D10.1.pdf), RI managers find definitions, principles and guidelines for the access to Environmental Research Infrastructures (ENV RIs), being for the most part distributed research infrastructures presenting specific challenges and opportunities.

D10.1 gives a set of recommendations to be used as a reference for the ENV RIs when defining data and access policies, and explores the pertinent aspects related to access such as access and data policies (including data management plan, access management plan, access types, modalities, procedures and monitoring, user support, post-access provisions, costs, confidentiality and IPR rules, legal and ethical issues, etc.)

The different modalities of access to RIs are summarized in the graphic below:

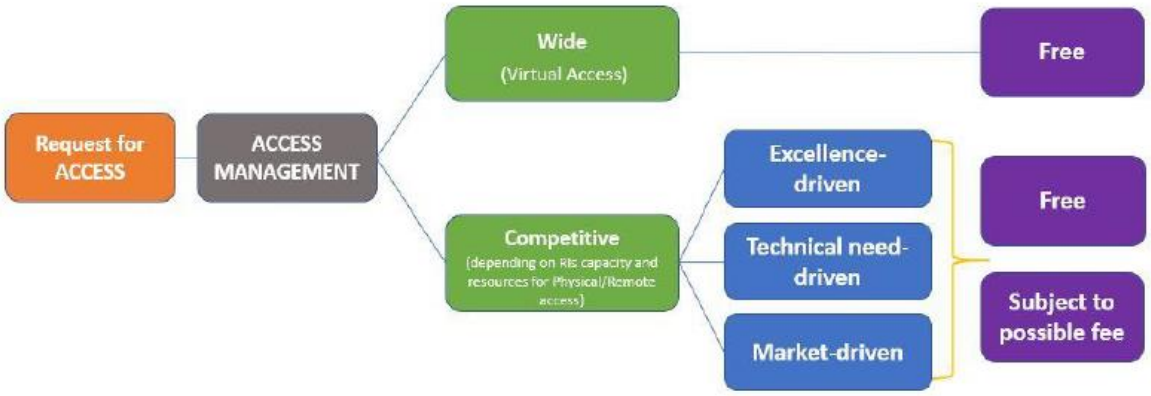


Figure 1: type of access provided by ENVRIs

A majority of the research infrastructures in the environmental domains (biosphere, atmosphere, hydrosphere, lithosphere), as well as in the ENVRIplus project, can categorized the different access modalities as physical, remote or virtual.

Physical access type is access involving hands-on access of any user, i.e., the users physically visit the RI installation. A competitive selection is needed for this access as it is capacity-driven and depends on the available resources. This is access to different facilities, observatories, laboratories, stations, platforms, research vessels, instruments etc.
Virtual access type is any access through communication networks in which resources can be simultaneously accessed by a theoretically unlimited number of users. A competitive selection process is not needed. This is typical for access to data and other digital tools.
Remote access type is the non-physical access of a user at the installation. The resources to be accessed are not unlimited and a competitive selection is needed. This is remote access to sensors, remote access to calibration facilities for instrument calibration, access to machine time, distribution of reference samples etc.
Such access can be granted, amongst others, to data, data-communication services, software, computing resources, samples, archives, observational facilities, fixed and mobile experimental facilities, education and training, expert support and analytical services.
Different access modes can also be defined:

- The Excellence-driven access mode regulates the competitive selection of users and is dependent on the scientific excellence, originality and quality, technical and ethical feasibility of an access proposal for scientific purposes;
- The Technical need-driven access mode regulates the competitive selection of users and is based on a technical need that can be satisfied through an access to RI services and/or facilities;
- The Market-driven access mode applies when there is a market need that can be satisfied through an access to RI to find market-oriented technical or scientific solutions.

D10.1 sets the base for a charter for access that specifically targets environmental research infrastructures defining the types of access provided, the selection modes, the procedures to select users, the support provided to users, post-access provisions, data and access policies, as well as the considerations related to access costs, confidentiality and IPR rules, legal and ethical issues, and principles for the monitoring of Research Infrastructures performance.

The document takes as its starting point the information gathered through a questionnaire sent to the research infrastructures participating in ENVRIplus. It is completed by a second deliverable D10.3 - Description of performance criteria for open access and list of performance indicators (http://www.envriplus.eu/wp-content/uploads/2015/08/D10.3.pdf) that addresses how specific Performance Indicators (KPIs) can be used to support the access strategy at RIs, especially considering the specific aspect of distributed RIs. KPIs should follow, in this sense, the specific objectives and specific strategies of the RIs.

D10.3 describes a range of key performance criteria for environmental RIs with respect to their open access activities and provides a list of possible key performance indicators. It is recommended that key performance indicators be set up at an initial stage in the lifetime of a research infrastructure, preferably during the establishment of the business model as part of the strategic plan for the infrastructure during its conception. They should be subject to periodic review to ensure they are fit for purpose and providing the necessary information.

D10.3 defines the KPIs into 4 different categories of metrics: 1) User metrics, that count the effective use and relevance and is most suited to virtual access, 2) the operational metrics, that are used to evaluate the organizational capacity to provide access. They include categories such as access, service, reliability, visibility, and size and are suited to all access type, 3) the

strategic indicators that are used to ensure that the research infrastructure is relevant for the scientific progress and for the community at large. It includes information on peer-reviewed publications and other scientific products, cross-disciplinarity use of the RI services, estimated economic impact. Finally, KPIs must also include 4) Financial metrics, with a clear mapping of its funding resources, in particular regarding to access. These could be either national funding, research infrastructure funding, funding from the European Commission, user fees, or a combination of all of these. Cost calculations are carried out to determine the return on investment (if any) for the monetary value of the research infrastructure. The document specifies however that the value on investment for a research infrastructure is not limited to the financial return, but instead often comes in less tangible forms such as visibility, scientific output or international collaboration.

Task 10.2. Develop Master plan to facilitate and encourage access (CNRS/UGA, EISCAT, CNR, RCN, UiT, FMI)

Among ENVRIplus objectives, one is to provide tools to the RIs to facilitate their implementation. This is clearly the case for the work performed in Task 10.2 under the responsibility of CNRS, which focuses on the tools that help to facilitate easy provision of access to services. Guidelines found in D10.2 - Master plan to facilitate and encourage access to RIs (http://www.envriplus.eu/wp-content/uploads/2015/08/D10.2.pdf) will help to ensure that access processes are handled responsibly and efficiently.

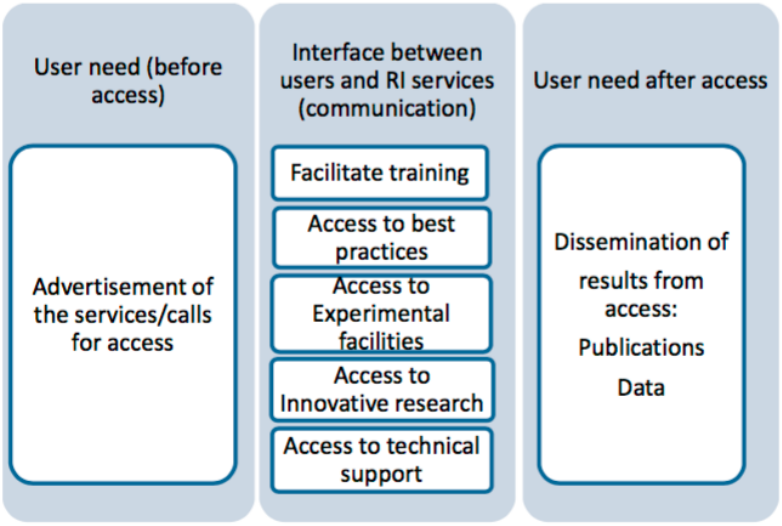
Good access and data policies should underpin the development of an access management plan and a data management plan establishing the key elements of successful access and data provision. Such plans define the access process, how data are to be handled for research use and provide guidelines for both staff and users. This sets of recommendation addresses 1) the need for Data Management Plan (DMP) to describe the methods and procedures in place for the management of data covering the collection, processing, data production, organization, storage, curation, publishing and sharing of data. A data management plan ensures that data are well managed in the present and prepared for preservation in the future. But the DMP must be completed with a specific 2) Access Management Plan (AMP) describing the guiding principles of the access management and process. AMP describes the types of access to these services as well as timelines for access to these services and the access management

procedures. Access and data management plans elaborate the roles and responsibilities of all parties throughout the process.

Effective use of RI services, particularly in the case of distributed ENV RIs, requires an efficient access management plan and management tools to ensure that the entire access process is easy, flexible, and facilitated. Fundamental requirements include i) the establishment of a single entry point, representing the interface between the users and the RI and its key elements (facilities, services, access providers, reviewers), and ii) a central RI access management ensuring a well-organized and harmonized handling of the entire access process, including advertisement and communication activities, helpdesk support, managing of the application and selection process, access workflows, access provision and support, post-access activities and outreach, and monitoring of access. The central management accompanies and supports the users throughout the entire process and is underpinned by proper management tools for efficiently managing and monitoring the access and results and for continuous and efficient information exchange and communication with the key players involved in the access process. A single-entry point ensures that users have a unique entry point for proposal submission, the RI through this principle is able to provide support and monitoring. This single-entry strategy is a strong demand from users, and in particular from users from the private sector, as the complexity and the diversity of the RI organisations are often difficult to overcome for non-academic users.

RIs should develop an on-line catalogue of services that allows users to easily find all relevant information about the RI services and access, availability, access modalities, costs, etc. The catalogue of services should be interactive and regularly updated, and help guiding the users in their quest for the needed infrastructure services. The catalogue of services aims at improving the visibility of the available RI services, and increases the efficiency in the RI services management.

Building trust in access procedures is also indicated as a key step in access provision. Clear criteria must be communicated in relation to the selection process, which is a multiple stage process to evaluate the access request following a defined procedure. D10.2 stresses the importance of a review panel with clear terms of reference. Finally, D10.2 insists on the importance of communication and outreach strategies for dissemination and stakeholder reach.



ENVRIplus_RP3_WP10_Fig2.png

Figure 2: Modalities for outreach and communication for access

Task 10.3. Develop RI strategy for flexibility and sustainability (CNRS/UGA, EISCAT, CNR, ETHZ) RCN, UiT, FMI, EGI.eu

CNRS/UGA has been leading task 10.3 addressing the strategy for flexibility and sustainability with respect to access to RI. A successful and performant RI provides services, resources and tools in line with the demands and needs of its user communities. Therefore, each RI should develop an appropriate strategy that considers the user dimension and user requirements and identifies potential gaps between the user needs (current and future) and its services offered. A research- and innovation-oriented user strategy must be developed that is clearly articulated and transparent, and which is continuously updated based on a solid knowledge of its user community, considering the category of users, their origin, size, and purpose of use and aiming at widening its use base. Implementing a sustainable strategy that will maintain access to services at acceptable conditions, and regular upgrades of services to maintain attractiveness is a key challenge.

Among the different RI types, distributed RIs are particularly challenging, requiring a high level of coordination and harmonized procedures. The principles of cost sharing for accessing the services depend on the specific RI type (virtual, single-sited, distributed). A funding mechanism appropriate for each RI type and its activities and common elements (including access and services provision) should be developed to guarantee long-term sustainability.

This is addressed in D10.4 – RI strategy for flexibility and sustainability (http://www.envriplus.eu/wp-content/uploads/2019/07/Deliverable-10.4_final-1.pdf), that is the resulting report for the whole WP10 and task 10.3 in particular. RIs are expected to consider and follow a set of guidelines that are recommended to ensure successful access to their data, services, and resources (see D10.1, D10.2 and D10.3).

D10.4 principally addresses the funding options to develop a robust financial framework key to favor a RI's long-term perspective of access provision and to ensure high quality services that are aligned with the user needs. The funding of access requires the calculation of the full cost of operations, and RI member should agree on how to cover the costs that are needed to ensure long-term sustainability of access. The possible pathways explored to make optimum use of the available funding sources for access provision are summarized in Table 1 below with possible benefits and drawback related to each funding sources. To date, the majority of environmental RIs do not consider systematic funding related to physical and remote access in their business model, and mostly rely on EU funding, and in particular via INFRAIA TNA, for financing physical and remote access. Being based on competitive calls, EU funding may fund access to RI only on a short-term basis.

Table 1: Benefits and drawbacks of access funding sources

Funding source	**Benefit**	**Drawback**
National and regional funding	+ Visibility to national nodes and facilities + Foster international cooperation + Long-term leverage effect and socio-economic impact	• Access provision mobilizes substantial additional resources (unequal country investment) • Requires a cost-benefit approach from the national side
EU funding (TNA)	+ Access is open and free-of-charge to all users (including those from countries outside the RI) + Access is user-driven + Additional funding for user mobility + Contribution to scientific excellence and user needs + Prevents potential user fees	• Project based (short-term) funding • High administrative effort required • Long-term sustainability is not guaranteed
RI funding	+ Access provision is based on a coordinated and harmonized access programme	• Membership contribution from RI members required

	+ Attractive to users + Support to long-term sustainability of access provision and aligned with RI user strategy + Free access to users from at least RI member countries + User mobility costs may be partially covered + Contribution to scientific excellence and user needs + Prevents potential user fees	• Agreement among RI members is required for division of costs to support costs of providing distributed resources (country-dependent access? Third country access? …)
Other funding	User fees: + Additional funding to cover variable costs of services + Provision of tailored or added-value services Private sector funding: + Additional funding to cover full costs of services + Provision of services-oriented access (user-specific and tailored services) + Promote technological development, knowledge transfer and innovation capacity + Promote co-innovate public-private collaborations	User fees: • Undermines RI principles of open access to services advancing knowledge, services and open science (open access is a driver for achieving and sustaining scientific excellence) • Restricted access to RI limits attractivity to users • Selection based on scientific excellence must prevail over user fees Private sector funding • Small fraction of users concerned • Limitations with respect to IP rights and scientific output (publishing policies)

The funding mechanisms may differ from one RI to another and vary according to the overall RI type, strategy, structure, and targeted user groups. Options provided in the table can only be implemented when the appropriate access cost models have been developed that allow estimating the relevant costs for efficiently deploying RI services based on the available access funding sources. The cost models need to be properly analysed and based on a calculation of access costs that consider all relevant costs required for access provision (Figure 3) .

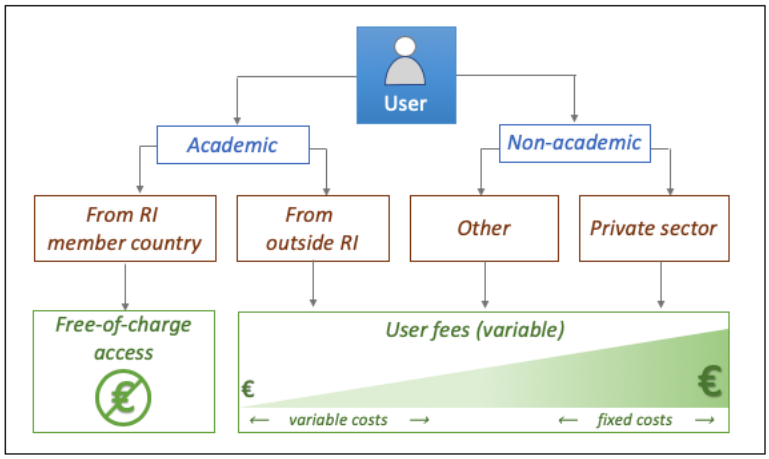


Figure 3: Schematic example of how a cost model may consider user fees based on the user category and origin.

To date, at the end of the ENVRIplus project, the majority of Environmental RIs finance their physical and remote access via EU projects, based on the TNA costs model. Very few RIs have adopted systematic funding mechanisms to cover the costs of physical and remote access, i.e., most of the RIs are based on access cost models that do not ensure a sustainable access provision in the long run.

It is clear that sustainability of access can only be guaranteed by aiming at a synergistic and optimal combination of available access funding sources. Each individual access funding source may be limited in time by itself but contributes to cover a limited fraction of the access costs. A sustainable access funding strategy for distributed research infrastructures requires a coherent and coordinated approach on all levels where all stakeholders, including the RI, European and national funders, RI managers and access providers, and the users, contribute to a fair level of expenses and support the access costs through an adequate coordination of the available funding mechanisms.

Therefore, funding for access – and in particular for physical and remote access within distributed RIs, requires an access programme for the majority of services provided, based on a competitive selection process, and coordinated and financially supported by the RI through membership contributions. In cases where access to users cannot be provided free-of-charge, funding from other sources (EU funding, users fees) may help to close the gap but should not be a priority. Access funding mechanisms should be considered in the early stages of an RI lifecycle (during preparation and implementation of an RI). A sustainable access funding

strategy requires a clear access policy, coordinated and harmonized access procedures, a centralized access management, and monitoring of access performance. A coordinated access funding plan along with an effective governance, trained personnel and staff, and long-term funding are fundamental conditions to facilitate and provide effective and efficient access to a large user community in a sustainable way.

Conclusions

Appropriate access mechanisms with dedicated access programmes are often not yet in place at environmental RIs, although their importance is widely recognized. It is not trivial to created modalities for access, which ensure easy access for users, as well as being well managed and recognized in KPIs. Viability of access provision can only be guaranteed by implementing access funding mechanisms that aim at synergies of all available funding sources, including national and regional funding, RI funding based on membership contributions, EU funding, or other funding (user fees, private sector funding) to be properly explored and optimally combined and coordinated. RI access provision should be competitive, based on scientific excellence, with RI funding that guarantees free-of-charge access as much as possible to services aligned to the needs of a variety of users.

Significant results

- Deliverable D10.1 provides guidelines and recommendations for defining data and access policies.
- Deliverable D10.2 proposes the essential tools for facilitating efficient access of users to RI services.
- Deliverable 10.3 describes a set of performance criteria allowing to evaluate an RI's access activities.
- Deliverable 10.4 discusses and provides recommendations for developing sustainable and flexible solutions for access to RI services.

Deviations, reasons for deviations and corrective actions

No deviations from the work plan, besides change in coordination from EISCAT to CNRS in Month 30th, that explain delays in submitting some deliverables.

WP11 New Concepts and Tools for Physical Access

WP leader: Sabine Philippin (s.philippin@opgc.univ-bpclermont.fr) and Abad Chabbi (abad.chabbi@lusignan.inra.fr)
WP Participants: INRA, CNRS, UGA, UR, UHEL, EISCAT, IFREMER, INGV, RCN

Introduction

The aim of this work package was to improve access to environmental RIs through exploring and promoting synergies of joint observation sites, cross-cutting research, and trans-national access programmes, to identify related requirements for the governance tools of RIs, and to explore best possible methods and procedures to provide cross-disciplinary access to sites. To promote the use of RI platforms and to explore and promote synergies of joint observation sites, the work was organized in three tasks with the objectives:

- to address the challenges that are connected to physical access and to the access across disciplines also outside the RI communities and including e.g. SME (Task 11.1);
- to implement physical access across disciplines to four identified fixed platforms operated by ENVRIPLUS partners that are used for test cases that can be particularly suitable for performing innovative research at the frontier between different domains. (Task 11.2)
- to suggest methods and procedures for future based on the outcome from tasks 11.1 and 11.2 (Task 11.3).

Task 11.1 - Assess the existing paths of physical access to RIs

and

Task 11.2 - Explore conditions for access to RIs across disciplines in fixed platforms and exploring conditions for access to RIs across disciplines in fixed platforms

Implementing physical access to multi-disciplinary fixed platforms

CNRS/UGA has been leading tasks 11.1 and 11.2 with the goal of exploring and testing a pilot access programme for access and use of multi-instrumented observation platforms for multidisciplinary research. This has involved a selection of dedicated multidisciplinary observation sites and a coordinated physical access process. In the first reporting period

(RP1), ENVRIplus has implemented physical access at different multidisciplinary platforms: each platform required to cover at least two or more environmental domains (atmosphere, bio-ecosphere, marine, and solid earth domain), and involve at least one or several RIs in order to enable multidisciplinary research through access to state-of-the-art instrumentation and expertise. During RP3, the four initially selected observation platforms (SMEAR II/UHEL, OSU-R/CNRS, INGV ETNA/INGV, SOERE-ACBB/INRA) were extended to ultimately six accessible multidisciplinary platforms (see figure 11.1). Two additional airborne platforms, a fleet of research unmanned aerial vehicles (USRL) and a drone-based research platform (P2OA/CNRS), for vertical profiling and applications in the atmospheric, marine, and bio-ecosphere domain, have been added in the last project period based on user demand and corresponding research needs. All observation sites are either singled sited, offering multidisciplinary collaboration in a single location (SMEAR II, SOERE-ACBB, USRL, P2OA), or multi-sited with several facilities located within a confined area (ETNA INGV, OSUR). Throughout the final reporting period, all facilities have offered access to the state-of-the-art on-site instrumentation, space for additional equipment, and in particular the expertise of the scientific and technical staff to support the access, as required.

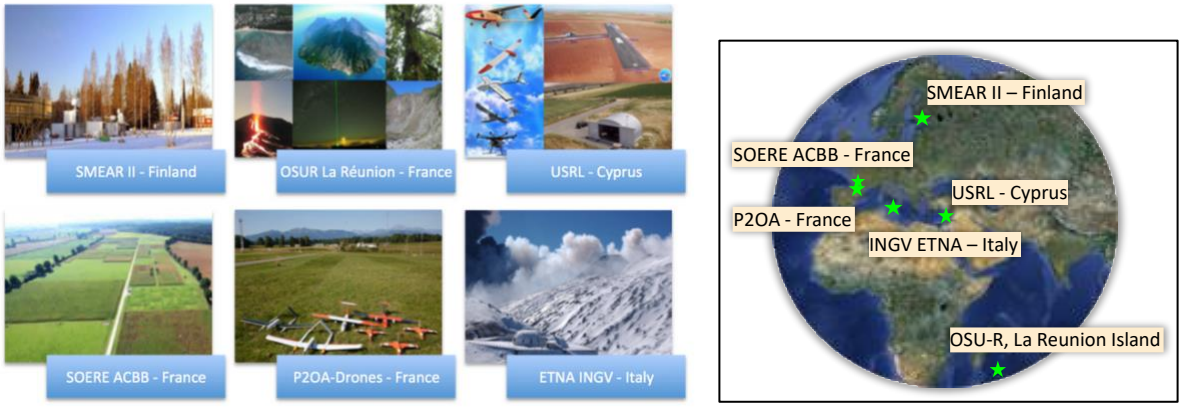


Figure 11.1: Overview of multidisciplinary sites for physical access (left) and their geographical location.

A coordinated access process for ENVRIplus has been implemented, which continued throughout the access provision in RP3, as a prerequisite. It has involved a central access management unit at CNRS to efficiently interact with the different actors including users, access providers (CNRS/OSU-R, INRA, INGV, UHEL), and the review panel (latter representing various environmental domains for evaluating the requests for multidisciplinary access). The coordinated process has been essential in the case of different RIs having adopted different access modalities to distributed facilities, for overall coordination and

monitoring of the access process, including adequate promotion of the multidisciplinary opportunities for access, support to the users, communication with all key actors involved in the process, reception of the proposals, coordinating the evaluation process, communication of the selection results to the users, collection of the reporting documentation and user feedback, and dissemination of the results. The access management office has provided administrative as well as financial support to facilitate the access of the users and their reimbursement of travel and subsistence expenses.

Three calls for multidisciplinary access have been made during the course of the ENVRIplus project, of which one final (third) call was issued in the final project period (call information for the final call: http://envri.eu/2018/03/04/3rdenvriplustnacallopen/). The call was open from January, 15-March, 9, 2018 for an access period from May, 1-December 31, 2018, granting up to 10 k€ of financial support to each user group. The procedure for application, review and selection is described in detail in deliverables D11.3 (http://www.envriplus.eu/wp-content/uploads/2015/08/D11.1-Report-on-planning-and-implementing-physical-access-across-disciplines.pdf) and D11.4 (http://www.envriplus.eu/wp-content/uploads/2019/06/Deliverable-11.4.pdf). A strong emphasis was placed on multidisciplinarity, which was required to be central in the project planning, work methodology and plan, choice of participants, and overall objectives. Applicants were also required to agree on making the results from the access projects available (including data and publications). The review has involved a two-stage process were the access providers were asked to evaluate the proposal with respect to feasibility, timing, and capacity, and only projects that passed the first stage were accepted for the second stage of the evaluation carried out by the review panel. Selection criteria focused on multidisciplinarity, scientific quality, innovation, and user profile with priority on new and young users and cross-domain training, and a gender-equal participation. The evaluation process has been the result of continuous discussions and improvement throughout the project with the access providers and particularly with the panel members. This was done at physical review meetings and during the ENVRI week meetings in order to optimize the process and reinforce and help to trigger the notion of multidisciplinarity in the very diverse ENVRI community, and also in exchange with the users. The improvements were implemented in the planning and execution of the access project of the final call.

Table 11.1: Overview of access project supported in the third call for multidisciplinary access including observation platform, environmental domain concerned and access period.

CALL 3					
1	NOME-TROPITREES (K. Machacova)	Nitrous oxide (N2O) and methane (CH4) fluxes from stems of different tropical tree species in Mare Longue Nature Reserve	OSUR	ATMO, BIO	Oct-Nov 2018
2	ENTER (A.L. Rizzo)	Emission in atmosphere of Natural gases and TEmporal variations Related to volcanic activity	OSUR	ATMO, SOLID EARTH	Oct 2018
3	RAVE@Etna (P.J. Gauthier)	Radon Analyses in Volcanic Emissions from Etna volcano: a tool to shed light on magmatic processes and environmental issues	ETNA-INGV	ATMO, BIO, SOLID EARTH	May/ Jul/ Oct 2018
4	GEOCUBE+@Etna (P. Briole)	Design of a light multi-parameters station based of the GEOCUBE+ architecture	ETNA-INGV	ATMO, SOLID EARTH	July/ Oct 2018
5	VAMOS-MS (J. Diaz)	Volcanic Airborne Gas Monitoring using the miniGas and miniature Mass Spectrometer UAV based Systems	ETNA-INGV	ATMO, SOLID EARTH	Sep 2018
6	FOXYY (I. Van Der Laan-Luijkx)	Measuring Forest Carbon and Oxygen Exchange in Hyytiälä	SMEAR II	ATMO, BIO	May/ Jul 2018
7	InLandOnABL&RCC (L. Pysarenko)	The Influence of Land cover changes On Atmospheric Boundary Layer and Regional Climate Characteristics	SMEAR II	ATMO, BIO	Aug 2018
8	ILUC-SH-GHGE (Taken over by N. Bilyera – *project accepted during ENVRI call 1 and carried out in RP3)*	Impact of land-use changes on soil health and greenhouse gases emissions	SOERE-ACBB	ATMO, BIO, SOLID EARTH	Jun – Dec 2018

Altogether, the three calls for multidisciplinary access resulted in 25 high quality projects being selected out of a total of 39 proposals received from both multi-domain and multi-national research teams. 23 of the projects were carried out. More than 80 researchers (including senior and early career scientists), engineers and technicians from 19 different countries inside and outside the European Union accessed the platforms. An overview and details of all access projects is given in deliverable D11.4.

Each individual call for access triggered between 10-15 submitted projects. All calls were very well planned and were accompanied by efficient advertisement through multiple channels, and significant financial support was provided to each user groups (up to 10 k€). The specific nature of the call (focus on multidisciplinarity) might have resulted in more limited responses of the user communities, and was possibly the reason why almost half of the proposals were considered insufficient either for their scientific quality or the missing multidisciplinary nature of the project. This, however, has been intended in order to push for more multi- or even interdisciplinarity. The planning and development of cross-domain projects through physical access might require a long(er) time period and maturation among and across the research communities. In a number of proposals received, the implication of the resources from multiple domains, including personnel, expertise, and instrumentation, has still been limited. The results, nevertheless, have proven that the access opportunities with some additional financial support have allowed to succeed in this direction, advance the knowledge, stimulate world-class research, and leverage the realization of novel projects and new collaboration at the interface of environmental domains.
The ENVRIplus post-access questionnaire, completed by the users and used to investigate and analyse their needs for interdisciplinary research, demonstrates that the scientific community is greatly favourable to the interdisciplinary access programme and to the provision of a

framework and research capacity for multidisciplinary approaches on a user-oriented basis. The users have confirmed that the ENVRIplus pilot access programme has been an excellent opportunity to gather research teams that have never worked together before and start an interdisciplinary collaboration, to complement disciplinary expertise and stimulate the planning and organisation of research using multidisciplinary approaches and, thus, broaden, the impact and findings and make science in a successful way.

The ENVRIplus multidisciplinary pilot access programme has been beneficial for both the scientific community and beyond. It has demonstrated that some of multidisciplinary research projects would have never been carried out without the support of a coordinated framework. Multidisciplinary research is challenging, as it requires combining diverse expertise and well-chosen skills for the scientific question concerned, both on the user side but particularly also on the facility side providing access to equipment and instrumentation as well as technical and scientific support. A strategy is required for integration among the scientific communities around the multi- or interdisciplinary research project. Experience from ENVRIplus has shown that initial collaborations (among users, but also with the facility staff) have triggered further research. Financial support is key to generate high-quality research and outcomes. In this sense, ENVRIplus has been efficient in promoting the mobility of environmental researchers and foster international collaboration. The requirements and multidisciplinary criteria have achieved a synergistic approach for advancing the integration of research activities across environmental domains at the RI and facilities and for pushing multidisciplinary collaboration among the scientific user communities world-wide. A purely user-driven approach by itself does not prove to be sufficient to promote interdisciplinarity, and particularly not within a single research infrastructure. Coordinated programmes, access procedures and funding are required to promote and tackle scientific challenges across RIs and domains.

The status, progress and outcome of tasks 11.1 and 11.2 were presented and continuously discussed at the meetings listed in table 11.2. The results of the research projects are summarized in deliverable D11.4 and the detailed scientific reports of each access project are available on the ENVRI community platform (https://wiki.envri.eu/display/EC/Multidisciplinary+Access). CNRS has provided administrative and financial support and reimbursed the research teams. All access providers (INRA for SOERE-ACBB in France, CNRS/UR for OSU-R on La Réunion Island in France,

UHEL for SMEAR II in Finland, INGV for MT ETNA INGV in Italy) have been involved in providing the physical access on their platforms and the facility staff has been very efficient and supportive to the users for preparing and carrying out the access projects. The users have been publishing the outcomes of the access projects and presented the results at international conferences and meetings but also in the frame of the ENVRIplus project meetings. The publications resulting from the three calls for access are listed in table 11.3. As the analysis of the results from physical access takes time (often beyond the project duration), the data and results are only published with some time lag. A number of ENVRIplus data sets resulting from access have been placed on Zenodo or institutional repositories. WP11 open datasets are included in D19.7 ENVRIplus final data management plan (http://www.envriplus.eu/wp-content/uploads/2019/07/D19.7.pdf).

The ENVRIplus pilot programme has been very successful in implementing the multidisciplinary access programme and supporting high-quality projects. The selected projects present a clear added value to ENVRIplus, beyond the limits that a single environmental RI could achieve. They are a first step towards cutting-edge research at the interface of different environmental domains. In the third call, eight out of twelve projects have been supported (see table 11.1).

Table 11.2: Overview of WP11 meetings related to tasks 11.1+2 during the project. Those held in RP1 and RP2 are greyed out.

Event	Date	Location	Available material
ENVRIplus Kick-off meeting	May 11-13, 2015	Helsinki, Finland	Presentations
WP11 planning meeting	Jun 15, 2015	Paris, France	
WP11 session at 1st ENVRIweek	Nov 16-20, 2015	Prague, Czech Republic	Presentation, minutes
1st Access review meeting	May 3, 2016	Paris, France	Presentation, minutes
WP11 session at 2nd ENVRIweek	May 9-13, 2016	Zandvoort, Netherlands	Presentation, minutes
WP11 session at 3rd ENVRIweek	Nov 14-18, 2016	Prague, Czech Republic	Presentation, minutes
2nd Access review meeting	Mar 29, 2017	Paris, France	Presentation, minutes
WP11 session at 4th ENVRIweek and MTR meeting	May 15-19, 2017	Grenoble, France	Presentation, minutes
WP11 session at 5th ENVRIweek	Nov 6-10, 2017	Malaga, Spain	Presentation, minutes
WP11 planning meeting	Jan 22, 2018	Clermont-Ferrand, France	
3rd Access review meeting	Apr 24, 2018	Paris, France	Presentation, minutes

Event	Date	Location	Available material
WP11 session at 6th ENVRIweek	May 14-18, 2018	Zandvoort, Netherlands	Presentation, minutes
COOP+ /ENVRI workshop on shring experiences and solutions	May 17-18, 2018	Zandvoort, Netherlands	Presentation
WP11 session at 7th ENVRIweek	Nov 5-9, 2018	Riga, Latvia	Presentations (incl by users)
WP11 session at 8th ENVRIweek	Mar 25-29, 2019	Helsinki, Finland	Presentation
ENVRIplus Dissemination event	June 4, 2019	Brussels, Belgium	Presentation

Implementing physical access to research vessel (IFREMER)

The activities related to subtask of Task 11.1 have been completed in RP2 under the responsibility of IFREMER and are described in the technical RP2 report. The plan for a sustained multi-year planning of oceanographic vessels for the European environmental RIs has been comprehensively summarized in deliverable D11.2 (http://www.envriplus.eu/wp-content/uploads/2015/08/D11.2-Plan-for-sustained-multi-year-planning-of-Oceanographic-Vessels-for-the-Environment-European-Research-Infrastructures.pdf). The work has investigated the available capacities of the European oceanographic fleets and related it to the needs of the Research Infrastructures in Europe (ICOS, EUROARGO, EMSO/FixO3, SIOS, EMBRC, JERICO). The work has mostly been based on data collected by the EUROFLEET 1 (2009-2013) and EUROFLEET 2 (2013-2017) integrating activity projects aimed at fostering the coordination of and access to European research vessels. The recently started project EUROFLEETS+ (2019-2023) will bring together the key marine research actors (research vessel operators) world-wide to continue addressing the evolving needs of the research and industrial communities including physical access.

Table 11.3: Currently available publications resulting from the ENVRIplus pilot access programme. This list is not exhaustive as more publications are expected once the outcomes from the projects carried out during the final reporting period have been analysed and published.

Access call n°	**Publications and presentations linked to the ENVRIplus access projects**
Call 1	Chen H., Kooijmans, L.M.J., Sun, W., Aalto, J., Erkkilä, K.-M., Maseyk, K., Seibt, U., Vesala, T., Mammarella, I: "Observations of carbonyl sulfide in a boreal forest", Keck Institute for Space Studies workshop, Caltech, Pasadena, CA, USA, Sep 18 – 22, 2017. Kooijmans, L.M.J., Maseyk, K., Vesala, T., Mammarella, I., Baker, I.T., Seibt, U., Sun, W., Aalto, J., Franchin, A., Erkkilä, K.-M., Kolari, P., Keskinen, H., Levula, J., and H. Chen: "From Carbonyl Sulfide (COS) ecosystem fluxes to GPP: integrating soil, branch and ecosystem fluxes", AGU Fall meeting, 12-16 December, San Francisco, California, 2016. Kooijmans, L.M.J., Sun, W., Aalto, J., Erkkilä, K.-M., Maseyk, K., Seibt, U., Vesala, T., Mammarella, I., and H. Chen: "From Carbonyl Sulfide (COS) ecosystem fluxes to GPP: integrating soil, branch and ecosystem fluxes", International Carbon Dioxide conference, 21-25 August, Interlaken, Switserland, 2017. Kooijmans, L.M.J. "Carbonyl Sulfide as a tracer for gross primary production (GPP): from instrumentation to application", BBOS autumn meeting, 25-27 October, Nijmegen, The Netherlands. Linda M. J. Kooijmans, Wu Sun, Juho Aalto, Kukka-Maaria Erkkilä, Kadmiel Maseyk, Ulrike Seibt, Timo Vesala, Ivan Mammarella, and Huilin Chen: "Influences of light and humidity on carbonyl sulfide-based estimates of photosynthesis", PNAS February 12,2019 https://doi.org/10.1073/pnas.1807600116 Liebmann, J., Karu, E., Sobanski, N., Schuladen, J., Ehn, M., Schallhart, S., Quéléver, L., Hellen, H., Hakola, H., Hoffmann, T., Williams, J., Fischer, H., Lelieveld, J., and Crowley, J. N.: Direct measurement of NO3 reactivity in a boreal forest, Atmos. Chem. Phys. Discuss., 2017, 1-34, doi:10.5194/acp-2017-975, 2017.

Liebmann J., Sobanski N., Schuladen J., Karu1 E., Hellen H., Hakola H., Ehn M., Riva M., Williams J., Fischer H., Lelieveld J. and Crowley J.N.: Alkylnitrates in the boreal forest: Formation via the NO3 and OH induced oxidation of BVOCs and atmospheric lifetimes, Atmos. Chem. Phys., 18, 3799-3815, https://doi.org/10.5194/acp-18-3799-2018, 2018.

M. Polacci, D. Andronico, J. Taddeucci, A. Cristaldi, M. de' Michieli Vitturi, Mechanisms of ash generation at Mount Etna, manuscript in preparation.

P. Sellitto, G. Salerno, P. Briole, The EtnaPlumeLab (EPL) research cluster: advance the understanding of Mt. Etna plume, from source characterisation to downwind impact, Annals of Geophysics, 60, ISSN 2037-416X, 2017

P. Sellitto, G. Salerno, A. La Spina, T. Caltabiano, L. Terray, P.-J. Gauthier, P. Briole, A novel methodology to determine volcanic aerosols optical properties in the UV and NIR and Ångström parameters using sun-photometry. Journal of Geophysical Research: Atmospheres, Accepted for publication. Doi: 10.1002/2017JD026723, 2017.

P. Sellitto, G. Salerno, A. La Spina, T. Caltabiano, S. Scollo, A. Boselli, G. Leto, R. Zanmar Sanchez, S. Crumeyrolle, and P. Briole "Small-scale volcanic aerosols variability, processes and direct radiative impact observed at Mount Etna during the EPL-RADIO campaigns", in Preparation

P. Sellitto, S. Scollo, A. Boselli, G. Leto, R. Zanmar Sanchez, G. Salerno, A. La Spina, T. Caltabiano "LiDAR observation of co-located volcanic, dust and biomass-burning aerosol and their radiative impact", in Preparation

Terray L., Gauthier P.-J., Salerno G., Caltabiano T., La Spina A., Sellitto P., Briole P., A New Degassing Model to Infer Magma Dynamics from Radioactive Disequilibria in Volcanic Plumes, MDPI Geosciences, 8(1), 27; Doi:10.3390/geosciences8010027, 2018.

Zha, Q., Yan, C., Junninen, H., Riva, M., Aalto, J., Quéléver, L., Schallhart, S., Dada, L., Heikkinen, L., Peräkylä, O., Zou, J., Rose, C., Wang, Y., Mammarella, I., Katul, G., Vesala, T., Worsnop, D. R., Kulmala, M., Petäjä, T., Bianchi, F., and Ehn, M.: Vertical characterization of Highly Oxygenated Molecules (HOMs) below and above a boreal forest canopy, Atmos. Chem. Phys. Discuss., 2017, 1-32, doi:10.5194/acp-2017-1098, 2017.

	P. Sellitto, G. Salerno, A. La Spina, S. Scollo, A. Boselli, G. Leto, R. Z. Sanchez, T. Caltabiano, S. Crumeyrolle, and P. Briole. Small-scale volcanic aerosols variability and processes observed at Mount Etna during the EPL-RADIO measurement campaigns, EGU General Assembly 2019 (Wien, Austria), 2019 P. Sellitto, G. Salerno, A. La Spina, S. Scollo, A. Boselli, G. Leto, R. Z. Sanchez, T. Caltabiano, P.-J. Gauthier, L. Terray, S. Crumeyrolle, and P. Briole. Caracterisation of volcanic aerosols emissions, small-scale variability and processes at Mount Etna during the EPL-RADIO measurement campaigns. IAVCEI Cities on Volcanoes 2018 (Naples, Italie), 2018. P. Sellitto, G. Salerno, A. La Spina, S. Scollo, A. Boselli, G. Leto, R. Z. Sanchez, T. Caltabiano, P.-J. Gauthier, L. Terray, and P. Briole. Small-scale volcanic aerosols variability and processes observed at Mount Etna during the EPL-RADIO measurement campaigns. Journée thématique LiDAR 2017 (Palaiseau, France), 2018. P. Sellitto, G. Salerno, and P. Briole. The Etna Plume Lab research cluster. 2eme Colloque ENS/SGF (Ecole Normale Supérieure/Société Géologique de France) Panaches Volcaniques (Paris, France), 2017.P. Sellitto and A. Miconi. Expédition au sommet de l'Etna. GEO France (online), https://photo.geo.fr/expedition-au-sommet-de-l-etna-19882, 2017 S. Barbosa, 2018, Space-atmosphere-surface interactions from ambient radioactivity measurements at Hyytiälä RI – 7Th ENVRI week 5-9 November 2018 Tallink Hotel Riga - Latvia N. Bilyera, 2019 Grassland introduction into cropping cycles increases natural soil fertility and soil microbial activity. - Lunch-Time Talks At Envri Community Booth - ENVRI Community Booth @EGU19 Stands 02-03, Exhibition Entrance Hall
Call 2	Moinet, G. Y., Midwood, A. J., Hunt, J. E., Rumpel, C., Millard, P., & Chabbi, A. (2019). Grassland Management Influences the Response of Soil Respiration to Drought. Agronomy, 9(3), 124. https://doi.org/10.3390/agronomy9030124

	Marco Liuzzo; Andrea Luca Rizzo; Andrea Di Muro; Patrice Boissier; Philippe Kowalski; Guillaume Boudoire; Pierre Tulet; Jean-Marc Metzger Natural Impact of passive and active volcanic CO2 degassing activity on the atmosphere. ENVRI week 14-18 May 2018 NH Hotel Zandvoort - Netherlands Irene Olive Samarra, 2018 MACRORE project - A multidisciplinary approach for tropical seagrass – 7Th ENVRI week 5-9 November 2018 Tallink Hotel Riga - Latvia
Call 3	Lasri, Mohamed-Amjad, Briole, P, Thom, Christian, Martin, Olivier, Verluise, F, Bonforte, Alessandro, VOLCANOES MONITORING USING THE GEOCUBE SENSORS NETWORK. Feed-back from a deployment on Mount Etna, DOI 10.13140/RG.2.2.35180.05761, Doctoral Congres ED560, 2018 March 2018 Lasri, Mohamed-Amjad, Utilisation de réseaux de capteurs pour la mesure conjointe des déformations du sol par GPS de précision et de paramètres physico-chimiques dans un contexte volcanique, Thèse de l'Ecole Normale Supérieure, 2018 December 18. Machacova K, Borak L, Agyei T (2019) Trees as net sinks for nitrous oxide (N2O) and methane (CH4) in tropical rain forest on La Reunion island. EGU General Assembly 2019, Vienna, Austria, 7–12 April 2019. (Geophysical Research Abstracts Vol. 21, EGU2019-7045, 2019). Boudoire, G., Rizzo, A.L., Arienzo, I., Di Muro, A., 2019. Helium isotopes decipher paroxysmal eruptions inducing caldera collapse. EGU General Assembly 2019. Boudoire, G., Rizzo, A.L., Di Muro, A., Grassa, F., Liuzzo, M., 2018. Extensive CO2 degassing in the upper mantle beneath oceanic basaltic volcanoes: first insights from Piton de la Fournaise volcano (La Réunion Island). Cities on Volcanoes 10 Conference. Andrea L. Rizzo, Marco Liuzzo, Guillaume Boudoire, Fausto Grassa, Andrea Di Muro, Patrice Boissier, Philippe Kowalski, Pierre Tulet, Guillaume Guimbretiere, Jean-Marc Metzger 2019. Emission in atmosphere of natural gases and temporal variations related to volcanic activity – 7Th ENVRI week 5-9 November 2018 Tallink Hotel Riga - Latvia

	Marco Liuzzo, A.L. Rizzo, G. Boudoire, F. Grassa, A. Di Muro, P. Boissier, P. Kowalski, P. Tulet, G. Guimbretiere, J-M. Metzger 2019. Volcanic gas emissions in the atmosphere at la Reunion Island: results from NICO and ENTER projects supported in the framework of the ENVRIplus (TNA) - Lunch-Time Talks At Envri Community Booth - Life Below Water & Multi-topic - ENVRI Community Booth @EGU19 Stands 02-03, Exhibition Entrance Hall

Task 11.3 Assess the use of governance tools and TNA within clusters of RIs to promote inter-disciplinary research

Based on the output from the tasks 11.1 and 11.2, task 11.3 has explored solutions for future multidisciplinary physical access, and assessed its added value and benefit to the community. Interdisciplinary research is considered as an essential approach to tackle the environmental problems that our society is facing, as the processes between the biosphere, geosphere, hydrosphere, and atmosphere are closely interlinked. Experience from the pilot programme for multidisciplinary access shows, however, that interdisciplinary research requires more time and effort than single discipline research. In order to encourage interdisciplinary research, dedicated and coordinated research programmes are needed. Based on lessons learnt from the pilot access programme, ENVRIplus recommends best methods for implementing physical access to interdisciplinary research capabilities:

- **Use the full capacity of joint observation sites**. A first step towards multidisciplinarity builds on the existing RIs capabilities. Bringing together the research teams from multiple disciplines at locations where several RIs are present as well as encouraging and optimizing multiple platform use is a key to integration. A strategy to develop multi-domain efforts is required to enhance synergies across the disciplinary boundaries.
- **Central access management and a coordinated access process.** Adequate governance tools are more essential to the implementation of physical access for multidisciplinary purposes than within a single discipline, including an access policy and management plan describing the modalities and procedures for the access process, and a data policy and management plan setting the principles for the use, sharing, and exploitation of multidisciplinary data and results. Central access management will ensure that the required communication and access procedure between the key actors in the process are efficient and effective, and that the access strategy within the multidisciplinary context is adequately implemented from the planning to application, evaluation and selection of users, support to access, management of results, dissemination, and monitoring.
- **Enhance the use and availability of multidisciplinary research data.** Archiving and management of multidisciplinary data resulting from access is still challenging, requiring some degree of interoperability between RIs and handling of often heterogeneous user data, potentially or partially collected by non-standardized

methodologies. Nevertheless, research findings and highlights from multidisciplinary research collaborations and synergistic approaches should be made available to the scientific communities and users encouraged to publish their results. Multidisciplinary research may produce new breakthroughs and be essential for advancing our knowledge and understanding of the environmental processes and interactions, and be of great benefit for scientists, modellers, regional and national authorities, and the society.

- **Funding of physical access to multidisciplinary research**. Funding and financial support to users is crucial. Experience from ENVRIplus has shown that even limited funding has been able to initiate new collaborations and to develop multidisciplinary research projects, and to allow composition of multi-national research teams with expertise across domains. Specific and dedicated funding is a big and necessary incentive for promoting multidisciplinary research, also at the RI facility level as physical access requires additional resources.
- **Communication and outreach**. The advertisement of access opportunities, particularly in a multidisciplinary framework, are a key and strategic tool to promote the available capabilities to wide user communities and beyond the RI boundaries. Communication and its tools are fundamental for building the bridges between the RIs and their scientific communities in order to bring them closer towards common multi-/interdisciplinary research goals. Multidisciplinary research is still at its beginning, with a large potential to be developed. It is often hindered by a lack of communication between the RIs and research communities, and an intradisciplinary (and limited) vision for addressing scientific questions.
- **Coordinated access framework and attractiveness to users**. Coordinated access programmes and appropriate funding based on a coherent approach where different stakeholders (funders, research organisations, RIs, scientists, users) contribute at a fair level, are essential to enhance the attractiveness of multidisciplinary research opportunities. Finding common ground for multidisciplinary research can be challenging for users. Collaborating RIs strategies are essential for multidisciplinary objectives. Future coordinated programmes should support user-driven efforts within a regulated access framework, considering research needs and gaps. Some major issues pertaining to multidisciplinary access were outlined from this ENVRIplus experience by both users and access providers. The need for scientific contacts with experts among the environmental domains in order to fully exploit cross-cutting scientific topics is

evident. Therefore, networking efforts will be essential in future to stimulate the research across domains towards more interdisciplinarity.

Multiple benefits of interdisciplinary research opportunities through the physical access activities can be demonstrated. Experience from the ENVRIplus access programme has shown that the activities have clearly promoted multidisciplinary collaboration and triggered further research. They have fostered combining of diverse expertise and well-chosen skills, coherent methodologies, and common objectives, as well as understanding and respect for other disciplines and approaches. Innovation is part of the integration process but requires incentives. The multidisciplinary research opportunities and collaboration across RIs supported by the project have been an important step towards interdisciplinary research. Given the complexity of the Earth's system, interdisciplinary research is the right approach to address the environmental problems we are facing today. Changes in the environment cannot be decoupled form our economic, societal, and political structures. Advances in science, integrating the knowledge and expertise of different RIs, allows for optimized use of the available RIs and facilities in a most efficient and innovative way. This in turn can help to address environmental issues and bring important benefits for the society. Therefore, new insights from multidisciplinary science are for the benefit of the society as a whole. Optimizing the use and access to RIs for multidisciplinary research by scientists and stimulating innovation will promote competitiveness and set the ground for addressing societal challenges. The capacity for interdisciplinary integration, end user needs, access implementation requirement and added value for the scientific community is summarized in deliverable D11.4 (http://www.envriplus.eu/wp-content/uploads/2019/06/Deliverable-11.4.pdf).

A white paper has been provided by INRA as deliverable D11.3 (http://www.envriplus.eu/wp-content/uploads/2019/08/ENVRIplus-DWP11.3-final.pdf), analyzing critical issue regarding the multidisciplinary access to environmental RIs with the goal to ensure that both anticipated and unanticipated users can find, obtain, evaluate, understand, compare, and use legacy data in new ways or performing complementary experiments to a better understanding of the underlying problems. The white paper provides specific insights on how to build capacity for multidisciplinary research within the environmental RIs and the path forward to improve multidisciplinary access including the principals for building interdisciplinary access to RIs. The main aspects were presented at the final ENVRI.

Significant results

- Implementation of third call for access to six multi-instrumented observation platforms, with eight high-quality multidisciplinary projects selected and supported, expected to result in further publications and available data on leading-edge work carried out across environmental domains.
- Development of a strategy for needs of a coordinated framework to support access to multidisciplinary opportunities, specific requirements, and benefits to the community.
- Deliverable D11.2 is an exhaustive analysis of the needs and available capacities of the European oceanographic research vessels and delivery was delayed to this RP due the comprehensive scope of the work.
- Deliverable D11.3 is a whitepaper that strongly advocates the need for a new approach based on interdisciplinary access to address the complex environmental problems society is facing today.
- Deliverable D11.4 is a comprehensive report assessing the experience and outcome of WP11 work, on the benefits and recommendations of interdisciplinary research through physical access.

Deviations, reasons for deviations and corrective actions

There are no deviations to be reported in WP11. It is essential to note that the results of WP11 and lessons learnt have been a fundamental input for work carried out in WP10 for developing the governance tools for access to RI, also reflected in deliverables D10.1-4.

WP12 A Framework for Environmental Literacy

WP leader: Florian Haslinger (florian.haslinger@sed.ethz.ch)

WP participants: ETHZ, ICOS ERIC, IFREMER, INRA, EAA

Introduction

Embedded in ENVRIplus theme 4 'Societal Relevance and Understanding', WP12 'A Framework for Environmental Literacy' addresses the role of Environmental domain Research Infrastructures in the generation of knowledge from observation and the subsequent derivation of actions and decisions, in the context of interactions between the environment and human societies.

WP12 aimed to provide operative indications that can feed into best practices of environmental RI development to assist program managers and policy makers to make informed decisions on the further development of RIs.
The main objectives of WP12 were thus defined

- to implement a practical approach to link Earth observation data provided by European RIs to human systems by questionnaires and use cases;
- to develop a module for the ENVRI Reference Model that enables RIs to describe their data impact within a common approach;
- to develop an efficient feedback system to adjust their data generation to the evolving needs of the human system, including efficient funding mechanisms;
- to improve connections with other ESFRI domains (Culture, Biological and Medical Science) and to the economy in its broader sense.

Summary of activities

The three tasks of WP 12 have continued their activities in accordance with the work plan. As noted already in the 2nd periodic report, we encountered various delays on the way, so that some of the deliverables shifted towards later stages of the project. Further, a new deliverable was added to task 12.3 (D12.4) as part of the 3rd amendment to the Grant Agreement.

During the last 19 months of the project, task 12.1 finalized the work on building the new ENVRI RM module to characterize 'societal relevance' of RIs with respect to published Grand Challenges systems and submitted deliverable D12.1, task 12.2 finalized deliverable D12.2, and task 12.3 elaborated the newly added deliverable D12.4 on the development of a prototype centralized interface to a federated site catalog for ecosystem observation facilities.

WP12 partners participated in the ENVRI weeks during the reporting period, organizing WP specific discussions and reporting status and intermediate results.

Task 12.1 Template for a ENVRIplus Reference Model Module embedding the HES approach

EAA achieved the development of the RM module template to capture the Grand Challenges classification as a new class within the ENVRI RM 'science viewpoint'. In addition, EAA with contribution from all WP partners, executed a thorough comprehensive analysis of the RI responses to the initial 'Grand Challenges questionnaire'. The results of this analysis again highlighted the strength of this classification approach that provides a very particular view of environmental RIs connection to and relevance for the various societal challenges, further enhanced by the assessment of RIs role with respect to the 'observing - forecasting - confining - responding' science workflow.

IFREMER completed its investigation how to assess the economic impact of RIs within the 'upstream-downstream-feedback' systematic, and developed an approach to capture this assessment. The approach highlighted different categories of impacts and proposed a set of indicators to be used in the assessment.

ETH supported the development of the final deliverable and coordinated with the other partners regarding their respective inputs.

The results of these efforts are comprehensively described in deliverable D12.1 'ENV RIs and Grand Challenges', submitted at the end of the project.

Task 12.2 Operational forecasting, communication and decision making in crisis situations

This task was basically completed at the end of the last reporting Period (12/2017). The Deliverable D12.2 'White paper on general guidelines, recommendations, and best practices on communication and decision making under uncertainty for environmental hazards and natural disasters' was submitted for internal review early 2018, and was finally submitted early March 2018. The results were further discussed with colleagues within and outside ENVRIplus, and will feed discussions in other new projects especially in the EPOS context. A future scientific journal article is still envisioned.

Task 12.3 Operational framework for RIs terrestrial ecosystem research related to biogeochemical cycles

A new activity was included in Task 12.3 late 2018, to allow for better integration and discovery of site information across environmental RIs. Based on the existing DEIMS-SDR platform, EAA developed the prototype of a distributed site catalogue, allowing for discovery of and access to site descriptions. Results of this work are documented in Deliverable D12.4 'Prototyping a distributed site catalogue', including an analysis of existing site catalogs, design considerations regarding a federated site catalog, a concept for an RDF based federated site catalog, alignments of DEIMS-NEMSR and DEIMS-ICOS, requirements and conclusions.

Significant results

Main results achieved during the reporting period were the completion and publication of deliverables D12.2, D12.4, and the finalization of the work in task 12.1 with the submission of D12.3 at the end of the project.

Despite the various delays encountered during the execution of WP12, the various tasks managed to complete their work by the end of the project, and the results achieved have already shown significant impact within the ENVRI community.

Publications

no new journal publications during this reporting period

IFREMER presented the economic impact assessment work at EGU 2019.

Deviations, reasons for deviations and corrective actions

The efforts required for the completion of task 12.1 (creation of the RM model template and comprehensive analysis of the Grand Challenges review) turned out to be significantly higher than initially envisioned, and D12.1 wass therefore only submitted at the end of the reporting period.

WP13 Developing an Ethical Framework for RI

WP leader: Silvia Peppoloni (silvia.peppoloni@ingv.it)

WP participants: INGV, ETHZ

Introduction

WP13 was included in Theme 4 of the ENVRIplus project and it was organized into 3 tasks. Participants in this WP came from INGV and ETHZ, and were involved in two RIs (EMSO and EPOS). The activities of WP13 aimed to:

- increasing the awareness of both the scientists and the public on the importance of ethical aspects in Earth sciences;
- establishing a shared ethical framework of reference, to be adopted by RIs governing bodies;
- increasing the awareness of RIs management and operational levels and of the individual involved scientists on their social role in conducting research activities and research work environment;
- assessing the ethical and social aspects related to the results achieved and deliverables released within the project.

Task 13.1. State of art/reconnaissance of ethical issues

The task 13.1 has been firstly dedicated to define a state of art on ethical issues useful for the goals of the WP13. The state of art assessment consisted of the collection and analysis of materials already existing within scientific organizations and institutions all over the world (codes, definitions, statements relative to ethics in the research and professional activities). The list of documents that were considered significant for the goals of task 13.1 was included in the internal milestone report iMi 13.1.1, available in the ActiveCollab page.

The second main activity of the task 13.1 was the creation of a questionnaire entitled "What do you know about ethics in geosciences?", through which we explored how individual participants in ENVRIplus and each RI involved in the project face ethical issues in relation to their activities. ETHZ collaborated on the design and development of the questionnaire and the evaluation of the initial testing.

The topics included in the questionnaire concern data integrity and truthful research conduction, respect towards colleagues, dissemination of research results and uncertainties,

risk and science communication, education to the public, relationship between RIs and stakeholders, the awareness of the responsibility by scientists towards the society and environment.

Before compiling the questionnaire, the interviewed individuals were informed about the characteristics of the survey. The questionnaire was filled out anonymously, aimed at people in the performance of their institutional activities, therefore without requesting personal data, and without any reference to the physical, physiological, mental, economic, cultural or social identity.

The results of the survey allowed to identify key-points on which to act in order to:

- increase the awareness of scientists on the importance of ethical aspects in science;
- establish a shared ethical framework of reference, to be adopted by RIs governing bodies;
- increase the awareness of RIs management and operational levels and of the individual involved scientists on their social role in conducting research activities and research work environment.

All the elaborations related to the answers to the questionnaire were included in the deliverable D13.1, available in the ENVRIplus website at: http://www.envriplus.eu/wp-content/uploads/2015/08/D13.1.pdf.

Costs

Costs related to the activity of the task 13.1 have included those relative to the participation in the following congresses to promote activities and results of the WP13:

a) 72nd IUGS meeting (Potsdam, Germany, 22-25 January 2018)
b) EGU General Assembly 2018 (Vienna, 9-13 April 2018)
c) RFG Conference (Vancouver, Canada, 14-23 June 2018)

Significant results

The results of the survey show positive and negative points. On one hand the importance of ethical and social aspects of scientific activity is recognized by most of the interviewees, on the other hand the real perception of these issues and the knowledge of the instruments to face them seems to be not adequate, especially with regard to society. Details are available in the deliverable D13.1 (http://www.envriplus.eu/wp-content/uploads/2015/08/D13.1.pdf).

The questionnaire allowed also to collect feedback and indications from the participants that will improve the sharing of values and contents within the ENVRI community, once they

will be incorporated in the guidelines. Moreover, the participation in the survey has already had in itself an impact on the project, since many scientists for the first time have had to deal with issues that usually are not subjects of the scientific/technical discussion or part of their usual research activity. Finally, activities and results described in the deliverable D13.1 could represent a relevant contribution especially for those participants in the project who are working on issues related to data management, on geo-education/communication aspects, or on science-industry relationships.

Deviations, reasons for deviations and corrective actions

No deviation from the Work plan.

Task 13.2: Ethics Guidelines for RIs

In the task 13.2, the Ethical Label Template was defined and developed to be used by partners in order to provide essential information about the ethical and social implications of their products developed within the ENVRIplus project, and beyond. The ethical label is structured to characterize each product of the project from an ethical point of view: this includes for example its impact, end users, warnings. The goal of this label is to provide to the published deliverable (for example a database, a software, a report) additional information about its social, environmental, ethical implications and on its impact, to be added to the description of the technical-scientific characteristics usually associated to the products of a project. The label is structured as a user-friendly tool, with predefined choices within specific fields: type of product (Database, Software, Technologies, Website, Report, Tool, Method), accessibility (public or restricted to academy, industry, etc.), target (social, educational, political, scientific, professional, technological, environmental, industrial), end users (researchers, government agencies, schools, industries, decision makers, professionals, infrastructures, media), field of potential impact (knowledge, methods, datasets, training and education, dissemination-outreach, social benefit, environmental safety, risk prevention, professional skills), warnings (danger of falsification, misuse, conflict of interest, high level of uncertainty).

Moreover, in the task 13.2 Ethics Guidelines (EGs) for RIs were defined. They represent a set of principles and indications to be used by partners for building their policies and their own codes of conduct. The objectives of the ethics guidelines were the definition and

development of a framework of reference for the Research Infrastructures, concerning ethical and social aspects of the research activities, a set of principles and values within which to develop the activities and carry out the final products of the ENVRIplus project. A preliminary ethical framework for describing ethical and social aspects involved in the research activities of the RIs was defined. The EGs are the result of an extensive survey of relevant literature produced by scientific and professional organizations, institutions, and bodies focusing on applied ethics for research and other professional activities conducted at RIs. Ethical values included in the EGs refer to four ethical domains, affecting RIs as a whole as well as individual scientists working at RIs. The domains mirror the ethical profile of each scientist/technician/administrator, his/her relationships with colleagues and their working environment, the interaction with society, and their obligations towards the Earth system. In addition to these four domains, the EGs discuss several issues which are considered to have a particular importance for RIs: working environment, data life cycle, conflicts of interest, and relationship with decision-makers. EGs are an indispensable tool to foster a respectful and caring work environment and are needed to ensure a fair reflection of the institutional activities and results towards society.

Significant results

The Ethical Label Template was the first practical tool to help the ENVRI community to address ethical and societal issues, for characterizing easily a project product to be released both to specialist and not-specialist, highlighting through a standard format those ethical and social aspects. The Ethical Label Template is included and described in the deliverable D 13.2. (http://www.envriplus.eu/wp-content/uploads/2015/08/D13.2-Ethical-label-template.pdf)

The Ethical Guidelines are a fundamental step to provide the ENVRI community with a tool that has a twofold goal. One is to give a point of reference to those working at a Research Infrastructure, supporting them to declare personal obligations and to assure the integrity of their activities. A second goal is to fix a starting point in tracing the RIs path in developing specific ethical guidelines and codes of conduct for each RI, so that better working conditions can be assured and society can be served in a fully trustfulness atmosphere. The final version of the Ethics Guidelines is included in the deliverable D 13.3. (http://www.envriplus.eu/wp-content/uploads/2019/05/D13.3_Ethical-guidelines-for-RIs.pdf)

Costs

Costs related to the activity of the task 13.2 have included those relative to the participation in the following congresses to promote activities and results of the WP13:

a) ENVRI Week in Riga (5-9 November 2018)

b) EGU General Assembly 2019 (Vienna, 7-12 April 2019)

Deviations, reasons for deviations and corrective actions

No deviation from the Work plan.

Task 13.3 Development of public education & dissemination material on the ethical and social issues

The deliverable 13.3 "Ethical Guidelines (EGs) for Research Infrastructures (RIs)" (www.envriplus.eu/wp-content/uploads/2015/08/D13.3.pdf) presents a general framework of ethical values each research infrastructure of the ENVRI community shall use. The framework offers a basis to design or to shape ethical guidelines considering RIs' peculiarities with respect to their status, duties, activities, and goals.

In order to facilitate access to the ethical guidelines for a wider audience, ETH Zurich developed a series of dissemination products. The main product is a handy leaflet summarizing the most important ethical values to consider on an individual, inter-personal/institutional, societal, and environmental level. It aims at making potential users familiar with important ethical values to adhere to when working for a research infrastructure. In order to support RIs in the disclosure of the ethical values considered, a preprogrammed table was developed. After having selected the applicable elements, a summary of the ethical considerations taken is generated and can be integrated into any documentation. In addition, a short Twitter campaign has been designed to help promoting the dissemination products.

For a detailed description, please refer to Deliverable 13.4. (http://www.envriplus.eu/wp-content/uploads/2019/06/Ethical-Guidelines-for-RIs_13.4-1.pdf)

Significant results

- The leaflet as well as the preprogrammed table are downloadable on the ENVRIplus website;
- Ethics in Research – a Guideline:

www.envriplus.eu/wp-content/uploads/2019/06/Ethical-Guidelines-for-RIs_13.4.pdf;
Ethical Label Template Table:
www.envriplus.eu/wp-content/uploads/2019/06/Ethical-label-template_final_13.4.xls.

Deviations, reasons for deviations and corrective actions

No deviation from the work plan.

WP14 Citizen Observatories and Participative Science

WP leader: Mairi Best (mmrbest.interimoffice@emso-eu.org)
WP participants: INGV, IFREMER, EMSC, UGOT, MBA

Introduction

A necessary component of environmental Research Infrastructures is and will increasingly become participative or "citizen" science. This is for two key reasons: 1) it raises societal awareness and engagement about environmental change and 2) provides data that is otherwise logistically inaccessible for monitoring change on our planet. This work package developed and summarized resources for environmental Research Infrastructures to engage with the public in citizen science, an area providing innovative solutions for data or sample collection, management, processing, curation, annotation, and archiving. In particular, this work package moved beyond a review of status quo to targeted test cases in leading areas of citizen science to develop:

1. resources and best practices for public contributions to the annotation of imagery (a charismatic form of scientific information with which to engage the public, while also being a resource-intensive information source for RI's) (Task 14.1) and
2. a framework for distributed networks of observers and sensors who collect data and can perform response actions (Tasks 14.2 and 14.3).

Summary of activity

Management of WP14 was carried out through INGV and EMSO ERIC, which has included management and lead of ENVRI week activities, management, editing, and review of all deliverables, management of communications and sustainability input, and facilitation of collaboration with external groups (e.g. seismic, marine biological, and citizen science communities).

Task 14.1 Imagery Annotation: Taking complex scientific images and turning them into data

This task, led by IFREMER, developed a web-based application for deep-sea image annotation, called 'Deep Sea Spy'. The software is built as a game with a mission to annotate a series of images extracted from archived video sequences acquired with deep-sea

observatories. The development can be applied to any situation where humans are needed to successfully annotate images in order to derive data.
The first version of the online application was officially announced and launched in March 2017 and has been operational since. The first results were analysed during the fall 2017 (D14.2)
D14.1: Prototype of a web-based annotation tool for user testing. [15]
D14.2: Report describing image annotation results [30]
The last period of the project was mainly dedicated to communication actions in general public events, schools, conferences and online on the project website (www.deepseaspy.com).

Significant results

- The V0 of the app is online (deepseaspy.ifremer.fr) along with the project website (www.deepseaspy.com);
- The application is still widely used and keeps attracting new users. As of August 2019 the number of registered users reached 1543 from 24 countries. The number of images annotated 27636. The current mission is achieved at 70%;
- Educational booklets were developed (in French and English) for kids from 3 to 11 and are available on the website (https://www.deepseaspy.com/en/Educational-material2);
- Between 15 and 20 classes in Brittany have enrolled in the project and participated over the school year;
- The project was officially proposed via the Academy of Rennes (Brittany, France) as school projects, thus reaching all high-schools (228) in Britanny;
- The project was also included in the project Young Reporters for Art, Science and Environment of the Oceanopolis center for ocean discovery. This program relies on a partnership between a class and a researcher to produce in fine a piece of art;
- We are working with a national entity to develop a data package to include the project in middle and high school programs;
- A computer terminal proposing the game is available at the Oceanopolis aquarium in Brest, France;
- The project was presented in 6 public conferences, and displayed as part of a booth in 7 regional and national public events;

- The project was mentioned in 9 web articles, 9 newspapers, on local TV and in radio broadcasts.

Deviations, reasons for deviations and corrective actions

No deviations from the work plan

Task 14.2 Citizen virtual seismological observatory

Task 14.2, led by EMSC, consisted of the development of a graphic user interface to easily query and visualize the data of the sensors connected to EMSC QCN (Quake Catcher Network) server. It evolved to include testing of the RaspberryShake sensors and network.
D14.3: Report on development and implementation of a citizen seismology sensor observatory and education platform [30]
D14.4: Guidelines for developing citizen sensor observatories and education platforms [36]

Main activities PER TASK

- Test of the RaspberryShake project which operated by the company OSOP. It's a good seismic sensor with high potential in citizen seismology, notably for convergence between school, citizen and classical seismology.
- The EMSC was in discussions with OSOP on how to test their sensors (Raspberry Shake) and their seismic event detections for improving the reliability of information EMSC gives to the general public and to eyewitnesses. The citizen project “near real time Earthquake competition game” developed by Taiwan earthquake Research Center is almost finished and will be released soon. It's designed to learn how to locate earthquakes and to measure a magnitude with real data.
- The EMSC was invited by Dr. Naoshi Hirata (Univ. of Tokyo) to the Japan Geophysical Union on May 18-24, 2018 to present recent advances in citizen seismology and how it can be used for earthquake public information for foreigners (in relation to the 2020 Tokyo Olympic games). This activity was beforehand accepted by the EC project officer.
- The EMSC has participated in the review of the deliverable D14.6.

Significant results

Deliverables 14.3 and 14.4 on time.

Deviations, reasons for deviations and corrective actions

No deviations from the work plan

Task 14.3 Marine Biodiversity citizen participative science programme

This task, led by MBA with contributions from UGOT, involved the setting up of a citizen observer platform for marine field biology and the training of scientists in using citizen science as a research tool.

There were three deliverables:

D14.5 Test version of an EMBRC citizen observatory system (M18)

D14.7 Citizen observation training program, training delivery and evaluation, and impact assessment report (M36)

D14.8 Collection Training sessions/presentations/materials (M44)

Main activities PER TASK:

Demonstrator platforms:

Crab Watch App, developed using the COREO system and online, Indicia-based forms for Mitten Crab Recording; Marine Invaders; Crab Watch; Wakame Watch and Mitten Crab Recording are now online and active.

Guidance document on how to set up Indicia-based data-capture pages was produced and used during training workshops. It is included in the online training materials

Training Workshops:

'Marine Citizen Science Data Tool Chest' Workshops were developed for scientists, policy makers and citizen science participants. The workshops explored current tools, including demonstrators produced in ENVRIplus. An interactive element enabled participants to share their own ideas, needs and barriers.

Geneva (ECSA), Switzerland June 2018 * (6)

Oban, Scotland - July 2018 (2 day) (6)

Oostend, Belgium- Sept 2018 (1 day) (6)

London, England – November 2018 *(short workshops for under 18s) (60+)

Online Training outputs:

Made use of the ENVRIplus online training platform (WP15) to make resources, presentations available online alongside tutorials in an e-learning format. Outputs are also available through Google Classroom.

Significant results

- We successfully communicated our Citizen Science tools to European research and infrastructure networks with potential users, including: EMBRC (http://embrc.eu/), SeaChange (http://www.seachangeproject.eu), AssemblePlus (http://assembleplus.eu/), and NeiC (https://neic.no/).
- New CS platforms have been developed based on the ENVRIplus results, including citizen observer apps for use in field locations and Artificial Intelligence processing of imagery.
- D14.5 has been used in a scientific case study (https://doi.org/10.3389/fmars.2018.00164). Here the CS system was used to produce data for research on endangered species (http://horseshoecrabs.myspecies.info/).
- ***Crab Watch Apps are online and active***

Deviations, reasons for deviations and corrective actions

D14.7 and 14.8 were delayed due to the schedule of workshops, however they have been submitted and the training materials have been made available through the ENVRIplus website.

Task 14.4 RI Citizen Science Toolkit

This task, led by INGV and EMSO ERIC with contribution from all other task leaders, produced a working document (D14.6) to provide a framework for WP 14-Citizen Observatories and Participative Science members in developing their cutting edge test cases above. Also, within this task is the production of a final summary report for WP14 (D14.9), summarizing the results of the test cases and updating D14.6.

Main activities PER TASK:

D14.6 Review of existing Citizen Science tools was circulated for wider discussion within the ENVRIplus membership and updated through the course of the project. Including a review of:

- how to effectively engage, train, and maintain Citizen Scientists,
- data systems for acquisition, assessment, access, and analysis of distributed data sources
- These include:
- Community Online Platforms: websites, social networks, discussion forums
- Crowdsourcing Tools: image acquisition, web and smartphone applications, surveys/questionnaires
- Information and Training Resources: webinars, public lectures, websites, public/museum displays
- Citizen Mobilization: rapid response observations of events (e.g. earthquakes, oil spills)

Discussions also continue with related groups working in Citizen Science, such as NSF RCN OceanObs, ONC, OOI, ECSA, CSA.

Significant results

See results in all tasks above, which contribute to the overall impact of this Work Package.

Deviations, reasons for deviations and corrective actions

D14.6 continued to evolve over the course of the project. An updated version will be included with the final report for the WP (Deliverable 14.9). The summary report D14.9 was delayed due to extension of the project.

WP15 Training, e-Learning and Courses

WP leader: Jacco Konijn (J.L.Konijn@uva.nl)

WP participants: UvA, CNRS, INGV, UNILE, UiT, CU, EGI.eu

Introduction

WP15 and WP16 (Staff Exchange) constitute Theme 5 in the ENVRIplus project. The WP leader of WP15 is also Theme leader for this theme and as such part of the Executive Board of ENVRIplus, entrusted with managing the overall daily progress of the project as a whole and represent the project.

This required traveling to all ENVRIweeks, including the final dissemination event, ICRI conferences as well as dedicated Executive Board meetings and representation in the EGU conferences of 2015-2019.

Task 15.1: Teaching RI operators key skills

This task contains two main components: Training of e-Infrastructure technologies and e-learning/e-training materials about the ENVRI reference model

Training of e-infrastructure technologies (EGI.eu)

Main activities

- Populated and integrated e-Infrastructure training webinars/materials into the ENVRIplus e-Learning platform;
- The webinar to present the “Lightweight Service Management for Research Infrastructure and introduce the FitSM standard approach” [1] was organized on March 20th 2018. A total of 11 participants attended the webinar. The webinar has been published on the ENVRIplus e-Learning platform [2];
- The webinar to officially introduce “The EGI Notebooks for interactive analysis of data using EGI storage and compute services” [3] was organized on March 19th 2019. A total of 18 participants attended the webinar. The webinar is not published in the e-Learning platform yet;
- The webinar to introduce "The EC3 portal in the EGI Applications on Demand service: how to create virtual elastic clusters in the EGI Federation" [4] to deploy elastic and virtual clusters over multi-clouds was organized on May 16th 2019. A

total of 29 participants attended the webinar. The webinar is not published in the e-Learning platform yet;

- Support of the organization of the International Summer School on “Data Management in Environmental and Earth Science Infrastructures: theory and practice” [5] in Lecce (09-13 July 2018);
- EGI.eu contributed to the "Data processing on e-Infrastructure" session with lecture and hands-on, and provided access to the cloud resources of the EGI Training infrastructures for students and lectures of the summer school. During the school, EGI.eu introduced the status of the EGI infrastructure and the Jupyter Notebooks service for helping data scientists to process big data sets leveraging on the computing capacity offered by the EGI Federation. A total of 20 participants attended the summer school;
- Support to Markus Stocker to register the New Particle Formation Event Analysis Events (NPFE) in the EOSC portal marketplace [6];
- Organization of training tracks on data platforms for data processing and solutions for publishing and archiving scientific data sets [7];
- Organization of a training track on the AAI solutions developed in the context of the EOSC-hub project to target the service provider perspective [7].

Significant results

- Successfully delivered face-to-face and webinar trainings as well as training tracks;
- Successfully integrated the New Particle Formation Event Analysis Event in the EOSC Portal marketplace [6] and introduce the scientific application during the official EOSC launch in Nov. 2018.

Deviations, reasons for deviations and corrective action

No deviation from the work plan.

References

[1] https://indico.egi.eu/indico/event/3906/

[2] https://training.envri.eu/course/view.php?id=13

[3] https://indico.egi.eu/indico/event/4537/

[4] https://indico.egi.eu/indico/event/4626/

[5] http://www.envriplus.eu/2018/05/08/international-summer-school-data-management-in-environmental-earth-science-infrastructures-theory-practice-july-9-july-13/

[6] https://marketplace.eosc-portal.eu/services/new-particle-formation-event-analysis
[7] https://www.eosc-hub.eu/events/eosc-hub-week-2019/

e-Training/e-learning materials about the ENVRI Reference Model (CU)

Main activities

- CU concluded its participation in ENVRIplus at Month 37 (May 2018). The course on the practical introduction to the ENVRI Reference Model was completed with the addition of two modules for the Engineering and Technology Viewpoints;
- CU participated in the ENVRI Development team visit to the Institute of Science and Information Technology (ISTI) CNR Pisa (January 2018), where we discussed the latest version of the ENVRI RM, as well as approaches for disseminating the knowledge gathered, training materials and other tools for support;
- An introductory overview video for the ENVRI RM was created and published on the ENVRI community channel (February 2018). This video was prepared by CU and reviewed during different ENVRI visits and in online discussions;
- A poster was submitted to the General Assembly of the European Geosciences Union. CU participated during two days in the poster sessions, explaining the ENVRI RM and the available learning materials;
- CU collaborated with UEDIN in developing and publishing a second training course targeted at non-technical users. CU and UEDIN published the two courses in the online ENVRI community training platform;
- CU and UEDIN collaborated on a short paper for the 32nd British Computer Society Human Computer Interaction Conference, July 2018. Using Persona as Lenses for a Reference Model.

Significant results

The objectives of developing and delivering adequate training materials for fermenting the understanding and use of the ENVRI RM has been achieved. Additional ideas such as the use of videos and posters to complement training materials have been explored as well.
The poster for the EGU 2018 is available from Zenodo:

- EGU Poster: https://doi.org/10.5281/zenodo.1246245

The learning materials are publicly available for download as scorm learning objects in Zenodo:

- Practical Introduction to the ENVRI RM: https://doi.org/10.5281/zenodo.3269798;
- ENVRI Reference Model for Research Infrastructure Professionals: https://doi.org/10.5281/zenodo.3269861

The video introduction to the ENVRI RM is available in the ENVRI Community YouTube Channel or directly at:

- What is the ENVRI RM? https://www.youtube.com/watch?v=4jc_vLkcU6g

Deviations, reasons for deviations and corrective action

No deviation from the work plan.

Task 15.2: Training workshops on Time series analysis

Main activities

UiT organized the 3rd Time series conference, held in Tromsø from 28-31 January 2019. The focus of the conference was on environmental science and applications to climate change, in particular on atmospheric composition and time series measurements.
The concept of this event was to gather scientists from a large range of disciplines in Earth Sciences based on regular and constant in-situ measurements, and provide a discussion forum in the field of time series analysis and forecasting.
Target audience: Based on in-situ and remote data analysis and modelling, the conference gathered senior and young researchers (post-doctoral, doctoral and master students) to share their experience in time series interpretation across several scientific fields. The event gathered 60 PhD students, post doc and researchers from 14 different countries.
The event consisted of two parts:

- Training school 28.-30.01.19 at the Institute of geosciences;
- Joint scientific conference 30.01.-31.01.19 at the Hotel The Edge.

Central topics:

- Atmospheric compositional change;
- Ocean and marine environment, including connections with land and atmosphere;

- Mathematical tools to understand climate change.

The deliverable D15.2 was finalized based on this conference and the previous one, also held in Tromsø and organized by UiT.

Deviations, reasons for deviations and corrective actions

The conference was planned in August 2018 but was postponed to the beginning of 2019 due to summer vacation, delaying the organization and the registration processes.

Task 15.3: RI management training

In Cooperation with the management training project RITrain, ENVRIplus offered an RI management program directed towards RI management and leadership.

Main activities (UvA)

During the last period of the project, this task delivered the agreed training workshop during the 6th ENVRI week. A follow up workshop was also organized on 4-6 February in Milan especially dedicated to senior management personnel in the RI's connected to the ENVRI community.

In preparation of both of these workshops, a session of the EMMRI master program was attended in March 2018, to discuss the setup and topics to address as well as the required trainers and materials.

Training workshop 1: Building a sustainable governance and funding for your research infrastructure

This workshop was delivered during the 6th ENVRI week. The topic was chosen out of the full list of topics that are part of the EMMRI master in RI management which has been developed by the University of Milano Bicocca (UNIMIB) in collaboration with the RITrain project. The staff from UNIMIB was hired by the ENVRIplus project under a subcontract to prepare and deliver the training.

The full program of the training can be found here: http://www.envriplus.eu/wp-content/uploads/2018/03/ENVRI-Plus-Workshop_Unimib-program.pdf.

52 Persons registered for the training, covering almost all RI's in ENVRI. Each RI was offered a grant of max. 500 euro to fund the travel of one person to attend the training. This budget was made available from the training events budget, held by UvA for all WP15

training activities. Participants were asked to complete an evaluation form afterwards; in general, the training was received as very useful and the training staff as knowledgeable and cooperative.

Training workshop 2: Strategic leadership

The budget dedicated to Task 15.3 allowed for hosting an additional workshop, which was specifically requested by the BEERi (see task 17.2) to organize a dedicated training on RI leadership, mainly for directors and higher management in the RI's or their representing institutions.

This training was set up in a similar way as training Workshop 1, with topics borrowed from the full EMMRI master and a subcontract to deliver the training by UNIMIB. A full program can be found here:

https://wiki.envri.eu/display/EC/Training?preview=/1868322/50593998/Strategic%20Leadership_PROGRAMME_Draft_v0.pdf

The training took place in Milan, 4-6 February and 25 persons registered for this event. This was the target number of participants, as we aimed for an in depth and intensive collaborative workshop. The evaluation after the training showed a very high level of satisfaction.

Significant Results

- This task delivered two training workshops, which exceeds the expectations as written down in the DoA;
- Another significant result is that through this activity, we were able to introduce the ENVRI community to the EMMRI master in RI management which could be a valuable source for further capacity building in the development of human resources in RI management.

Deviations, reasons for deviations and corrective action

No deviation from the work plan.

Task 15.4: Development of training packages for the use of Environmental Research Infrastructure products

The task was aimed at the development/customisation of the ENVRIplus e- Training Platform (EeTP) and the development of training products and packages for the optimising access to ENVRI RIs and use of their products.

Main activities

UNILE focused on the following actions:

Develop the e-Training platform and organization of the training on the use of this e-Training platform adding new training courses from other Environmental RIs. The design and the development of the e-Training Platform, in order to collect all the educational and training materials produced within the different activities. The Moodle architecture has been adapted and customized for the ENVRIplus needs, and has been integrated with the IdP supplied by EGI to assure the complete integration of the e-Training Platform with the ENVRI community tools. The platform was then populated with different training courses produced by the Research Infrastructures participating to the project, each one of these has a dedicated online area where the infrastructure goals are described and with an introductive video of the key person involved in the RI.

- Development of a space on the e-Training platform for the introduction of other games of the ENVRIplus project;
- Development of space for the multimedia education of secondary school level teachers and students, addressed on major thematic research areas and challenges on Biodiversity and Ecosystem Services, Greenhouse effect and Earth Warming, Ocean acidifications and Environmental sustainability;
- Organization of the following Summer Schools:
    - International Summer School “Data Management in Environmental and Earth Science Infrastructures: theory and practice”, held in Lecce, Italy, from July 9th to July 13th 2018. The course has been built as a five-day summer school providing an unique insight into the contemporary debate on Data Management in the environmental and earth sciences. Twelve leading scientists have addressed this topic from different perspectives. 22 Students including RI staff and PhD Students, have participated;

- International Summer School "Data Fairness" held in Lecce, Italy from July 1st to July 5th 2019, including a preparatory meeting on 27/28 June, attended by the trainers and the WP leader. The summer school, organized jointly with LifeWatch ERIC, covered in depth the Data Curation Process, focusing on methodologies and tools to make the Data FAIR. In the second edition we received more than 40 student registrations and at the end we decided to admit to the school 27 students from Slovenia, Spain, Italy, The Netherlands, Belgium, Greece, the large part of them RI Staff.

INGV elaborated actions to improve the content of the ENVRI e-Training Platform for multimedia education of secondary school level teachers and students (see also T15.5). Consequently, the training platform was extended by training material for the secondary school teachers, collected and developed by the project.

Significant results

- Successful development, population and the maintenance of the Virtual Training platform;
- Successful organization of two summer schools.

Deviations, reasons for deviations and corrective action

No deviation from the work plan.

Task 15.5: Secondary School level education on environmental issues related to the RIs

Task15.5 is led by INGV, in collaboration with UNILE. The task is aimed at improving the ENVRIplus e-Training Platform for multimedia education of Secondary School level teachers and students on environmental issues dealt through the RIs.

Main activities (UniLe):

- UNILE completed the development of the ENVRIplus Serious Game on 4 different topics (i.e. Biodiversity and Ecosystems, Hydrogeological Risks, Computing Environment and Marine Science), involving the other Environmental RIs which participated in the ENVRIplus Project;

- UNILE completed the development of ENVRIplus Serious Game Platform for the better integration of the 4 topics of the ENVRIplus Project Serious Game and all the materials referred on the 4 topics: 1. The topic Biodiversity and Ecosystems is based on the expertise of the UNILE and LifeWatch Infrastructure, 2. The topic Hydrogeological Risks is based on the expertise of the INGV and EMSO Infrastructure, 3. The topic Computing Environment is based on the expertise of the EGI Infrastructure and 4. The Marine Science still needs more work to be done.
- UNILE ran the second and the third year of the ENVRIplus Game' Europe wide Pilot and two school award ceremonies during the 7th ENVRI week and Final dissemination event in Brussels June Brussels.

Significant results

- The development of the Serious Gaming into 4 topics (Biodiversity and Ecosystems, Hydrogeological Risks, Computing Environment and Marine Science) include the development of game guides for the teachers and the students, as well as the demo of the Serious Game and the complete Serious Game for each topic;
- Development of the Serious Gaming platform have been completed integrating the 4 topics and during this year and the ENVRIplus Game' Europe wide Pilot were applied with all the 4 topics.

Main activities (INGV)

INGV developed the teaching material for the training platform:

- INGV prepared a questionnaire addressed to teachers to improve and better fit the content of the Platform, in order to catch their needs and help in feeding the platform with targeted contents [2];
- Questionnaires were distributed: a) during the 2017, GIFT (Geosciences Information for Teachers workshop) organized in the frame of EGU; b) at the Open Science event of Teacher Training Meeting organized by INGV on 11 May 2017, and c) during the 2018 GIFT workshop [2];
- INGV analysed the questionnaires [3]. Results were useful in order to develop a test e-digital repository in which we realized and tested the e-learning courses for teachers and students. In a second step the courses were uploaded and made available on ENVRI e-learning platform [4;

- Inventory of available RI training material was completed and published on the website. Inventory of the educational resources focusing on the same topics as ENVRIplus (i.e. Biodiversity and Ecosystem Services, Greenhouse effect and Earth Warming, Ocean acidifications, environmental sustainability) was also made available on the web;
- 25 courses were implemented in the e-learning platform, and divided in the 5 domains: 17 for Aquatic domain, 26 Solid earth, 1 for Atmospheric, 0 for Ecosystem and Biodiversity, 3 for Multi-domain.
- The tools used in the courses are: presentations, quiz, labs, videos, web site links and documents. The courses are easy to find thanks to different research modality: research bar, tags, and category [4].

INGV developed the Serious Game in Marine and Solid Earth Domain.

- INGVproduced the informative .pdf for the Natural Risks topic and some contents for the Natural Risks multimedia game [5] [6];
- INGV produced the Marine Science contents for the multimedia game and informative .pdf [7];
- INGV involved two Italian high schools in ENVRIgame competition in 2018 (Liceo Costa and ITIS Capellini-Sauro): the first school won the first place in ENVRI game competition and Capellini-Sauro won the second place. INGV attended with Liceo Costa students the award ceremony in Riga in 2018. In 2019 INGV involved one school in the competition, ITIS Capellini-Sauro, and the group of students won again the second place [8];
- INGV organized a training of Secondary Schools teachers to use the ENVRIplus e-learning platform;
- INGV collaborated with the Committee on Education of the EGU to plan a joint preparation of the Call and Selection for training Course Attendees (teachers) in the frame of Gift workshop. INGV also collaborated on the 2019 GIFT event program, list of speakers and list of teachers who have applied and have been accepted (80 coming from 22 countries) [10]. The ENVRIplus e-learning platform was presented during the GIFT WS [11].

Significant results

- Successfully delivered the actions undertaken for the development of Task 15.5 [1];
- Successfully administrated and collected questionnaires to teachers [2];
- Successfully realized the contents for the e-learning platform [4];
- Successfully realized the .pdf implementation for Serious Game development [5];
- Preliminary production of the Marine Science and Natural Risk multimedia game [6] [7];
- Successful support of the students during the ENVRIplus serious games. The research activity elaborated by the student suggest a real research activity [8];
- Successfully organized and developed a training event for secondary School teachers [10] [11]

Deviations, reasons for deviations and corrective actions

The Summer Schools were originally not foreseen in the project plan. Most of the education/training material was developed for the e-learning platform, but this WP decided to benefit from the availability of a dedicated budget for training events to actually be able to host face-to-face training events on top of the online development of training material. This ended up in two very successful Summer Schools working on exactly the right and relevant topics for the involved Environmental Research Infrastructures, going into more depth on various topics and more individual support from trainers.

Since dedicated budget was reserved for this type of events to support developments in WP15, there were no negative budgetary consequences attached to this additional task, in fact the budget was exactly spent what it was meant for

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WP16 Staff Exchange

WP leader: Robert Huber (rhuber@uni-bremen.de)

WP participants: UniHB, UiT

Introduction

The overall objective of work package 16 is to facilitate the cross-fertilisation and knowledge transfer of new technologies, best practices, approaches and policies across RIs using two instruments:

- An exchange of personnel (EoP) program, which will enable short stays in hosting RIs, preferably organized either on a bilateral basis or on a triangular basis. The main activity of the exchanged personnel during these stays should not aim at data acquisition or fundamental research.
- A series of experience sharing symposia, either virtual and physical symposia for sharing experiences and best practices in terms of data access, understanding and usage. The symposia aim to raise the awareness of opportunities in other, cross domain RIs to learn and adopt these best practices, experiences or ways of working.

Task 16.1 Experience sharing symposia for RI staff

UniHB organized an experience sharing symposium during the 7th ENVRI week dedicated to best quality control practices. The workshop aimed at promoting harmonisation of quality control procedures within environmental RIs in different fields. Based on the exchange of best practices currently in place within RIs options to harmonise QC - on (near) real time data as well as delayed mode and archived data - across scientific domains were discussed. A particular focus of the workshop was on quality flagging habits and codes and on documentation of QC in general, taking into account current high level standardisation developments. The resulting recommendations shall be fed into upcoming project initiatives like ENVRI-FAIR and proposals to be submitted in response to the EC Call BG-07-2019-2020: The Future of Seas and Oceans Flagship Initiative.

Task 16.2. Staff exchange

UiT participated in Task 16.2 "exchange of personnel", concerning the eligibility criteria for personnel and costs as well as the selection procedures. Ongoing work and discussion on best criteria based on experiences, also in comparison with SIOS.

UniHB continued to manage the ENVRIplus staff exchange programme (EoP) which included management of proposals and organising the review process with the ENVRIplus EB. UniHB has further provided the administrative services for managing the reimbursement and reporting of staff exchange activities.

During this reporting period, six staff exchange activities have been proposed within the second EoP call. Five proposals could be funded which initiated a broad range of successful staff exchange activities:

- Aerosol Use Case: This activity was planned as part of ENVRIplus TC 17 (see D9.2), entitled “Connecting the particle formation research community to research infrastructure” (aka “aerosol use case”). The visit of a PANGAEA related researcher at one of the ACTRIS stations allowed a first meeting with the aerosol research community to present the use case and discuss how to advance the work in collaboration with the research community. The visit resulted in a major enhancement of the use case and its contribution to D9.2 as a D4Science Virtual Research Environment integrated in the EOSC Portal Marketplace;
- VRE workshop: A workshop was organised to bring together the ENVRIplus RIs ICOS and EISCAT with the D4Science technology provider as well as EGI to improve the D4Science VRE support for the ENVRI community by integrating EGI Jupyter notebooks. In this workshop, three ENVRIplus use cases evaluated this service: IC 3, which aims to support individual scientists from the EISCAT 3D community to process their experimental data using their own algorithms; TC 17, which aims to develop a VRE for the aerosol research community; and IC 13, which aims to optimise ICOS data processing, to process data from multiple sites simultaneously and/or in Near Real Time modality;
- Economics of Research Infrastructures: This activity dealt with business development and RI economics in general and aimed to exchange ideas and experiences related to the economics of RIs. Specifically, a visiting staff from PANGAEA was interested to learn from EGI and ESFRI Research Infrastructures (EMSO, ACTRIS, ICOS) about solutions for funding and transfer of funds within

distributed multinational infrastructures, pros and cons of legal forms and organisational structures, contractual frameworks, business development and commercialization as well as legislative, administrative and fiscal impositions or restrictions;

- Governing Access: The purpose of this EoP activity was to exchange experience and knowledge between three very different and diverse research infrastructures (SIOS, ACTRIS, EISCAT) as well as to share best practices and discuss problematic issues in the context of governing and facilitating access and sustainability. One additional purpose was to introduce tools that are adaptable to Environmental research infrastructures;
- Sustainability of Access: This activity was a continuation of the 'Governing Access' activity described above that aimed at additional knowledge exchange between numerous research infrastructures (ACTRIS, DANUBIUS, EISCAT, EUFAR, EUROCHAMP, FIXO3, SIOS) in the context of governing and facilitating access and sustainability. On-site visits were planned at the Abisko Research Station. It aimed to compare common procedures and strategies based on RI reference documents and existing policy documents.

UniHB has led the finalisation of the Deliverable 16.2, the 'synthesis report on staff exchange and how this service can be sustained by RIs'. The report contains detailed descriptions of funded staff exchange activities, a summary of modalities and procedures implemented during the project to manage the exchange of ENVRIplus personnel scheme as well as a summary of costs associated with the staff exchange.

The report further contains a detailed sustainability concept that proposes several possibilities to sustain a staff exchange program, e.g., under the umbrella of the ENVRI community which might be the most appropriate solution to sustain the EoP scheme and their positive impact on the RI community.

Significant results

Deliverable 16.2*, 'Synthesis report on staff exchange and how this service can be sustained by RIs'*

Deviations, reasons for deviations and corrective actions

No deviations from the Work plan.

WP17 Coordination of RI communication, development and implementation of the ENVRI strategy

WP leader: Sanna Sorvari Sundet (sanna.sorvari@fmi.fi)

WP participants: FMI, UHEL, ICOS ERIC, EURO-ARGO, EISCAT, CNR, CNRS, IFREMER, FZJ, INGV, UKRI, UvA, INRA, EAA, MBA, RCN, EMBL, UiT, EuroGOOS, UCPH, EGI.eu

Introduction

The main objectives of the WP17 were to 1) coordinate the internal (within the project) and external communication and 2) further develop and implement long-term ENVRI strategy. These actions are needed to overcome fragmentation in the environmental RI landscape and to enhance the operational efficiency and provision of RI services for the users by seeking the optimal economy of scale and suitable common guidelines and operations.
The WP established efficient operational and organisational means for the coordination and communication at the domain level, across the cluster, and for overall environmental RI community that goes beyond the ENVRIplus project partnerships. WP17 organized the communication and knowledge transfer of the joint ENVRIplus policies and strategies in the environmental RI community and to other relevant clusters and initiatives. National, European and international policy dialogs with other RI clusters, strategy platforms (e.g. ESFRI) and funding organisations were also be established to ensure that the planned developments in the ENVRIplus are aligned with the national and international RI developments.
FMI led the WP17 by planning and coordinating the WP17 activities. FMI also organized WP17 and WP18 WebEx-meetings (Theme 6 meetings), participated in the ENVRI EB meetings, and produced all the WP17 periodic reports.

Task 17.1: Facilitation of the communication and coordination at the domain level on the ENVRI strategy

While finding common solutions is the main objective of ENVRIplus, space was left in the project to maintain a level of exchange driven by thematic areas: terrestrial and ecosystem domain, atmospheric domain, Marine domain and Solid Earth Domain. The main focus of this activity in ENVRIplus is connected to the implementation and further development of services at RI level while ensuring the highest possible level of standardisation at the domain

level. It is clear that, from the view of a RI operator, interaction at domain level remains key for some of the ENVRIplus discussion. The task 17.1 is therefore aimed at developing and operating smooth communication means in the 4 respective domains.

Goals are sharing vision, strategies and ways toward interoperability, common operations and services considering different development levels, needs and interests of participating research infrastructures, RI networks and RI related projects within the domains. From there the work was designed addressing three levels of implementation and development: 1) the RI level accounting for the fact that participating RIs are of certainly different maturity and have individual constraints for their implementation, 2) the domain level (Atmosphere, Marine, Solid Earth, and Biodiversity / Terrestrial Ecosystems) which currently corresponds to the most-effective science-driven user level including, for example, institutional users such as Copernicus, and 3) on the cluster level which is most-effective for addressing standardisation with EOSC, e-infrastructure (dominantly EOSC) or with international organisations (GEO, WMO, RDA etc.). Task 17.1 was targeting level 2 and has been completed by establishing the four working groups, one for each domain to focus on domain specific development needs and issues. These need to be overcome on the way to achieve the aim of higher-level interoperability and joint strategy targets. Well advanced flagship RIs with a high level of maturity will lead the development and implementation of interoperable services and provide support and guidance to the less mature and upcoming RIs.

During the third reporting period, physical meetings of the working groups (separate domain meetings) continued to be organized during the regular ENVRI weeks. FMI, supported by UHEL and ICOS ERIC, has facilitated the domain level meetings. Representatives from all of the four ENVRIplus domains have participated to the 6th, 7th and 8th ENVRI weeks. FZJ (IAGOS) coordinated the atmospheric domain meetings and IFREMER (Euro-Argo) chaired the marine domain meetings during the reporting period. The ecosystem/biosphere domain meetings were organized by CNRS and INRA (AnaEE), and UKRI (EPOS) led the solid Earth domain meetings during the third reporting period. In general, the domain meetings have been successful in bringing the community together and informing all domain partners about ongoing activities within the ENVRIplus Themes.

The chairs of the domain meetings coordinated and provided the input to the deliverable “Domain report on development needs and actions” (D17.1), which was coordinated by UHEL and produced during the third reporting period. The document summarizes the domain level discussions during ENVRIplus and focuses on three main issues: 1) domain level approach towards FAIRness in RI data, 2) Developing the domain landscape, and 3) Other

activities undertaken at domain level. The deliverable concludes that the domains are vital to ENVRI community by providing a) requirements, b) ideas, c) skilled research scientists with understanding of both data and methods, and d) skilled IT professionals with not only general IT expertise but also expertise in applying IT to the domain.

Domain-level meetings have also been an important place to prepare for the domain topics and cross-domain discussions in BEERi. Domain activity and discussions has been regularly reported to BEERi via the BEERi representatives.

Another important activity within this task is the development of the deliverable D17.6 "White paper on further integration of RIs in the environmental field including recommendations on collocating research sites on national and international level" coordinated by ICOS. The background of the D17.6 was that during the BEERi discussions, it was realized that the landscape analysis implemented in the biosphere/ecosystem domain (WP12) could be useful in other domains too as the exercise has helped to sharpen the necessity to cooperate and define the gaps of RIs. The biosphere/ecosystem landscape analysis focused on solutions for terrestrial ecosystem research cooperation in Europe including defining of core variables, core competences of RIs, cross-RI services etc. During the 3rd reporting period, the single domain analysis was widened to the atmospheric and marine domains and mapped the core competences of the domains, sites, existing collaborations, synergies, and joint services.

The outcomes of the three domain reports created the foundation for the white paper (D17.6) that was produced during the 3rd reporting period and integrated all domains to get an integrated overview on the ENVRI landscape by exploring possible scenarios for reinforced cooperation between RIs. The overarching goal of the white paper was that it could be utilized as a background document for a common strategic planning and as an input to ESFRI Roadmap 2021.

All RIs of the ENVRI community contributed their share to the preparation of deliverable D17.6 either by providing relevant information for their activities or by commenting the draft versions of the domain reports and/or the final report.

Deviations, reasons for deviations and corrective actions:

None relevant. The submission of D17.1 was delayed because it was seen beneficial to capture the outcomes of the domain level discussions held during the whole project lifetime (separate domain meetings in ENVRI weeks and domain related discussions in BEERi), and to be able to utilize and implement the development needs and actions e.g. within ENVRI-

FAIR. The submission of D17.6 was delayed due to summer holidays. D17.6 was not originally envisaged in the Work plan and was only added after the 3rd amendment to GA.

Task 17.2: Facilitation of the communication and coordination of the cluster level integration in the frame of ENVRI strategy

Within task 17.2, the ENVRI community research infrastructures have formed a Board of European Environmental Research Infrastructures (BEERi) that met at least twice a year and followed the work of the ENVRIplus, validated the deliverables of the ENVRIplus project, and further developed common environmental ENVRI strategy and its' implementation actions. The board has two representatives per research infrastructure, normally the coordinator/director of the RI and the deputy-director or high-level manager of the RI. FMI, as the Task leader, prepared the preliminary BEERi agendas and followed the implementation of agreed actions after the BEERi meetings. Members of the BEERi were also committed to work on the agreed actions between the BEERi meetings. The BEERi board seeked balance between the common implementation needs of the infrastructure cluster and the specific implementation needs of individual research infrastructures and on the domain level.

During the third reporting period, FMI organized altogether four BEERi meetings: in Zandvoort (6th ENVRI week), Prague (January 2019), Helsinki (8th ENVRI week) and Brussels (Final dissemination event). In addition to these regular meetings, a dedicated workshop for the BEERi members was organized during the 7th ENVRI week. This workshop concentrated on ENVRI sustainability and strategy issues and identified the steps forward regarding the common future path for the ENVRI community. FMI as Task leader chaired the BEERi meetings, drafted the agenda and ensured that the needed meeting materials and meeting minutes are provided to the BEERi members, and took care of implementation of agreed actions between the BEERi meetings. Draft BEERi agendas have been introduced and discussed at the ENVRIplus Executive Board meetings, which have been chaired by INRA (AnaEE) and FZJ (IAGOS) during the third reporting period. Between the BEERi meetings communication has been handled via BEERi email list administrated by the Project Coordination. FMI has also coordinated the application and approval process of the new BEERi members. During the third reporting period, two new BEERi members were approved on board: EMPHASIS and HEMERA. At the moment altogether 28 environmental RIs are involved in the BEERi.

The BEERi meetings during the third reporting period were focusing on long-term strategic issues and ways to sustain the ENVRI community - topics that are vital in the end of the project. The strategy discussions have included renewing of the ENVRI vision statement and brainstorming on mechanisms to implement the new vision. In addition, identifying common topics to work further together and options for the future structure of the ENVRI community has been tackled in the BEERi meetings during the third reporting period. Moreover, discussion on other relevant topics took place, including ENVRI involvement in EC funded projects and proposal preparations, ENVRI response to H2020 consultations and interactions, ENVRI positioning to existing and proposed committees/forums, landscape strategies of domains, BEERi support letter practices, planning of common events (such as ENVRIplus Dissemination event in Brussels), and ENVRI connections to other initiatives.

All the Task 17.2 beneficiaries representing different RIs took actively part in BEERi meetings and follow-up activities.

Significant results

- During the reporting period, BEERi members have agreed on several elements that help in building and implementing the new strategy for the ENVRI community. These elements have been summarized in the ENVRIplus deliverable "Updated version of the ENVRI strategy" (D17.2), which describes the strategy development during ENVRIplus by bringing together the available strategy related material and outcomes based on common discussions held in the BEERi meetings and dedicated workshop on ENVRI strategy and sustainability. The deliverable highlights that the strategy process is ongoing and will continue after the end of the project.
- One of the main elements of the new strategy is that the ENVRI community has agreed upon a new vision statement for the future that describes how European environmental RIs contribute to the society and what the community wants to be and achieve within the coming decade. In addition to the updated vision, it was agreed the Themes identified in ENVRIplus are still valid for future collaboration. Moreover, RIs have defined new common topics that they want to work forward together: 1) Visibility and communication, 2) Fragmented funding landscape, 3) Positioning of RIs, 4) Collaboration of RIs, and 5) Organizational structure. Related to the organizational structure, the ENVRI community has decide to proceed with a step-wise approach towards a federated structure.

Deviations, reasons for deviations and corrective actions

None relevant. The submission of D17.2 was delayed by 1 month due to summer holidays.

Task 17.3: Environmental research infrastructure community platform

Task 17.3 - where UHEL acted as a leader, consisted of two subtasks: 1) Development of the Virtual ENVRI Community platform and 2) Organization of the Open ENVRI community meetings. Both subtasks aimed at bringing the entire Environmental Research Infrastructure community together - to apply ENVRIplus results and solutions as broadly as possible, as well as to engage the community in dialogues about its current and future needs.

1) During the third reporting period ICOS ERIC worked on the improvement of the ENVRI community virtual platform and its regular maintenance. The website was regularly filled with new engaging content. The content was gathered by a person at ICOS ERIC responsible for the platform, but there is also a function at the platform through which anyone can submit their own content. Thus, the platform serves as a tool through which RIs advertise their own activities. The platform thus helps to increase their visibility. This tasks also focused on further ENVRI community building, the community engagement (through joint activities) and increasing its visibility (mainly through the ENVRIplus communication tools and organization of joint community booths – they are described in more detail in Task 18.2). There has been a lot of discussion during the RP3 concerning the sustainability of the platform and later, after the new cluster project ENVRI-FAIR has been funded on the transfer and optimized maintenance of the platform as well as its integration with ENVRI-FAIR website. The platform was hosted and supported by EGI.

2) ICOS ERIC, together with FMI, organized the third ENVRI community meeting in November 2018 (During the 7th ENVRI week in Riga). In order to ensure the community is aware of the event, ICOS ERIC, together with FMI, have revisited the mapping of the entire ENVRI landscape (relevant H2020 projects from different domains, H2020 projects funded by INFRASUPP, other RI clusters, global networks, EAA, ESA, and many others). The scope of the meeting was to introduce the cluster and project activities to RIs and network that were not yet part of the community. The most solid outcome of this period is cooperation with HEMERA, a new RI for access to balloon-borne platforms and EMPHASIS, a pan-European distributed plant phenotyping infrastructure. Both RIs became part of the BEERi. The outcomes of this activity are summarized in D17.3 ("Landscape analysis of the environmental RI community in Europe")

Significant results

- Submission of D17.3;
- Two new RIs became part of the ENVRI community;
- The visibility of ENVRI community has been further improved, especially thanks to joint RI communication activities;
- The sustainability and further development of the virtual community platform has been achieved.

Task 17.4: Policy communication and strategic collaboration with other RI communities, national, regional and international key actors

CNR led the Task 17.4, which promotes policy and strategy communication with European and international strategy and funding bodies, such as dialogs with ESFRI forum and its working groups, EC, Joint Programming Initiatives and Belmont Forum.

As leader of the task, the CNR took care of maintaining sound dialogue and good relations with all relevant stakeholders in Europe and beyond to disseminate the ENVRIplus joint strategic visions, objectives, actions and achievements. Efforts in the period especially focused on the update of the ESFRI Landscape analysis report and the ongoing ESFRI activities towards a common framework for monitoring the RIs performance.

Information and feedback from environmental RIs were incorporated in the new Landscape Analysis in Part 2 of the ESFRI Roadmap 2018 and also inspired the all-new study in Section 2 of the Analysis made to highlight the interconnections and relevant links that exist among different thematic areas and domains.

As regards the monitoring of the RIs' performance, ENVRIplus had the opportunity to express the ENVRI community opinions during the ESFRI workshops that were held in Milan, Italy, in November 2018 and in Brussels in July 2019 to contribute to the work of the Forum to develop a common methodology for monitoring Research Infrastructures, periodic update of Landmarks and use of KPIs.

Finally, activities culminated in the production of a comprehensive report (ENVRIplus deliverable D17.4) of all the activities carried out by ENVRIplus to promote, coordinate and cultivate sound and significant relations with key local, regional and international organizations in various fields and to obtain feedback.

All the partners involved in the task 17.4 have promoted actively ENVRI cluster and raised the awareness of Environmental Research Infrastructures in Europe at international

meetings (some of the partners regarded this type of activity as one of the significant results during the third reporting period), participated in discussions related to EOSC initiative, and strategic collaboration with other RI communities.

Below short descriptions of the contributing partner activities:

- FMI has participated in writing of the D17.4 “Summary report on policy communications” by providing information on policy and communication activities in Finland (relations with Ministries, ESFRI National Delegate, regional and local authorities and other stakeholders). In addition, FMI representatives have been involved in EOSC PILOT and EOSC HUB initiatives (incl. involvement in meetings, panels etc.) and RDA plenaries on the behalf of ENVRI community and have had regular communication with European Commission on RI activities, especially representing the ENVRI cluster. In addition, FMI/BEERi chair has represented European environmental research infrastructures in ICSU WDS Steering committee, and represented ENVRI in various international and European meetings and events. FMI representative has also been co-chairing the Strategic Cooperation Council (SCC), which is the integration of CoopEUS Strategic Cooperation Board (US initiative) and COOP+ Open Board (European initiative).
- FZJ promoted the ENVRI Cluster at IAGOS RI meetings and at international meetings, e.g. at DACH 2019, Conference of the Meteorological Societies of Germany, Austria and Switzerland, Garmisch-Partenkirchen, 18 to 22 March 2019.
- Euro-Argo ERIC promoted the ENVRI Cluster at Euro-Argo RI meetings and at international meetings.
- CNRS (IS-ENES) participated in EOSC discussions.
- EuroGOOS contributed to the ENVRI policy communications discussions during the ENVRI weeks in Zandvoort in May 2018, in Riga in November 2018, and in Helsinki in March 2019. In addition, EuroGOOS promoted ENVRI cluster in many arenas: at the European Maritime Days 2018 (Burgas, Bulgaria) and 2019 (Lisbon, Portugal), the EuroGOOS General Assembly meetings in May 2018 (Brussels, Belgium) and May 2019 (Heraklion, Greece), the European Ocean Observing System Forum in March 2018 (Brussels, Belgium) and Conference in November 2018 (Brussels, Belgium).
- RCN (SIOS) promoted the ENVRI Cluster at Arctic related international meetings and conferences.

Significant results

- The feedback collected through ENVRIplus was included in the Landscape analysis and ENVRI community was mentioned there several times. It is clear that ENVRI community is perceived as a good instrument to drive strong messages from the environmental RIs and it recognized "to be an excellent tool to coordinate Environmental RIs regarding everything from Management, Access policy, Data handling etc." (See ESFRI Public Roadmap 2018, Part 2, Landscape Analysis, p. 75).

Deviations, reasons for deviations and corrective actions

None relevant. To be reported only a delay of 4 months in the submission of D17.4, due to the need to collect information about activities carried out at national level in the different countries and the relations with the national stakeholders (policy-makers, funding bodies, local organizations and communities).

Task 17.5: ENVRIPLUS Sustainability plan

UvA led the task 17.5, which main goal is to analyse operational and organisational model for maintaining cluster level common operations, services and collaborative bodies. During the third reporting period, ENVRIplus deliverable "Sustainability plan" (D17.5) was finalized by UvA. The Sustainability plan focused on ENVRIplus project results relevant at the cluster level. Results that are only relevant to one or a few research infrastructures should be secured by these facilities themselves.

ENVRIplus had, from the very beginning of the project, strong attention for sustaining all the achievements after the end of the project. The main customers of the project are the cooperating research infrastructures, and it is in their interest that the project results of common interest continue to be accessible, updated and serviced. Considering that each individual research infrastructure has its own legal entity with dedicated governance and management, the challenge is to agree on modes of cooperation to keep the results - tools and services of common interest - up to date and operational. The development and agreement on the final Sustainability Plan is framed by the views of stakeholders, more specifically the views of the involved research infrastructures, and also of relevant scientific bodies, policy bodies. The methodology applied to craft the Sustainability Plan followed two approaches. First, a 'bottom-up' approach to identify and analyse each developed result in the ENVRIplus

project in the perspective of relevance for all cooperating research infrastructures. Second, a 'top-down' approach to consider the future ENVRI structure, regardless of any funded collaborative project. Considerations in this respect departed from a common strategic view on the purpose and benefits of continued cooperation.

Sustaining the results of a collaborative project implies that all actors have to be aware of the implications of their joint responsibility in this respect. Responsibility refers to ownership of jointly developed project results, and to the future structure to maintain and update these results as common services. To this end, one activity was to identify crucial common services, products and other results to be sustained after the end of the project, and by which organisations. This "bottom-up process" focused on the results relevant for all research infrastructures. A number of ENVRIplus partners will sustain these results with continued service provision. However, not all required tasks could be taken up by individual organisations. Covering these tasks brings into consideration a kind of collaborative structure. This was a "top-down" process, focusing on the future ENVRI: what is the perspective for the infrastructures at the level of joint cooperation after the end of the funded ENVRIplus project.

The bottom-up process required intensive interactions with the WPs of ENVRIplus in order to identify their developed project results as relevant at the cluster level for, in principle, all involved research infrastructures. In addition, the relevant WP partners had to consider their responsibilities to sustain their developed services, how to advertise these, and to estimate associated efforts and annual costs. The top-down process asked primarily attention of the management of the research infrastructures. While being concerned with the construction and operation of their facilities, it proved to be a challenge to elaborate on common ENVRI challenges. Importantly, discussions with all cooperating research infrastructures assisted to appreciate each one's positions and the expectations of collaborative efforts. In order to guide the discussions, two successive on-line surveys were run to receive input about the opinions. In addition, a dedicated workshop for the leadership of the research infrastructures promoted a common understanding on the process toward a sustained ENVRI.

Below short descriptions of the contributing partner activities:

- FZJ provided input to the Sustainability Plan during the BEERi meetings and to the sustainability chapter of the ENVRIplus Theme 2 book;

- FMI has contributed to the Task 17.5 by organizing the ENVRI sustainability and strategy workshop targeted for the BEERi members (6th ENVRI week). The workshop was led by external experts (facilitators) and for that, FMI took care of calling for tenders for the workshop facilitators according to the law, and after that prepared the meeting agenda with the facilitators, participated to the actual workshop and helped in summarizing the outcomes and minutes of the workshop to be circulated to the BEERi members. In addition to helping in organizing the workshop, FMI has contributed to Task 17.5 by keeping the sustainability issues actively on the BEERi meeting agendas and helped to prepare the meetings materials related the sustainability and strategy during the 3rd reporting period;
- INRA participated in the meetings and discussions under the framework of the Task 17.5 and reviewing /editing the draft text report of this task;
- Euro-Argo ERIC provided input to the Sustainability Plan during the BEERi meetings;
- RCN (SIOS) contributed to the Sustainability Plan;
- EuroGOOS contributed to the Sustainability Plan and presented recent work with EEA analysing the overall levels of sustainability for the atmospheric, ocean and atmospheric composition domains;
- UKRI has actively contributed to the development of the ENVRIplus sustainability plan, including participation in the associated BEERi-led workshops that led to the development of the operational and organisational model for maintaining the ENVRI community beyond the end of the project. UKRI has also reviewed and commented on the resulting sustainability plan, and participated in the working group tasked with drafting a Letter of Intent for the RIs to confirm their support and participation in the ENVRI cluster. UKRI regarded that EPOS contribution for the solid Earth domain to the deliverable D17.5 was a significant result during the reporting period.

Significant results

- Consultations and discussions about a common understanding and the purpose and vision of ENVRI resulted in an updated new strategy for the cooperation: *ENVRI – the large-scale cluster of collaborating European environmental research infrastructures – contributes to the grand societal challenges by providing in a systemic way high-quality multidisciplinary research data, services*

and expertise for scientific breakthroughs supporting the mitigation of societal risks. With these resources, it is the ambition that by 2030 ENVRI is internationally strongly positioned with its attractive service portfolio and access opportunities for researchers, private sector and policy-makers.

- The next significant result is agreement amongst the research infrastructures on how to structure their cooperation and common activities in a formalized way. They agreed to initiate planning for a legal body taking up a few common tasks, but proceed through a step-by-step process. First step was collecting signed Letters of Intent by each infrastructure, confirming the willingness to continue cooperation and the agreement to draft a Consortium Agreement. Next step will be an agreement on entering a joint consortium based on the Consortium Agreement, and to experience how this would evolve. This has to underpin a future commitment to study and prepare a possible legal body with allocated tasks to be defined in detail. This resulted in joint work on the required legal arrangements and a business plan underpinning the common ENVRI activities for the upcoming years.
- As for sustaining individual results (tools, services, documents) the sustainability plan revealed that quite some project partners are committed to sustain produced project results, sometimes also by covering the involved costs. The ENVRI community will build on their plan for a common organization as basis for sustaining other results.

In conclusion, the cooperating research infrastructures continue with a common ENVRI view to position the cooperating research infrastructures strongly for the next decade. Agreements on a sequence of decisive steps to establish a sustained ENVRI will also support the collaborative infrastructure contributions to advanced research across traditional scientific borders, and to provide scientific support for a holistic understanding of our planet and its behaviour, processes, feedbacks, and fluxes.

Deviations, reasons for deviations and corrective actions:

Considering the extended work in this task, and the fact that most of the work was done and coordinated by UvA, UvA spent more person months than originally foreseen. In an earlier amendment, extra person months were allocated and budgeted for UvA to cover the work to be done.

WP18 Dissemination, Liaison and Collaboration

WP leader: Helen Glaves (hmg@bgs.ac.uk)

WP participants: NERC, UHEL, ICOS ERIC, EURO-ARGO, CNRS, INGV, UvA, INRA, UiT, EuroGOOS

Introduction

The objective of Work Package 18, which was led by partner UKRI, was the dissemination and promotion of the ENVRIplus objectives, activities and outcomes across a range of stakeholders using various dissemination, promotion and collaboration techniques. The activities of WP18 were intended to promote engagement with various user communities to ensure that the project remains up to date with their current needs, challenges and user requirements.

The ENVRIplus dissemination and promotion was coordinated using a robust and comprehensive strategy that has been periodically updated throughout the project in response to lessons learned and feedback received from stakeholders. A range of communication tools and techniques were used during the project for the purposes of internal liaison within the environmental cluster and to promote ENVRIplus with external stakeholders including those European and international initiatives which have similar objectives and activities e.g. GEOSS, COPERNICUS, ESA, Research Data Alliance (RDA), CODATA, COOPEUS etc.

Task 18.1 Outling of ENVRIplus dissemination strategy

This task was completed in month 4 with the submission of the strategy. However, this strategy document has been updated during the project in response to lessons learned and feedback from stakeholders, to ensure that the dissemination and promotion of ENVRIplus remained relevant and appropriate for its target audiences throughout the project.

Task 18.2 Promotional materials, publications, website and social media

This task was focused on implementing the dissemination strategy defined in the associated deliverable *D18.1 Dissemination strategy* developed in Task 18.1. During the current reporting period ICOS ERIC, which led this task with the support of UKRI and INGV, has actively sought opportunities for promotion of the ENVRIplus project and its results.

In particular ICOS ERIC has:

- continued to manage the visual identity for ENVRIplus;
- maintained the ENVRIplus online presence including
    - updating the website with new and engaging content
    - managing the ENVRIplus social media channels on Twitter, Facebook, LinkedIn, Slideshare and Flicker, including using the available analytics tools to monitor user traffic and modify content accordingly;
- produced and distributed the printed dissemination materials, including the highly popular colouring book introducing ENVRIplus and the participating RIs that was updated during the final reporting period to include new associated RIs. More than 3000 copies of the ENVRIplus colouring book have been distributed together with a set of pencils during the entire project.

Newsletter

ENVRIplus produced a regular newsletter to provide updates on recent project developments along with other related information of relevance to partners and stakeholders. The final edition of the ENVRIplus newsletter was produced during the current reporting period by ICOS ERIC with UKRI acting as lead editor. ICOS ERIC was also responsible for the design and distribution of the newsletter, while UKRI took the lead on soliciting and editing the content. This last issue of the newsletter, which focused on the topic of FAIR data and related initiatives, can be viewed at: https://mailchi.mp/972b79468e1f/5th-envriplus-newsletter

Stakeholder engagement activities

Conference and workshop presence

Task leader ICOS ERIC, with support from partner UKRI, organized and coordinated the ENVRI community booths at the large and high-profile EGU 2018, EGU 2019 and GEO 2018 conferences. These booths are of particular note because the participating RIs presented themselves jointly as a single ENVRI community whilst also having individual contributions from the participating RIs to provide a comprehensive programme of events at the booth throughout the duration of each conference. The successful organisation of these booths, which were considered a critical dissemination activity for raising the visibility of participating RIs, required a significant contribution of human resources from ICOS ERIC. As a result of the success of these community booths, they will continue to be organized as part of the new EU-funded ENVRI-FAIR project.

ENVRIplus also carried out dissemination and communication activities at other events, which include promoting the project through presentations at a number of conferences, for example ICOS ERIC and UKRI presented ENVRIplus at the recent EGU and AGU conferences. Furthermore, ICOS ERIC also created a roll up poster for promoting the project at the ICRI 2018 conference. https://www.icri2018.at/

Open Forum "Collaboration for an integrated knowledge of the Earth system - European environmental research infrastructures"

ICOS ERIC has organized an open forum, which was a public event where the collaboration of the Environmental research infrastructures was discussed. The forum was organized as part of the Final ENVRI week, but it was broadly promoted, aiming to have participants from public, local Finnish policy-makers, funders, etc. More information about the event is accessible here: http://www.envriplus.eu/wp-content/uploads/2019/03/ENVRIplus_Open_Forum_invitation-2.pdf

ENVRIplus Final Event

ENVRIplus organised a final dissemination event titled “Collaboration for the impactful science” that showcased the contribution of European environmental research infrastructures to global Earth Observations. This event, which was organised by ICOS ERIC and UHEL with support from partners EuroGOOS, UvA and UKRI, also provided an opportunity to discuss the results of ENVRIplus with stakeholders, promote the benefits of the collaboration amongst the RIs, and also look ahead to the future of the ENVRI community.

The event took place at the Royal Belgian Institute of Natural Sciences, Brussels, on 4 June 2019 with more than 130 participants registered to attend. The target audience for this event included: European and national decision-makers, the European Commission, national representatives in Brussels, European Environment Agency, ESA, EUMETSAT, IOC-GOOS, as well as GEO, Copernicus and other international organizations.

The event was formatted to include presentation of ENVRIplus results during the morning session with contributions from the broader community and international stakeholders, and a look to the future for ENVRI during the afternoon. The event also included a ‘Science Fair’ during the lunch break with displays and lightning talks from individual research infrastructures.

Further details of this highly successful event are available at:
http://www.envriplus.eu/2019/04/29/final-envriplus-event-agenda-and-registration-online/

The organization of this event required a lot of resources especially from UHEL, ICOS ERIC and EuroGOOS.

Other dissemination activities

As part of its contribution to ENVRIPlus, ICOS ERIC developed and maintained a network of communication officers from the participating RIs, who promoted the ENVRIplus products and services within their communities. During the second reporting period, two workshops and training sessions brought this network together with the objective of sharing knowledge and best practices. Professional communicators were also brought in for these events to provide tailor-made training for the RI communications managers. The training costs were covered by WP15.

ICOS ERIC also initiated a collaboration between the ENVRI communication managers and those from other RI clusters e.g. CORBEL, EMBRIC, PARENTHOS, ASTRICS, SINE2020, in an effort to share best practices for promoting the cluster projects and improving the exploitation of their results. The group had regular virtual meetings and also set up a joint work space using the online Basecamp collaboration tool to share information and documentation. The communications managers from other clusters were impressed by the long-term strategy for branding of the ENVRI community and organization of the joint communications activities with our RIs.
The network will continue to work together within the follow-up cluster projects.

Performance monitoring

As task leader ICOS ERIC was responsible for monitoring the ENVRIplus dissemination activities carried out by partners including gathering reports on relevant events some of which have been used as the basis for new material in the ‘News’ section of the ENVRIplus website.
ICOS ERIC also monitored the various ENVRIplus social media channels and uses appropriate analytics tools to report on the impact of these dissemination activities. This information is also used to guide further relevant content to be included as part of the ENVRIplus online presence.
The KPIs set to monitor the success of communications activities as well as other performance analytics can be found at the end of this report.

Significant results

- Significant benefit was gained from the ENVRI community booths that promoted the project with stakeholders, and also encouraged cohesion within the ENVRI community and among the participating RIs;
- The ENVRIPlus final event in Brussels was highly successful with more than 130 attendees. A range of stakeholders attended including policy makers and funding agencies, with many providing positive feedback on the event, the outcomes of the ENVRI project, and the benefits of the ENVRI cluster.

Deviations, reasons for deviations and corrective actions

No deviations from the work plan.

Task 18.3 Liaison and collaborative action with RI users

This task, which was led by the University of Amsterdam (UvA), aimed to raise awareness of how Research Infrastructures can support scientific research in the environmental sciences through a series of events aimed to disseminate the goals, activities and outcomes of ENVRIplus to a targeted scientific audience.

During the current reporting period a number of events have been organised by UvA in cooperation with other ENVRIplus partners:

EGU General Assembly, April 2018, Vienna Austria

The focus of the ENVRI presence in EGU 2018 was around the data management and virtual research environments for Environmental Science.

The main session ENVRIplus convened was titled ' *Environmental physical and data infrastructures: practices, access and technologies - towards system level understanding* '. It consisted of the following presentations:

- Further integration of European Research Infrastructures related to terrestrial ecosystem research (solicited) Highlight;
- Enriching the EnvThes controlled vocabulary via aggregated semantic concepts;
- DiSSCo: The physical and data infrastructure for Europe's Natural Science Collections;
- The ENVRIplus Architecture;

- Interoperable Publication of Sensor Observation Data: The SeaDataCloud SWE Ingestion Service;
- Accelerating minerals exploration with in-field characterisation, sample tracking and active machine learning.

The session was attended by approx. 45 persons and had a poster session organized as well.

GEO Week 2018, Kyoto, Japan

ENVRI hosted a side event during the GEO week 2018 in Kyoto. The side event focused on end user applications using both remote sensing and in-situ data. Invited speakers presented decision support systems based on both types of data, and stressed the importance of having that mix of data. The target message of ENVRI being a professional supplier of in-situ environmental data appeared to be well understood, as was the general concept of having in-situ data availability, in this mainly satellite dominated community. A full agenda of the session can be found here: http://earthobservations.org/geo15.php?t=schedule

To prepare for this meeting and the strategic positioning of ENVRI in the Earth Observation landscape, a workshop organized by the ECOPOTENTIAL project was attended in January 2018**;**

AGU fall meeting 2018, Washington, USA

The ENVRIplus presentation in the AGU conference 2018 was part of a bigger session titled 'Integrating Data and Services in the Earth, Space, and Environmental Sciences Across Community, National, and International Boundaries'

(https://agu.confex.com/agu/fm18/meetingapp.cgi/Session/61398)

This session was also scheduled at the EGU conference ensuring international visibility for ENVRIplus. At the same time, it also laid the foundations for successful events during the EGU 2019, which is a prime target for ENVRI.

The session was attended by approx. 45 participants and followed up by a poster session (https://agu.confex.com/agu/fm18/meetingapp.cgi/Paper/361880).

EGU General Assembly, April 2019, Vienna, Austria

During EGU2019 the ENVRIplus project was presented in three sessions:

GIFT Workshop for geo sciences teachers

In the annual GIFT workshop, Giuliana d'Addezio from INGV presented the e-learning platform that was developed within task 15.5 for high school teachers. The platform contains a number of materials for high school teachers to use in classrooms. The development is the

final part of an action within the GIFT workshop, to investigate the needs from these high school teachers.

EOS2.4: Games for geo science

In this session, Jacco Konijn presented the serious game for high school students that ENVRIplus developed in collaboration with LifeWatch. The talk was well received by an audience of at least 60 people. Full details of the abstract are available at: https://meetingorganizer.copernicus.org/EGU2019/EGU2019-17574.pdf

Town Hall Meeting TM5

ENVRIplus hosted a Town Hall meeting on the topic of worldwide collaboration of Research Infrastructures and other similar initiatives.

https://meetingorganizer.copernicus.org/EGU2019 /session/33565. The session included an international panel of experts with each starting their contribution with a short opening statements on a pre-selected topic. There followed a lively discussion with participation from relevant initiatives form around the world including AUScope (Australia), ESIP, AGU, EARTHCUBE (USA) and EPOS (Europe).

Due to the success of this session, similar events are now planned for the next AGU Fall Meeting conference (December 2019) and EGU 2020 as part of the new ENVRI-FAIR project.

Significant results

- This task organised a total of 10 event, which was more than planned in the DoA. There have also been a significant number of additional opportunities to promote ENVRIplus to scientific audiences, and the large organisational and scientific support network available within the ENVRI community and their related networks, could provide the necessary capacity to ensure these opportunities are fully exploited.
- Partner UvA also produced the deliverable *D18.3 Report on community workshops* that fully documents the various user events conducted as part of this task throughout the ENVRIplus project. This report also provides some conclusions on how to maximise the impact of user focused workshops for different target audiences, which have been drawn from the feedback from the various user events organised as part of this task.

Deviations, reasons for deviations and corrective actions

No deviations from the work plan.

Task 18.4 Linking the environment to economics: relevance of environmental research infrastructures for society

Task 18.4 was led by partner INRA with support from UKRI (EPOS). During the current reporting period the deliverable *D18.4 Synthetic report on best practices for linking RIs with societal needs, economics and policy* was developed and submitted for approval. This report provided a synthesis of the relationship between environmental RIs and industry alongside the contribution that RIs make to policy and decision-making in Europe. The issues and improvements that could potentially be made in the relationships between environmental RIs and both industry and policy makers to maximize the potential socio-economic benefit were also considered as part of this study and documented in the resulting report.

The progress and synthesized results of this work were also presented at the ENVRI week meetings in Riga and Helsinki where those attending were invited to provide feedback.

This work has also been published in the form of a white paper and a peer reviewed manuscript (see below). It will also form the basis of a forthcoming perspective paper that will be published later this year.

Significant results

- The results of the work undertaken in Task 18.4 have formed the basis of a white paper entitled *"Synthetic report on best Practices of linking RIS and societal needs, economics and policy"* ;
- A peer reviewed perspective article was also published which was authorded by Chabbi, A, Loescher, H.L. & Dillon M.S. 2017. *Integrating environmental science and the economy: innovative partnerships between the private sector and research infrastructures*. Frontiers in Environmental Science, 5 :49 doi : 10.3389/fenvs.2017.00049 is available via the link.

Deviations, reasons for deviations and corrective actions

Deliverable D18.4 was delayed to allow collection of additional information as suggested during the internal review of the first version of this report. The additional information was included to enhance the overall quality of the resulting deliverable.

Task 18.5 Establishment of an ENVRIPLUS consultation groups

This task, led by INGV-EMSO, was refocused as a result of feedback from the previous periodic review, which suggested that there was need for ENVRIplus to have a focused strategy for RI engagement with industry.

During the current reporting period partner INGV-EMSO conducted extensive work to develop a roadmap for RI engagement with industry that was presented at ENVRI week for feedback from partners, and was also discussed during the associated BEERi.

The resulting deliverable *D18.5 RI Innovation and industry liaison preparedness roadmap* has also been drafted during the current reporting period. This roadmap will now be taken forward for implementation by the environmental RIs as part of a dedicated task in the recently funded ENVRI-FAIR project.

Significant results

The deliverable *D18.5 Innovation and industry liaison preparedness* roadmap provides a set of guidelines that will enable RIs that make up the ENVRI cluster to develop closer links with industry, and use these relationships to promote innovation that will yield economic benefits for the EU Member states.

The implementation of this roadmap will form the basis for a task on the EU-funded ENVRI-FAIR project.

Deviations, reasons for deviations and corrective actions

The deliverable D18.5 was delayed due to the refocusing of this task following the previous periodic review. This allowed EMSO ERIC to fully develop the roadmap documented in the deliverable that was submitted for approval.

KPI No.	Activity/channel	Description	Target	Target audience	Time Scale	Target Achieved YES/NO	Actual Number
1.	Website	Number of page views	3.500 views	All stakeholders	Per month / on average	NO	3,442 views per month/on average
2.	Website	Number of page views	80.000 views	All stakeholders	The entire project life span	YES	103,073
3.	Website	Number of unique visitors	800 visitors	All stakeholders	Per month / on average	NO	725 visitors
4.	Website	Number of unique visitors	25.000 visitors	All stakeholders	By the end of the project	YES	31,253
5.	Community platform	Number of unique visitors	8.000 visitors	All stakeholders	By the end of the project	YES	
6.	Social media (Twitter)	Number of followers	1.000 followers	Science community /Policy makers/Decision makers/ Research funding bodies/Other projects and initiatives	By the end of the project	YES	1,218
7.	Social media (Twitter)	Number of new followers	1 new follower	Science community /Policy makers/Decision makers/ Research funding bodies/Other projects and initiatives	Per day	YES	On average 1 new follower per day
8.	Social media (Twitter)	Number of impressions	15.000 impressions	Science community /Policy makers/Decision makers/ Research funding bodies/Other projects and initiatives	Per month	YES	24.8K impressions
9.	Printed media (coloring books)	Number distributed	600	Scientific community	Per year	YES	Yes, especially at ICRI, 2018, EGU 2018 and 2019, ENVRI weeks,

							GEO 2018, Final Dissemination event, other events
10	Printed media (brochures)	Number distributed	600	All stakeholders	Per year	YES	Yes, especially at ICRI, 2016, EGU 2017, AGU 2017, ENVRI weeks, GEO 2017, AGU 2017, other events
11	Newsletters	Number opened	500	All stakeholders	Per issue	YES	662
12	Joint ENVRI community booth	Number of attendees (Actively engaged)	800	Science community/ ENVRI community/ Other projects and initiatives	EGU18/2019	YES	Estimation (based on the number of material distributed at the event)

Table 18.1 – Key performance indicator for the communications activities, the targets and the results

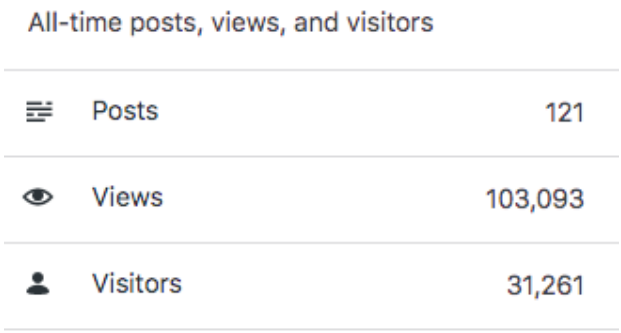

Figure 18.1: Shows total statistics for the ENVRIplus website since its launch in 9/2015

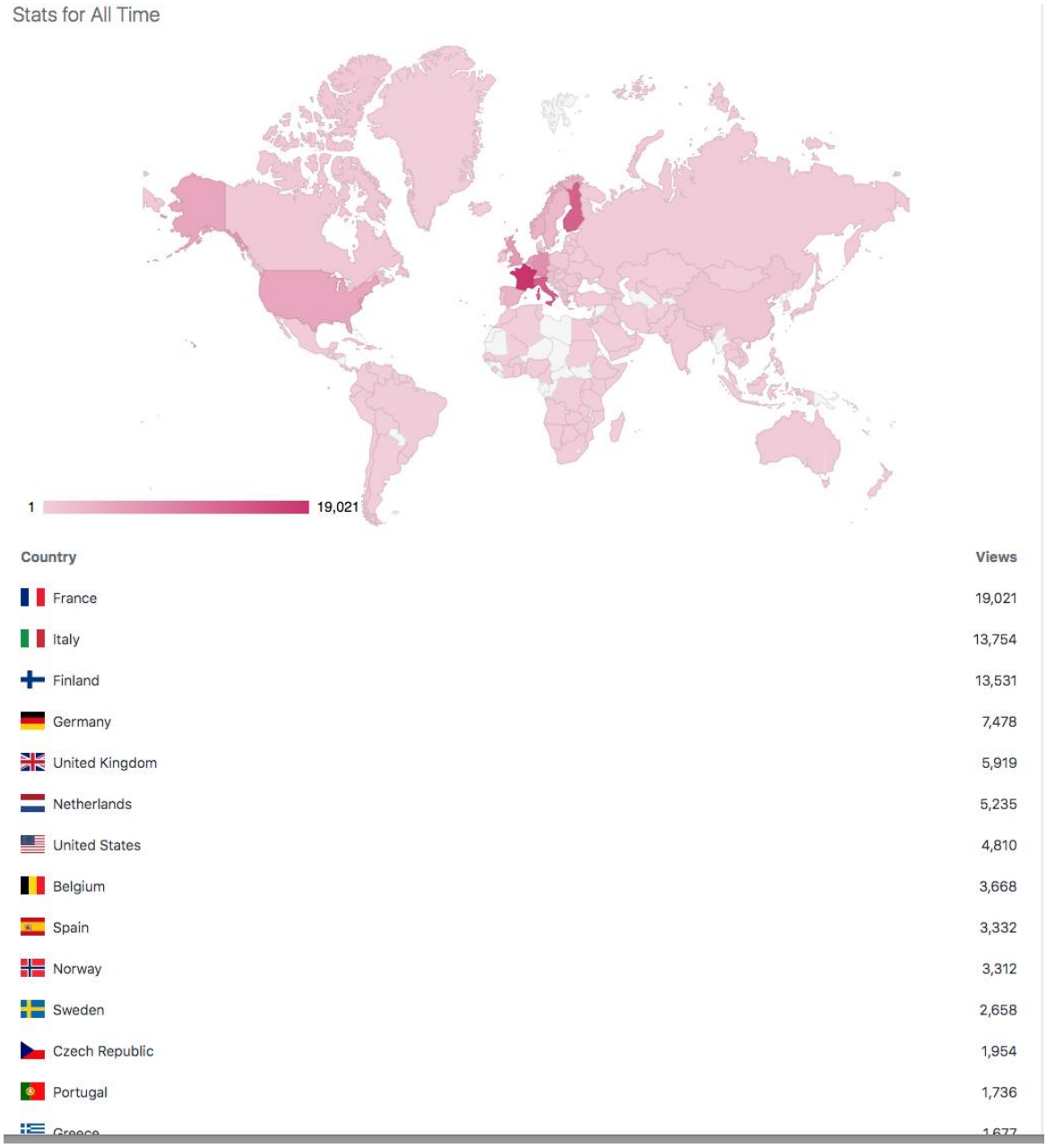

Figure 18.2: Illustration of the distribution of the ENVRIplus website visitors in different countries

Twitter Analytics

All time summary

Number of tweets: 1703

Number of following: 613

Number of followers: 1,218

April 2019 summary

Number of impressions per month: 35.2K

Number of impressions per day: 1,1K

Number of retweets per month: 80

Number of retweets per day: 3

Number of likes per month: 134

Number of likes per day: 4 likes

Number of original Tweets: 13

Profile visits: 583

Mentions: 27

New followers: 12

Facebook
157 followers

LinkedIn
130 followers

WP19 Project Management

WP leader: Werner Kutsch (werner.kutsch@icos-ri.eu)

WP participants: UHEL/ICOS ERIC

Introduction

The project management Work Package concentrated on day-to-day management activities of the project. It was responsible of project internal coordination structure, financial and administrative management, governance, project reporting coordination and risk management.

Task 19.1. Project financial and administrative management and Task 19.2: Project scientific and progress management

These tasks organized the overall financial, administrative and scientific management of the project, including coordination, planning, reporting, financial issues, and product development progress.

During the 3rd reporting period, the overall day to day management of the ENVRIplus Project was handled by the ICOS ERIC. The Project Office (PO) consisted of five persons: Project Coordinator, Project Co-coordinator (25%), Project Director, Project Manager, and Project Assistant. The PO maintained the communication with all the project partners and research infrastructures as well as the partner organization's administration. It organized the bi-annual consortium meetings called ENVRI weeks, with the participants representing the ENVRIplus partners, but also external collaborators. All the ENVRI weeks, including the agenda and participants list, are described in Deliverable 19.2, which is, however a confidential document (as it includes personal information). The organization included the preparation of the administrative and practical documentation, as well as event management (registration, conference venue, and services, catering, accommodation, etc.).

Project Office organized the Executive board meetings of ENVRIplus. Those are as well described in the Deliverable 19.2. Almost all the members of the office participated in the meetings to ensure smooth communication between the management and Board members. The project management also included the interaction between project Steering Group and the rest of the project and prepared the EB meeting agendas. The management was also responsible for the communication and follow-up of the EB decisions. There were 20 meetings of the EB organized during the project's lifetime, eight of them in the 3RP. The face-to-face meetings were organized twice a year, the rest was organized using the web-conferencing system Webex and later GoToMeeting software.

The overall management of the project was organised through the browser-based project management tool Active Collab (https://www.activecollab.com/). This web platform served as an internal collaboration workspace for the ENVRIplus partners. The Active Collab platform was a key instrument not only for monitoring the project's progress but also for enabling and facilitating the internal communication, as each project participant has had an access to all relevant information shared within ENVRIplus.

Besides that, the Project Office also participated in the meetings organised around the specific Themes, thus maintained direct communication between partners, WP and Theme leaders, as well as RIs and their coordinators. This ensured the internal coordination across all the Themes, avoiding duplication of efforts, but also follow up on the progress within certain WPs/Themes.

The project office also managed the communication with Commission, took care of the continuous reporting in the EC reporting portal and organized the overall reporting responsibility of the project. The project office organized three amendments to Grant Agreement during the third reporting period and applied for an extension of the project for additional three months.

Task 19.3: Project Internal communications

The internal communication within the ENVRIplus was also organized by the Project Office. Several communication channels were adopted to ensure an optimal information exchange within the project in order to:

- Inform the project partners of internal organizational issues;
- Explain the internal processes and decisions taken within the project to the members;
- Inform participants on news and events relevant to project;
- Give project partners a general overview of what is happening within the different parts of the project; present a “big picture”;
- Provide means of communication to specific Work Packages and other groups within the project;
- Create a community of people enthusiastic to work together towards the goals and aims of ENVRIplus.

To achieve the above-mentioned points, Task 19.3 set up and maintained various media that served as communication channels within ENVRIplus :

- Email lists
- Internal Collaboration site (ActiveCollab)
- Internal Bulletin
- Webconferences

All the communication tools were described in Deliverable 19.3

Task 19.4: Organization of Data Management Team and Theme leadership support

Data Management Team

The final version of the data management plan was prepared, using the existing plans and DMT meeting materials as a basis. The DMT prepared and sent the a questionnaire to all WPs on the products, data, and shareable services (including white papers, etc), and their current locations and plans for their long term storage. For datasets which had no clearrepository, Zenodo was recommended. The questionnaire collected key information on each research products:

Identification (title, authors, description, format, size, etc.)

Findability (location, PIDs)

Accessibility (Licences, limitations)

Interoperability (Vocabularies, standards)

Re-Use (QC procedures)

Sustainability (long term storage)

Results of the 24 key research products groups were collected and presented in the final Data Management Plan.

Theme leadership support

WP19 supported the Theme leaders in their management tasks by providing travel support for the Executive board and other Theme meetings. The budget for this was initially with the University of Helsinki/ICOS ERIC then handled by internally adjusting the organizational's budgets. WP19 as well supports the Theme leaders through its internal communication channels. In order to coordinate their teams, the Theme leaders could utilize several mailing lists, webex conference facilities and internal project management system that was set up by the project manaegent team. Project coordination team also participated in the specific Theme discussions, both virtual and physical, to provide a feedback from the general coordination view and to ensure the integration of transversal activities with other Themes of ENVRIplus.

Significant results

- All the project deliverables were submitted;

- All the Milestones were achieved;
- Internal Communication channels were operational and broadly used to maintain a high quality internal communication
- Organization of three successful consortium meetings and of final dissemination event in Brussels
- Coordination of the third periodic and final projectreport

Deviations, reasons for deviations and corrective actions

No deviations from the work plan

1.3 Impact

Collaborative development saves effort, resources, and creates better services

The ENVRI PLUS project collaboratively developed a wide variety of technical, e-science and other tools to be used throughout the cluster. Compared to individual developments by each RI this has been time and resource efficient, used hard-to-find expertise in an optimum way, and created interoperable services. Due to large differences in maturity and resulting expectations, such joint developments are not necessarily easy and mapping which parts of the services are common and which parts need to be developed separately is non-trivial, and require their own efforts. The experiences from the earlier ENVRI project(s) were very useful to overcome management and coordination challenges. Since we applied the same co-development cycle (RI internal and external experts develop together solutions), the joint technical developments were extremely successful in creating common tools and services, and the practical operational increase in the capacity of the ENVRI RIs was demonstrated by the numerous Use Cases For the Data-for-Science activities of ENVRI PLUS, this strategy clearly sets the foundations for fully interoperable data systems, a key aspect of the upcoming European Open Science Cloud.

Coordination of heterogenous environmental RI field has great potential

ENVRI PLUS united a large number of ESFRI projects, landmarks and initiatives, with widely varying missions, disciplinary customs and operational maturity. The broad approach beyond the ESFRI Roadmap was applied on purpose in order to include and engage the whole landscape. The project clearly demonstrated the added-value of enhanced collaboration and demonstrated the need for further collaboration and coordination,

especially on aspects such as interoperability of services, access provision to the facilities, possibilities of co-location, RI-to-RI services and many other features. The bottom-up development system of the ESFRI RIs is excellent for producing key services for selected research communities, but even moderate coordination efforts demonstrated to be very cost-effective. The project thus concludes that coordination mechanisms towards a further development of the RI landscape would be extremely beneficial. This should be done by combining at least four different viewpoints: (1) multi-disciplinary scientific questions, (2) overarching societal Grand Challenges, (3) common user expectations, and (4) economic benefits of synergies.

"Soft" developments can be extremely beneficial for the impact of the RIs

The ENVRI PLUS experience shows that actions not generally considered to be crucial for the RI operations can be actually extremely beneficial both for the RI and the interoperability of the RI cluster. For example, activities towards environmental literacy and ethics are crucial for the socioeconomic impact of the RIs. The same counts for the provenance and reliability of the provided services and data. Similarly, community building and communications can be crucial to keep the RI staff efficient and well connected – making the interoperability and efficiency goals far easier to reach. Collaboration with societal actors, such as schools and businesses can lead to far improved long term impacts of the investments to the RIs. The experiences of ENVRI PLUS have proven that a broader thematic approach is stronger than a narrow focus on technical or data-related topics.

Joint strategic actions make the ENVRI RIs better suited for societal and science impact

The in-situ segment of the Earth Observing system is very complex and involves multiple players, many of them now organized in the framework of ENVRIs. Coming together and creating a strategic approach has made the ENVRI RIs far more visible and influential in the international Earth System research (e.g. via COPERNICUS, WMO, and GEO(SS)), as well as strengthened the impact of ENVRI RIs on European developments (e.g. in EOSC). Work is at initial steps but joint planning and decision making in the cluster has been a very successful way to align the downstream activities in EUROGEOSS projects. Clustering the RIs collaboration have had direct implications for the partnership for the European private sector, offering, for the first time, a single voice and potentially offering a much larger and

potential market for innovation and collaboration with, societal actors, and education facilities.

Socio Economic Impacts

The ENVRI RIs are major investments from many European Union members states and associated countries. It is expected that such investments will yield a long-term return in the form of socio-economic impacts on their societies. The ENVRI PLUS - as a project of medium magnitude - is a very small additional coordination layer on top of these multi-billion investments, but has been very successful on leveraging the existing facilities towards societal, economic and scientific impacts.

ENVRI PLUS has incubated some approaches responding to the increasing demand for methodologies and tools that can assess the social and economic impact of RIs. While RIs are designed for research needs, their impacts reach beyond science, particularly in the environmental field. ENVRIs have a specific socio-economic impact because, besides scientific interest into the workings of the Earth system, humans have a large stake in a sound understanding of it to support their own lives. Improved insights into the functions of the Earth system, in a rational world, should lead to improved management and behavior. The related changes in policy lead to, or are in themselves, socio-economic impacts mainly by conserving existing rather than creating new wealth. Thus, the description of socio-economic impact of RIs is non-trivial. Some impact will be achieved far in the future, and it will be hard to pinpoint them to a specific project. Hence, the main impact the ENVRI PLUS can demonstrate is the increase in the potential for new services and interactions, which will (in the future) have significant benefits for the society. Moreover, the work towards making the data and data products from environmental RIs multidisciplinary, increases the quality of environmental information, and encourage the innovative use of existing information. These achievements may look small against the assets that are at stake related to environmental risks but may be crucial in generating the knowledge to avoid them.

Economic efficiency of the RIs themselves has been increased by joint technical and data developments that created far more integrated services for the participating RIs. Staff training and exchange improved operational services and enhanced the efficiency of organisational structures. Integrated access mechanisms will improve the usability of the RI services for the scientific users, particularly for interdisciplinary research. The first steps towards integrated

up and downstream collaboration with the private sector was started, and this joint approach is a very efficient way of providing for the SMEs a reasonable market base for their operations.
The common basis for new data services is directly impacting the EOSC service development, and increases the usability of the RI services for the COPERNICUS service provision.

The citizen science activities led to a development of several tools that are now being used by the public. This will not only help to gather new data, but also increase the awareness of the importance of (environmental) science within the society.

1.4. Infrastructures

N.A. - Even though the primary focus of this project is on supporting the Research Infrastructures, it is not a RI project per se.

1.4.1 Trans-national Access Activities (TA)

N.A.

2. Update of the plan for exploitation and dissemination of result (if applicable)

The authors of Dissemination strategy for ENVRIplus and the associated work plan decided the strategy is a living document that will be reviewed and updated during the project's lifetime in order to adapt to the changing needs of ENVRIplus and its stakeholders. So far, two updated versions of the strategy exist. The latest updated version is now available online at http://www.envriplus.eu/wp-content/uploads/2015/08/D18.1.2-ENVRIplus-Dissemination-strategy-updated.pdf

The Key performance indicators (See the report of WP18) suggests the dissemination activities of the project were well planned and executed and its results were communicated towards a broad range of different target audiences.

The project outcomes are accessible on ENVRIplus website. The site will be frozen and not populated with a new documentation anymore. More strategic output of the project is

accessible in ENVRI community documentation space hosted by FZ Jülich, the coordinator of ENVRI-FAIR. The population of the platform with new material will continue during the ENVRI-FAIR.

The already mentioned dissemination event in Brussels, was a huge step towards a broad dissemination of the project's results.

3. Update of the data management plan (if applicable)

See the report of Task 19.4: Organization of Data Management Team and Theme leadership support, describing establishment of Data Management Team, development of the first Data Management Plan, as well as its updated version.

4. Follow-up of recommendations and comments from previous review(s) (if applicable)

Not applicable for this reporting period.

5. Deviations from Annex 1 (if applicable)

Delayed Deliverables

The following deliverables were submitted after scheduled submission date. The reasons for the delays were communicated with and approved by the EC Project Officer.

Deliverable	Title of the deliverable	Lead Beneficiary	Due date (Month)	Actual Submission date
D12.1	Report describing the relation between challenges of human systems and environmental information generated in RIs as documented module of the ENVRIPLUS Reference Model updated based on the experiences from Tasks 33 and 34	EAA	30 Apr 2018	30 Sep 2019
D14.9	Summary report of WP14	EMSO ERIC	30 Apr 2019	30 Sep 2019
D17.6	White paper on further integration of RIs in the environmental field including	ICOS ERIC	30 Apr 2019	30 Sep 2019

	recommendations on co-locating research sites on national and international level			
D3.2	New set of standards for the qualification of instruments towards extreme conditions	CNR	31 Oct 2017	02 Aug 2018
D14.8	Collection Training sessions/presentations	MBA	31 Dec 2018	02 Aug 2019
D17.3	Landscape analysis of the environmental RI community in Europe	UHEL	28 Feb 2019	03 May 2019
D8.4	Interoperable cataloguing and metadata harmonisation for environmental RIs: prototype	IFREMER	31 Oct 2018	05 Dec 2018
D15.5	EeTP E – Learning, description of implementation of new functionalities	UNILE	30 Apr 2018	05 Jun 2018
D10.1	Guidelines on access to RIs	CNR	28 Feb 2019	05 Mar 2019
D10.3	Description of performance criteria for open access and list of performance indicators	CNRS	31 Oct 2017	05 Mar 2019
D9.2	Service deployment in computing and data e-Infrastructures Version2	EGI.eu	31 Aug 2018	05 Sep 2018
D8.2	Data curation in system level sciences: prototype and deployment.	NERC	31 Oct 2018	07 Nov 2018
D8.6	Data provenance and tracing for environmental sciences: prototype and deployment	EAA	31 Oct 2018	07 Nov 2018
D12.4	Prototyping a distributed site catalogue	EAA	30 Apr 2019	09 Jul 2019
D11.2	Plan for sustained multi-year planning of oceanographic vessels for the environment European Ris	IFREMER	31 Oct 2016	12 Jan 2018
D7.2	Interoperable data processing services for environmental RI projects: prototype.	CNR	31 Oct 2018	12 Nov 2018
D11.3	Whitepaper on improving access across to RIs disciplines	INRA	31 Aug 2018	14 Aug 2019
D15.2	Materials from the second time-series conference including tutorial and hand-book on the second time- series conference	CNRS	30 Apr 2019	14 May 2019
D1.1	Roadmap for the emergence of European industry providers and market landscape analysis	CEA	30 Apr 2017	15 Oct 2018
D13.3	Ethical Consensus Guidelines for Ris	INGV	31 Oct 2018	18 Feb 2019
D4.4	Report on intercalibration with Green repeater initiative	IFREMER	31 Oct 2018	18 Jun 2019
D1.3	Final prototype of ARGO float with pCO2 and pH launched	EURO-ARGO	31 Jan 2018	19 Jun 2019
D1.5	Report on opportunities and applications of unmanned observatories for usage across RI	CNR	30 Apr 2019	19 Jun 2019
D1.6	Results and recommendations from the comparison exercise of sensor embedded processing practices	CNR	30 Apr 2018	19 Jun 2019
D11.4	Report on interdisciplinary integration capacity, end-user needs TNA implementation requirement and added-value for the scientific community	CNRS	30 Apr 2019	19 Jun 2019

D1.7	Report on technological choices for dense networks of small sensors	IFREMER	31 Oct 2018	20 Jun 2019
D16.2	Synthesis report on staff exchange and how this service can be sustained by RIs?	UniHB	28 Feb 2019	21 Mar 2019
D2.1	Report on standardization in RIs and tree of metrology references (from international reference labs to RI collected data)	CEA	31 Oct 2018	22 Jul 2019
D3.4	Report on improved robustness in extreme conditions	CNR	30 Apr 2018	22 Mar 2019
D14.7	Citizen observation training program, training delivery and evaluation, and impact assessment report	MBA	31 Dec 2018	23 Jul 2019
D9.4	Serving key data service stakeholders and policy initiatives version 2	LU	28 Feb 2019	24 Jul 2019
D1.2	Specification report of common test protocols and inter-comparison methodologies	EURO-ARGO	31 Oct 2017	25 Jul 2019
D13.4	Contents for Websites, social media appearance, printed matter on ethical & societal issues for general public	ETHZ	30 Apr 2019	26 Jun 2019
D3.5	Demonstrating robust data provision - data transmission and near real-time QC - employing a use case in a remote ocean region	UniHB	30 Nov 2018	27 Jun 2019
D17.1	Report of domain WGs on domain-specific development needs and actions	UHEL	30 Apr 2018	27 Jun 2019
D17.4	Summary report on policy communication actions	CNR	28 Feb 2019	27 Jun 2019
D12.2	White paper on general guidelines, recommendations, and best practices on communication and decision-making under uncertainty for environmental hazards and natural disasters	ETHZ	31 Dec 2017	27 Mar 2018
D4.2	Achievements report on open interdisciplinary case studies highlighting the common operation of networks	INRA	31 Oct 2018	29 Apr 2019
D17.5	ENVRIPLUS sustainability plan	UvA	30 Jun 2019	29 Apr 2019
D4.3	Reference document for methane harmonized monitoring	INGV	28 Feb 2019	29 Jul 2019
D10.4	RI strategy for flexibility and sustainability	CNRS	30 Jun 2019	29 Jul 2019
D17.2	Updated version of the ENVRI strategy	FMI	30 Jun 2019	29 Jul 2019
D18.4	Synthetic report on best practicess of linking RIs and societal needs, ecnomics and policy	INRA	30 Apr 2019	29 Jul 2019
D18.5	Developing a common approach to fostering innovation partnerships between the environmental RI s and the private sector	EMSO ERIC	30 Jun 2019	29 Jul 2019
D19.7	Final DMP	UHEL	31 Dec 2018	29 Jul 2019
D18.3	Report on user community workshops	UvA	28 Feb 2019	30 Apr 2019

D2.3	Harmonization strategy report toward support to space mission and assimilation systems based on RI data	CNR	31 Mar 2019	31 Jul 2019
D19.2	Overview report of all annual meetings, General Assembly and Steering Committee meetings	UHEL	30 Apr 2019	31 Jul 2019
D7.4	Performance optimisation services for environmental ESFRI projects: prototype	UvA	31 Oct 2018	31 Oct 2018

These deliverables were delayed, but eventually all were submitted by the end of the project.

5.1 Tasks

All the tasks planned for the last reporting period were fully implemented and all the critical objectives were achieved.

5.2 Use of resources

The partners agreed on several internal budget shifts in order to support the tasks that were prioritized but did not anymore have sufficient funds. The changes are summarized and justified in the table below.

Partner	Deviation in the use of resources	Justification
UNILE	Extra resources spent on the organization of Summer School that was not originally envisioned in the DoA	WP decided to benefit from the availability of a dedicated budget for training events to actually be able to host face-to-face training events on top of the online development of training material
CNRS	CNRS required to increase its budget by 56.250€, which corresponded to 9PMs. Moreover, CNRS required additional 10 000€ from the Project Office (ICOS ERIC)	This additional work effort was needed to re-organize work in WP10. The 10K from PO was justified by the organization of the ENVRI week in Grenoble in RP2
INGV	Shifted 2PMs in WP14 and 4,2PM in WP18 to new partner EMSO ERIC	New partner EMSO ERIC
CSC	CSC required to increase its budget by 34.096€ which corresponds to 6PMs + 2PMs were shifted from Euro-Argo	This additional work effort was needed to complete work in WP9 for use case (TC_2): Integration of Data

		subscription service to Euro-Argo portal
CSC	3.410,64 € was shifted from ICOS to CSC	To cover Executive Board related travels
EAA	EAA required additional 38.374,86€ which corresponds to 6PMs	To fund their work on further development of the generic documentation of RI components using DEIMS-SDR
FMI	FMI required 40.000€	To cover the costs of additional Strategy and Sustainability meetings
IFREMER	required additional resources of 39.500€	To cover the costs of the "methane cruise"
NILU	NILU required 20k€ from CNRS for the organization of the time-series conference	UiT and CNRS required support with the coordination of the event
UniHB	UniHB spent part of the resources (60.000€) that were originally planned for WP16 on Staff Exchange in WP3	Extra work needed in WP3, task 3.3.
UvA	15.400€ was transferred from ICOS ERIC to UvA to cover Executive Board related travels	It was earlier agreed Project Office will cover the travels of EB members
	Transfer of 25.000€ to UvA	To further support the work on project's sustainability plan
CEA	4.500€ was transferred from ICOS ERIC to CEA	It was earlier agreed Project Office will cover the travels of EB members
INRA	2.040€ was transferred from INRA to ICOS to cover accommodation costs of the speakers/attendees invited to Task 4.1 related WS, organized in Zandvoort, 2nd ENVRI week	INRA had a difficulty to cover the payment on spot in the hotel
ICOS ERIC	Several partners transferred their funds to ICOS ERIC to cover the costs of joint ENVRI community booths at EGU 2017	Joint activity organized by WP18

5.2.1 Unforeseen subcontracting (if applicable)

N.A.

5.2.2 Unforeseen use of in kind contribution from third party against payment or free of charges (if applicable)

N.A.

Annex 1

Summary of the dissemination and communication activities of the ENVRIplus project within the third reporting period (presentations, exhibitions and popularised publications giving a visibility to ENVRIplus project and ENVRI community in general, its goals, products and services)

ENVRIPLUS PRESENTATIONS			
Author	**Title**	**Activity Type**	**Conference/meeting/ workshop name/Date/Location**
Jacco Konijn	ENVRI Environmental Science serious game for High School students	Talk in a session	EGU 2019 Vienna, April 2019
Magdalena Brus	Joint communications activities for better visibility of research infrastructures	Conference presentation	Final Dissemination event, Brussels, 2019
Magdalena Brus	Communications as a strategic function for the management and success of a large multidisciplinary project - ENVRIplus case	Conference presentation	EGU2019
Magdalena Brus	Lessons-learned from the Environmental research infrastructure (ENVRI) community building and engagement	Talk in the side event	AGU2018, Washington
Werner L Kutsch	Introduction of ENVRI community and ENVRIplus project	Conference presentation	Final Dissemination event, Brussels, 2019
Werner L Kutsch	Translating the Paris Agreement into observational needs	Conference presentation	COOP+ Conference Brussels, 11.2018
Werner L Kutsch	Permanent monitoring of the ESFRI Landmarks Remarks about ICOS and the ENVRI community	Workshop presentation	ESFRI Workshop – Monitoring of RIs, periodic update of Landmarks, use of KPIs; Milan, 11.2018
Werner L Kutsch	An analysis of the GCOS 2016 Implementation Plan from ICOS perspective	Meeting presentation	GCOS Science day 22. October 2018, Helsinki
Werner L Kutsch	The European Environmental Research Infrastructures a sustainable in-situ contribution to GEO	Conference Presentation	GEO Week 2018
Werner L Kutsch	Greenhouse Gases don´t respect borders	Conference Presentation	ICRI 2018, Vienna

	Global Cooperation on in situ GHG observations		
Werner L Kutsch	Introducing the landscape of environmental research infrastructures and benefits of their collaboration	Forum presentation	Open Forum "Collaboration for an integrated knowledge of the Earth system - European environmental research infrastructures", Helsinki, March 2019
Jean-Daniel Paris	Studying a methane transfer from the seafloor up to the atmosphere during the interdisciplinary Black sea expedition relying on four research infrastructures	Conference presentation	Final Dissemination event, Brussels, 2019
Sabine Philippin	Exploring the integration capacity of environmental observation sites for multidisciplinary research	Conference presentation	Final Dissemination event, Brussels, 2019
Helen Glaves	Interoperability of data, applications and services	Conference presentation	Final Dissemination event, Brussels, 2019
Olivier Gilbert	Solutions for energy units in extreme environments	Conference presentation	Final Dissemination event, Brussels, 2019
Jacco Konijn	The benefits of knowledge transfer among the environmental research infrastructures	Conference presentation	Final Dissemination event, Brussels, 2019
Zhiming Zhao	Enabling interdisciplinary sciences across research infrastructures	Conference presentation	Final Dissemination event, Brussels, 2019
Michael Mirtl	The analysis of research infrastructure relevance for the Grand Challenges	Conference presentation	Final Dissemination event, Brussels, 2019
Ari Asmi	Industry, Innovations, partnership with SMEs	Conference presentation	Final Dissemination event, Brussels, 2019
Sanna Sorvari Sundet	ENVRI beyond 2020	Conference presentation	Final Dissemination event, Brussels, 2019
Paolo Laj	Strategy and funding needs for transnational access	Conference presentation	Final Dissemination event, Brussels, 2019

EXHIBITIONS

Booth	Event	Date	Location
ENVRI community booth	GEO-XV Plenary	29 October - 2 November 2018	Kyoto, Japan
ENVRI community booth	EGU 2018	8–13 April 2018	Vienna, Austria

ENVRI community booth	EGU 2019	7–12 April 2019	Vienna, Austria
ENVRI community booth	ESA Living Earth symposium	13-17 May 2019	Milan, Italy
ENVRIplus project / ENVRI community	Final ENVRIplus Dissemination event	4 June 2019	Brussels, Belgium

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