ENVRI^{plus} DELIVERABLE

D17.4
Summary report on policy communications

WORK PACKAGE 17 – COORDINATION OF RI COMMUNICATION, DEVELOPMENT AND IMPLEMENTATION OF THE ENVRI STRATEGY

LEADING BENEFICIARY: CONSIGLIO NAZIONALE DELLE RICERCHE

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ABSTRACT

This report provides a summary of the activities carried out by ENVRIPlus to promote, coordinate and cultivate sound and significant relations with key strategic stakeholders at all levels, in order to provide them with information regarding the mission, priorities, and activities of the project and the ENV RIs agenda.

ENVRIPlus aims to improve the Earth observation monitoring systems and strategies by enhancing the transdisciplinary use of data and data-products to contribute to tackling global environmental challenges and cooperate with all stakeholders who may affect or be interested in the project's activities or outcomes. A continuous communication with all relevant stakeholders in Europe and beyond is essential to this objective.

The document opens with the description of the strategic objectives of the policy communication actions and the structured but flexible approach defined to build effective and proactive relationships with key organizations throughout the project, with a view to support the ENVRIPlus goals. The relations established, and the actions carried out to pursue and cultivate all different contacts, are described in subsequent chapters, each one focusing on different categories of stakeholders at different international, regional, national and local levels.

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TERMINOLOGY
A complete project terminology is included as an Appendix.

PROJECT SUMMARY

ENVRIplus is a Horizon 2020 project bringing together Environmental and Earth System Research Infrastructures, projects and networks together with technical specialist partners to create a more coherent, interdisciplinary and interoperable cluster of Environmental Research Infrastructures across Europe. It is driven by three overarching goals: 1) promoting cross-fertilization between infrastructures, 2) implementing innovative concepts and devices across RIs, and 3) facilitating research and innovation in the field of environment for an increasing number of users outside the RIs.

ENVRIplus aligns its activities to a core strategic plan where sharing multi-disciplinary expertise will be most effective. The project aims to improve Earth observation monitoring systems and strategies, including actions to improve harmonization and innovation, and generate common solutions to many shared information technology and data related challenges. It also seeks to harmonize policies for access and provide strategies for knowledge transfer amongst RIs. ENVRIplus develops guidelines to enhance transdisciplinary use of data and data-products supported by applied use-cases involving RIs from different domains. The project coordinates actions to improve communication and cooperation, addressing Environmental RIs at all levels, from management to end-users, implementing RI-staff exchange programs, generating material for RI personnel, and proposing common strategic developments and actions for enhancing services to users and evaluating the socio-economic impacts.

ENVRIplus is expected to facilitate structuration and improve quality of services offered both within single RIs and at the pan-RI level. It promotes efficient and multi-disciplinary research offering new opportunities to users, new tools to RI managers and new communication strategies for environmental RI communities. The resulting solutions, services and other project outcomes are made available to all environmental RI initiatives, thus contributing to the development of a coherent European RI ecosystem.

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Objectives of the policy and strategy communication

The policy and communication actions carried out during the project were meant to communicate the ENVRIPlus joint strategic visions, objectives, actions and achievements to all relevant stakeholders in Europe and beyond, so as to raise awareness, to engage in dialogue with local, regional and international organizations in various fields and to obtain feedback.

Linkages, partnerships and collaborations with other RI communities, national, regional and international key actors were established and implemented during the project to achieve the following main strategic objectives:

- Enhance understanding and increase opportunities for cooperation among ENV RIs, other research infrastructure communities and other scientific communities in different domains through the regular exchange of information regarding ENVRIPlus priorities and initiatives;

- Strengthen relations with national stakeholders and funding bodies, with a view to inform policy-making and support channeling of more funding to environmental research addressing national priorities.

- Develop sound relations and interactions with stakeholders at the regional level, across Europe

- Enhance the international dimension of the ENVRIPlus activities, providing opportunities for ENV RIs to collaborate and engage in cooperation with European and international networks and institutions to achieve mutual exchange of experiences and perspectives, and to raise the quality and utility of activities

All dialogues and communication actions to achieve the aforesaid objectives were carried out in such a way as to ensure that ENVRIPlus speaks with one voice for the European environmental communities in the international environmental infrastructure landscape. Also, activities were performed to guarantee the sound alignment of the developments planned in ENVRIplus with those of the national and international Research Infrastructures.

Further to all that, in the course of the project communication mechanisms and relationships were developed with local, regional and international organizations and networks in various fields, with scientific communities, research ministries, European, national and regional funding organizations, stakeholders and other research-oriented organizations from the private sector.

These relations, and the activities performed to establish and nourish each of them, are detailed in the following chapters.

Approach

In the belief that successful external relations cannot be improvised, and that every stakeholder community has a unique and evolving set of cultures, expectations and perceptions, at the beginning of the activities ENVRIPlus managed to establish a general, coherent but malleable approach to guide the relationship cultivation at different levels. That to ensure consistency and efficiency in the relations with all the key stakeholders whether as individuals, groups or organizations, and to ensure greater visibility of the project's role, tools, value and work.

The following general guidelines were set to organize and perform policy and strategy communication activities at the different levels, tailoring activities and messages to take into account the variety of the people to engage and work with and whose support and involvement are essential to project success:

- <u>Identifying stakeholders and performing little intelligence</u>, to shape different strategies, level of engagement, messages and communication channels for different stakeholders at different levels, depending on their

characteristics, key interest and needs. No matter who the stakeholder was, acquiring, presenting, and applying relevant knowledge about relevant stakeholders at the right time was vital to make the voice of ENV RIs heard.

- Encouraging involvement: both that of the stakeholders, and that of the team members and RIs communities' representatives. As regards stakeholders, active engagement was pursued especially leveraging all that ENVRIPlus community has to offer in terms of knowledge, data, models, etc. to support duly informed policy-making.
  As regards the ENV community, ENVRIPlus strived to make building and maintaining strong relationships a responsibility to be shared by the project leadership, the RIs and facilities leadership, the researchers and staff. It was really important to get both academic leaders and staff on board and involved in policy communication actions, as the more they were involved the more they would understand how many big opportunities flourish relations bring to research. And, as understanding grew, new development opportunities leading to funding or other partnerships begun to be identified.

- Establishing frequent channels of communication: the project greatly valued the importance to establish and maintain frequent communication with stakeholders at all levels. For national and regional stakeholders, this also meant providing frequent updates on project progress to gather input and feedback, as well as disseminating newsletters, making presentations at meetings, distributing materials, etc.

- Gathering and incorporating feedback: throughout all the engagement efforts, ENVRIPlus sought to gain feedback from stakeholders about their satisfaction with the project developments and, more in general, with the relationship with ENV communities. Feedback is to be used to feed future developments at all levels, with valuable information used to adjust and improve current and future actions and behaviors.

Relations with other RI communities and scientific communities in different domains

Relations with other RIs and scientific communities in different domains were actively pursued during ENVRIPlus in the belief that high quality environmental research and effective tackling of global challenges such as climate change, health, food and environment security can only be achieved through the establishment and implementation of linkages, partnerships and collaborations across institutes and scientific fields. Interdisciplinarity is strategic to face global challenges, as today real-world problems require the pooling and sharing of knowledge across disciplines and continents to enable the global community to find solutions for a more sustainable future.

This is particularly true for research in the environment domain, where efforts towards limiting the most damaging impacts of climate change, modeling a pathway to healthier, more sustainable communities in sustainable environments, and improving health and human security require a collective effort by different disciplines working in interdisciplinary groups.

Considering this, ENVRIPlus worked to develop the relevant links that already exist among different thematic areas, establishing and deepening relations with other RIs in the ESFRI Roadmap, so as to explore chances for new, interdisciplinary cooperation and research. ENVRIPlus approached, contacted and engaged in relations with other RIs mainly in the Health and Food, Energy and Data, Computing and Digital research domains, such as for instance INSTRUCT, EU Solaris, ELIXIR, PRACE.

Those RIs were invited to take actively part in the ENVRIPlus events, and were kept informed of the ENVRIPlus developments through periodic communications. Meetings, exchanges and working lunch/dinners with representatives of some of them took place whenever possible at conferences, workshops and seminars organized in Europe and abroad on matters of common interest.

This overall effort towards developing fruitful relations with other RIs was endorsed and all the more encouraged after the publication of the new ESFRI Roadmap 2018, whose Landscape Analysis contains in Section 2 an innovative study made to bring out the interconnections and cross-cutting aspects of the whole European RIs ecosystem.

Relations with national stakeholders (policy makers and funding bodies)

During the ENVRIPlus project emphasis was given to developing a common strategy to increase, improve and strengthen relations with national stakeholders, like policy-makers, funding bodies, local organizations and communities. The actions carried out were meant to help bridging the gap between research and policy-making, supporting ENV RIs and national stakeholders improve their mutual understanding, with research communities conveying their results and research interests to the political sphere and policy-makers receiving useful knowledge to eventually come into use and influence planning and decision-making processes. Activities performed with this regard also enabled to take advantage of possible synergies between EU and national funds, and to expand the scope and impact of both funds in terms of scientific excellence and socio-economic development.

Connections were initiated, maintained and cultivated with a view to explore potential for fruitful synergies both in terms of scientific excellence and socio-economic development at national level. A range of activities were put in place for that, from direct mail, telephone and email contacts through to events, personal visits and peer-to-peer networking. ENVRIPlus representatives also participated in various informal knowledge-sharing meetings for policy debate and information exchange on issues of relevance to the management of environmental issues at national level.

All these circumstances empowered ENVRIPlus to communicate the joint strategic visions and actions of the ENV RIs to national stakeholders and funding bodies, encouraging ENV communities to follow its example and actively act to strengthen policy engagement and to support the inclusion of projects and initiatives into national RI roadmaps and priority agendas for environment and sustainable development.

The following tables report some examples of activities realized in the ENVRIPlus countries to engage stakeholders at different levels.

TABLE 1 - POLICY AND COMMUNICATION ACTIVITIES AT NATIONAL LEVEL – ITALY

ITALY

Relations with Ministries
The Italian ENV scientific community in the ENVRIPlus engaged in maintaining extensive relations with the Government level, to inform national authorities of the developments and future perspectives of the environmental research, as well as of the serious need to support research both with more funding and with cutting red tape to simplify administrative burdens. Main objective of all the contacts held was to empower the Italian scientific community to have a say in the definition of strategic priorities for environment and research, on the basis of which operational initiatives are undertaken. Relations were cultivated especially with the **Ministry of Education, University and Research (MIUR)**, managing authority of the National Operational Programme on Research and Innovation, which includes a specific action to support the implementation of the existing or new infrastructures operating in the ESFRI domains and within the national smart specialization strategy. Briefings, meetings, frequent ad hoc visits were organized with ministerial officials, and periodic reports and information documents were prepared and distributed to ensure that the ministry was constantly updated on activities and trends of the research carried out in Italy and in Europe.

Contacts were also nurtured with the **Ministry of the Economic Development**, which shares the responsibility for innovation aspects along with MIUR. Relations were meant to provide some input on possible ways to strengthen the relations between research and industry and to pave the way for synergies regarding how to improve technology transfer and the uptake of the results of environmental research by industry.

Relations with the ESFRI National Delegate

Continuous, sound relations were kept with the national delegate to the ESFRI Forum, both to receive information on the Forum's activities and to transfer opinions and positions of the national scientific community operating in the environmental domain.

Contacts were especially frequent during the works for the update of the ESFRI Landscape Analysis, to secure a proper representation of the Italian landscape of environmental research infrastructures, the relations with other RIs included in the ESFRI Roadmap and operating in the same or different domain, as well as the existing or prospect synergies with international research institutions.

Relations with regional and local authorities

The Italian ENVRIPlus community engaged in constant interactions with the regional and local authorities in Basilicata, the region where the Institute for Methodologies for Environmental Analyses of the National Research Council of Italy (CNR-IMAA) is located. Representatives of the ENV scientific community kept reaching out to local officials and agencies, making one-on-one contacts with local regional, provincial and municipal leaders whom they know personally and organizing frequent visits to the local government offices.

Periodic reports were sent out to update local government departments dealing with research and environment. Contacts were particularly close with the Office for Research within the regional department that provides for the planning and coordination of the activities necessary for the implementation of policies for regional economic development (Production Activities), with the Department for Environment and with the managing authority of the European regional development fund (ERDF).

Regional officers participated in various workshops organized to disseminate the results of projects and environmental research in the atmospheric field and to explore synergies for facilitating the transfer of such results to the private sector.

Relations with other stakeholders (RPOs, Universities, ARPAB, industry, etc.)

Big effort was put in fostering greater synergies, exchanging knowledge with other research institutions, and developing cooperation with the private sector. The strategic objective of relations with other RPOs, Universities and public research bodies (for instance the Regional Environmental Protection Agency - ARPA) at national and local level was to contribute to involve the national scientific community and promote a more structured cooperation so to maximize the results of Italian investments in research.

Italian ENVRIPlus representatives continued engaging in a constructive two-way dialogue with relevant civil society organizations and all throughout the project, to share expertise and experience and consult on relevant issues and activities.

Relations with the private sector were searched for to facilitate innovation and transfer of knowledge to SMEs, considering the potential impact of the environmental research in terms of service development in different sectors: food security, tourism, water access, agriculture, public health, protection from risks related to climate change and resilience of territories. In these sectors science and technology intersect, and research results can be transferred to industry and converted into competitive applications, in addition to promoting new qualified ancillary industries, knowledge spillover and industrial spin-offs. Local SMEs were invited to access laboratories to receive training and conduct experiments and were involved in common projects submitted to the local regional authority for funding.

FINLAND

Relations with Ministries
In Finland, the decisions related to the RIs are made at the Finnish Research Infrastructure Committee (FIRI Committee). The FIRI committee functions under the Academy of Finland, but the representation is wide. The committee consist of representatives from ministries, universities and research institutes in Finland. FIRI decides on Finland's participation to international Research Infrastructures, monitors and develops Finnish and international research infrastructure activity, and provides funding to infrastructure projects and monitors funded projects. In addition to the FIRI Committee, all the ESFRI related RIs in Finland have national ministry representatives as stakeholders/delegates of respective RIs decision body. At the national level, ministry representatives do have at the minimum the preparatory meeting with the ESFRI RIs prior to their European level General Assembly meetings. In these meetings, cluster level activities and collaboration is often tackled. ENVRIplus via its Finnish partners has kept good and continuous relations with the ministries relevant to the Research Infrastructures. Particularly via the Finnish Research Infrastructure Committee. During the discussions with the ministries, ENVRIplus/ENVRI community has been actively promoted and the benefits of the cluster level collaboration have been demonstrated.
Relations with the ESFRI National Delegate
ESFRI national delegates are Petteri Kauppinen from the Ministry of Education, Science and Culture, and Riitta Maijala from the Academy of Finland. Both of the delegates are members of the FIRI committee and participate and monitor RI activities at national level. Knowledge exchange with the national ESFRI delegates is regular and fluent.
ENVRIplus beneficiaries are in regular contact with the ESFRI national delegates and are aware of the European level ENVRI discussions. ENVRI cluster activity has influenced also to the national landscape and domain level structuring of national RI landscape has been adopted.
Relations with regional and local authorities
Finland does not have regional level authorities. National RIs are as a default national level activities, not regional, neither local.
Relations with other stakeholders (RPOs, Universities, ARPAB, etc.)
All the national nodes/components of ESFRI RIs in Finland are operated by RPOs as they are the owners of the national observational and exploratory platforms that are contributing to the RIs. Therefore RPOs have an important role in the RI landscape. In Finland both universities and research institutes can have representation in the ESFRI consortia and the representation of the RPOs varies depending on the RI. RPOs contributions are the biggest share of the funding in the RIs financial framework.
ENVRIplus representatives have participated in national level to many RI related events and meetings at RPO level and most of the RPOs in the field of environment who host RI components, are aware of ENVRI community and ENVRIplus activities.
In addition, Finnish ENVRIplus partners led the Nordic level network activities of environmental RIs in the Nordic ENVRI project in 2014-2017. The project brought together 4 Nordic nodes of environmental RIs and partners from 10 different research institutions in Nordic countries, and this activity supported the Nordic collaboration according to the ENVRI philosophy.

Relations with regional stakeholders and key actors

Great part of ENVRIPlus' work carried out for the policy and strategy communication was dedicated to enhance the understanding of ENV RIs in European fora, platforms and organizations so as to ensure that a fair amount of attention was given to the project joint vision, goals and activities. The team worked to make sure that ENVRIPlus was actually perceived as providing real added value as a good instrument to convey strong messages from the ENV RIs.

Relations were cultivated especially with the ESFRI, being ENVRIPLUS a cluster of research infrastructures for Environmental and Earth System sciences built around the ESFRI Roadmap. Opportunities for a continuous exchange of information with ESFRI were actively chased in the course of all the project, during the ENVRI weeks organized twice a year by ENVRIPlus and dedicated to Environmental Research Infrastructures, as well as at further events and meetings, or through other more direct communication.

Interactions were particularly intense with the ESFRI Environment Strategy Group in charge of following developments and initiatives in the Environmental Sciences, to ensure that the position of the ENV RIs was properly taken into account in the formulation of the ESFRI strategic approaches in the environmental domain.

A joint workshop of the ESFRI Environment Strategy Working Group and the ENVRI community was organized in Malaga, in November 2017. It focused on the Landscape of Environmental Research Infrastructures and was intended to strengthen the dialogue between ESFRI and ENV RIs so as to contribute to the update of the ESFRI Landscape analysis. The workshop featured a combination of presentations and panel discussions addressing a number of important aspects, such as innovation, socio-economic impact, IPR and legal issues, Big Data and e-needs and position in EOSC, regional impact, and the pan-European and global dimensions.

Information and feedback from ENV RIs, directly collected by the Group during the workshop or reported to the Group in the other contacts held all throughout the project, were incorporated in the new Landscape Analysis in Part 2 of the ESFRI Roadmap 2018. The analysis presents the main results of the assessment of the user community conducted in 2018 in the framework of ENVRIPlus, and reports the ENVRIPlus as a best practice of networking among Research Infrastructures that fosters cross-disciplinarity:

"A federated approach should help to reduce overlaps, to maximize synergies and benefits, and to coordinate Research Infrastructures in order to optimize observing systems ranging from in situ and remote sensing data measurement and collection, to data analysis in the laboratory. Concrete actions towards this direction have started already within the ENVRIPLUS (Environmental Research Infrastructures Providing Shared Solutions for Science and Society) project, the cluster of ENV RIs, built around ESFRI roadmap and associated leading e-infrastructures and Integrating Activities, and RIs from other domains as Health & Food for fostering cross-disciplinarity. ENVRI has proven to be an excellent tool to coordinate Environmental RIs regarding everything from Management, Access policy, Data handling etc."[1]

Cross-disciplinarity and interconnections between RIs such as those promoted by the ENVRI cluster, and which the project was praised for, were object of an all-new study within the Landscape Analysis that was made to highlight the relevant links that already exist among different thematic areas, and to identify opportunities for new links and new research practices. The study pointed out the high potential for interdisciplinary and multi-disciplinary research, as synthetized in the following figure.

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[1] See ESFRI Public Roadmap 2018, Part 2, Landscape Analysis, p. 75

FIGURE 1 INTERCONNECTIONS BETWEEN ESFRI RIS AND SCIENTIFIC DOMAINS[2]
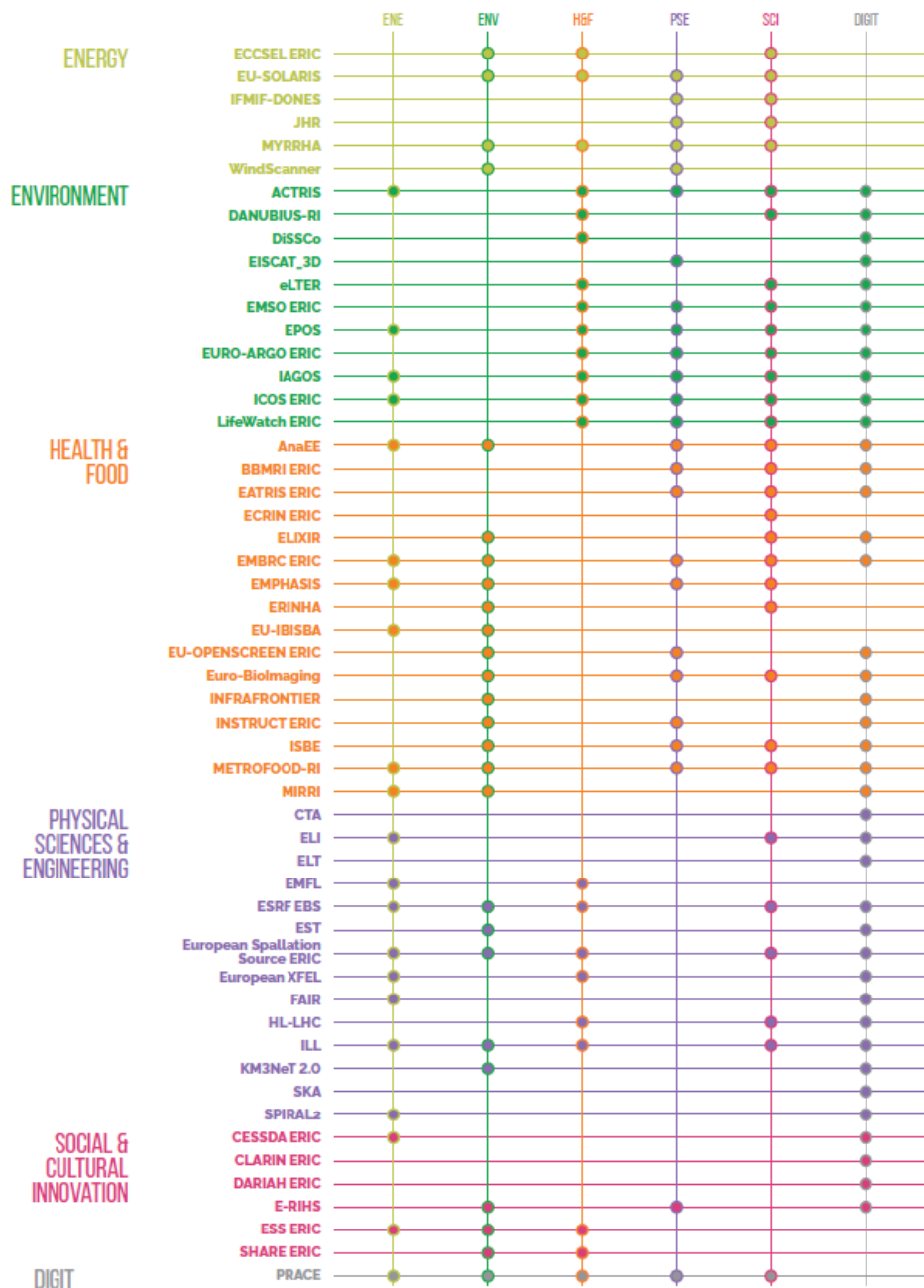
Beyond 2018 and for the longer term it'll be important to focus on these interconnections, which could guide the strategic development of the different RIs, and to avoid duplications, with all the RIs having a clear position in the landscape based on their specificities and exploring and exploiting synergies within and outside the ENV domain.

Besides cross-disciplinarity, ENVRIPlus had the opportunity to express the ENV RIs opinions also on the theme of RIs monitoring during the ESFRI workshop that was held in Milan, Italy, in November 2018 to prepare the work of the Forum to develop a common methodology for monitoring Research Infrastructures, periodic update of Landmarks and use of KPIs.

[2] ESFRI Public Roadmap 2018, Part 2, Landscape Analysis, Section 2.

Relations with European/international institutions and networks

ENVRIPlus placed special emphasis on fostering collaborations with foreign, international institutions, organizations and projects dealing with environmental science to tackle world global challenges. The community worked to embed the ENV RIs among the international actors in the global environmental research, gaining access to and visibility in various international fora and initiatives such as:

- the Group on Earth Observation (GEO), the intergovernmental organization working to improve the availability, access and use of Earth observations,
- the Global Earth Observation System of Systems (GEOSS) being built by the GEO to facilitate the sharing of environmental data and information collected from the large array of observing systems contributed by countries and organizations
- the World Meteorological Organization (WMO)
- the European Environment Agency (EEA)
- the European Space Agency (ESA)
- the European Monitoring and Evaluation Programme (EMEP)
- Copernicus, the European system for monitoring the Earth

ENVRIPlus took part in conferences and workshops, organized specific events and exchanged information to raise awareness on the role of the cluster of ENV RIs as key contributor to those international organizations and agencies. The contribution that ENV RIs can give to the work of such organizations, initiatives and programmes was highlighted as substantial to capitalize efforts in global environmental research ensuring complementarity.

ENVRIPlus booths and ENVRI community-related sessions were organized in the frame of the most important scientific conferences, such as the European Geoscience Union conference (EGU 2016, 2017 and 2018), the American Geophysical Unit conference (AGU 2015, 2017, 2018) and the GEO weeks (2017 and 2018).

ENVRIplus was presented in dedicated sessions organized at the **EGU 2016**:
- SM7.1 Integrated Research Infrastructures and Services in Geosciences – Environmental Research Infrastructures providing shared solutions for science and society (ENVRIplus)
- ESSI2.7 The Networks of Earth Observation, its coordination and their infrastructures to enhance international geoscience information access, provision and use – ENVRI Cluster – a community-driven platform of European environmental research infrastructures for providing common solution for science and society

Four specific sessions organized in frame of ENVRIplus were held also in the **EGU 2017**, dedicated to:
- CL5.13 – Towards CMIP6 internationally coordinated climate modeling experiments: the role and use of modeling and observation research infrastructures PICO session
- SMP51 – Experiences and practices of public–private partnerships in research infrastructures (public)
- SMI23 – Current European Research Infrastructure Initiatives (by invitation only)
- TM11 – Global environmental observations under pressure – new responsibilities for Europe?

During the **EGU 2018** five ENVRI community-related sessions and a Townhall meeting took place:
- ESSI2.8/GI1.6 Environmental physical and data infrastructures: practices, access and technologies – towards system level understanding (co-organized)
- ESSI2.4 – Virtual Research Environments: creating online collaborative environments to support research in the Earth Sciences and beyond (co-organized with the American Geophysical Union)
- ESSI2.9 – Integrating data and services in solid Earth sciences
- OS4.3 – Advances in water column and seafloor fixed point observatories
- AS3.12 – Radiative effects and global aerosol forcing estimates of natural and anthropogenic aerosols

- Town Hall Meeting "Opportunities to join international collaborative aquatic mesocosm experiments in H2020 AQUACOSM and more"

During the **AGU 2017** six specific sessions for the ENVRI community and a splinter meeting were organized:
- IN44B: International Collaboration on Environmental Data and Service Infrastructures, Practices, Access, and Technologies
- IN51G: Receiving Credit Where Credit Is Due: Overcoming Barriers to Effective Data Sharing for Collaborative, Transdisciplinary Research
- IN11F: Trustworthy Data Repositories to Increase the Visibility and Value of Your Research Data
- B31H: Integration of Ecosystem Research Infrastructures for Multiscale Analysis
- GC21I: Addressing Environmental Challenges Through Research Infrastructures and Cooperative Networks with an Emphasis on Marine and Coastal Regions
- NG21A-0134: New insights on the propagation of the Near Inertial Waves (NIW) governing the bottom dynamic of the Western Ionian Sea (Eastern Mediterranean Sea).
- Splinter meeting on Communication and Internationalization of Research Infrastructures

The ENVRI community took part in the **2017 GEO Week** with a joint booth and a side event addressing "The European Environmental Research Infrastructure Community a sustainable in-situ contribution to EuroGEOSS". The purpose of the event was to raise the awareness of the Earth Observation community on the considerable contributions from ENVRI to the challenges laid down in the most recent GEO work plans, GEO Flagships, Initiatives and Community Activities.

A side event was held also during the **2018 GEO Week** in Kyoto, Japan (October 29, 2018 - November 2, 2018), to present to the over 500 GEO people from intergovernmental, international and regional organizations working in Earth observation the continuous commitment of the ENVRI cluster towards Earth Observation efforts and the GEO community.

ENVRIPlus also benefited from the good and profitable synergies established with the Horizon 2020 COOP+ "Cooperation of Research Infrastructures to address global challenges in the environmental field" and GLOBIS-B "GLOBal Infrastructures for Supporting Biodiversity research" projects. The general goal of COOP+ is to strengthen the links and coordination of the European RIs related to Marine Science (EMSO), Arctic and Atmospheric Research (EISCAT), Carbon Observation (ICOS) and Biodiversity (LifeWatch) with international counterparts (NEON, TERN, AMISR/SRI, CGSM, OOI, INPA/LBA, IMOS, OCN, AMERIFLUX, etc.) and to leverage international scientific cooperation and data exchange with non-EU countries. EMSO, EISCAT, ICOS and LifeWatch are partners of or associated to ENVRIPlus.

Relations with GLOBIS-B empowered ENVRIPlus to enlarge cooperation with EU and global biodiversity research infrastructures.

List of main Events/Meetings

EVENT NAME	DATE AND VENUE	ATTENDANCE
GEO-XII Plenary and the 2015 Ministerial Summit	November 9-13, 2015 Mexico City, Mexico	Intergovernmental, international and regional organizations working in Earth observation and related activities.
AGU Fall Meeting 2015	December 14-18, 2015 San Francisco USA	Geoscientists and leaders from academia, government, and the private sector all over the world to examine and discuss the latest research and scientific

		developments in Earth and space science.
European Geosciences Union conference – EGU 2016	April 17–22, 2016 Vienna, Austria	Geoscientists from all over the world covering all disciplines of the Earth, planetary and space sciences.
ICRI 2016 - International Conference on Research Infrastructures	October 3-5, 2016 Cape Town, South Africa	RIs and high-level stakeholders from across the globe, as well as highly profiled key political Institutions, including the UN, European Commission, African Union, OECD
European Geosciences Union conference – EGU 2017	April 23-28, 2017 Vienna, Austria	Geoscientists from all over the world covering all disciplines of the Earth, planetary and space sciences.
GEO Week 2017	October 23-27, 2017 Washington, USA	Intergovernmental, international and regional organizations working in Earth observation or related activities.
American Geophysical Union - AGU Fall Meeting 2017	December 11-15, 2017 New Orleans, Louisiana,	Geoscientists and leaders from academia, government, and the private sector all over the world to examine and discuss the latest research and scientific developments in Earth and space science.
European Geosciences Union – EGU conference 2018	April 8-13, 2018 Vienna, Austria	Geoscientists from all over the world covering all disciplines of the Earth, planetary and space sciences.
IWSG 2018, 10th International Workshop on Science Gateways	June 13-15, 2018 Edinburgh, Scotland, UK	Researchers and scientists from different research domains, along with developers, to discuss problems and solutions in the area of Science gateways, Virtual Research Environments (VREs) and e-Laboratories / Virtual Labs (VLs)
ICRI2018	September 12-14, 2018 Vienna, Austria	RIs and high-level stakeholders from across the globe, as well as highly profiled key political Institutions, including the UN, European Commission, African Union, OECD
GEO Week 2018	October 29, 2018 - November 2, 2018 Kyoto, Japan	Over 500 people from intergovernmental, international and regional organizations working in Earth observation or related activities.

COOP+ Conference on the Research Infrastructures and the Paris Agreement on climate	November 20-21, 2018 Brussels, Belgium	Research infrastructures in Europe and other countries, research and policy communities
American Geophysical Union - AGU Fall Meeting 2018	December 10-14, 2018 Washington, USA	Geoscientists and leaders from academia, government, and the private sector all over the world to examine and discuss the latest research and scientific developments in Earth and space science.

CONCLUSIONS

ENVRIPlus resolved to adopt a structured but flexible approach to identifying and engaging all those having a stake, whether as individuals, groups or organizations, in the environmental research addressing the world's biggest challenges. Gaining a good understanding of the different stakeholder communities was at the base of all effort in the policy communications, and consented to develop robust relationships between the whole project (team and partner RIs) and its different stakeholders.

The project successfully performed different activities to involve stakeholders to secure their involvement and commitment. Contacts and synergies were initiated with RIs operating in different, but complementary domains. National stakeholders became more and more aware of, and interested in, the potential, the issues and needs of the environmental research in their countries, eventually increasing their (also financial) support to facilities and RPOs. The role, contribution and positions of the ENV RIs, as well as the role played by the ENVRI cluster itself, are well acknowledged at the European level, as testified by the frequent references in the ESFRI Landscape analysis and the approval of the ENVRI Fair (Environmental Research Infrastructures building Fair Services Accessible for Society, Innovation and Research) project, which represents an evolution of the ENVRIPlus.

Key messages about the ENV RIs community's contribution to global environmental research tackling climate change, health, food and environment security were disseminated in the international arena and resulted in growing opportunities for developing international partnerships and exploitation of strategic complementarity.

It will be up to the ENVRI cluster to seize all the opportunities opened up by the project, successfully develop long-lasting collaborations and create new ones

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APPENDICES

TERMINOLOGY

Acronyms and Abbreviations

CCSDS	Consultative Committee for Space Data Systems
CMIS	Content Management Interoperability Services
CERIF	Common European Research Information Format
DDS	Data Distribution Service for Real-Time Systems
ENVRI	Environmental Research Infrastructure
ENVRI_RM	ENVRI Reference Model
ESFRI	European Strategy Forum on Research Infrastructures
ESFRI-ENV RI	ESFRI Environmental Research Infrastructure
GIS	Geographic Information System
IEC	International Electrotechnical Commission
ISO	International Organisation for Standardization
OAIS	Open Archival Information System
OASIS	Organization for the Advancement of Structured Information Standards
ODP	Open Distributed Processing

OGC   Open Geospatial Consortium

OMG   Object Management Group

ORCHESTRA   Open Architecture and Spatial Data Infrastructure for Risk Management

ORM   OGC Reference Model

OSI   Open Systems Interconnection

OWL   Web Ontology language

SOA   Service Oriented Architecture

SOA-RM   Reference Model for Service Oriented Architecture

RDF   Resource Description Framework

RM-OA   Reference Model for the ORCHESTRA Architecture

RM-ODP   Reference Model of Open Distributed Processing

UML   Unified Modelling Language

W3C   World Wide Web Consortium

UML4ODP   Unified Modelling Language For Open Distributed Processing

Terminology

Access Control: A functionality that approves or disapproves of access requests based on specified access policies.

Acquisition Service: Oversight service for integrated data acquisition.

Active role: A active role is typically associated with a human actor.

Add Metadata: Add additional information according to a predefined schema (metadata schema). This partially overlaps with data annotations.

Annotate Data: Annotate data with meaning (concepts of predefined local or global conceptual models).

Annotate Metadata: Link metadata with meaning (concepts of predefined local or global conceptual models). This can be done by adding a pointer to concepts within a conceptual model to the data. If e.g. concepts are terms in and SKOS/RDF thesaurus, published as linked data then this would mean entering the URL of the term describing the meaning of the data.

Annotation: (verb) The action of annotating or making notes. (noun) A note added to anything written, by way of explanation or comment.

Annotation Service: Oversight service for adding and updating records attached to curated datasets.

Assign Unique Identifier: Obtain a unique identifier and associate it to the data.

Authentication: A functionality that verifies a credential of a user.

Authentication Service: Security service responsible for the authentication of external agents making requests of infrastructure services.

Authorisation: A functionality that specifies access rights to resources.

Authorisation Service: Security service responsible for the authorisation of all requests made of infrastructure services by external agents.

Backup: A copy of (persistent) data so it may be used to restore the original after a data loss event.

Behaviour : A behaviour of a community is a composition of actions performed by roles normally addressing separate business requirements.

Build Conceptual Models: Establish a local or global model of interrelated concepts.

Capacity Manager: An active role, which is a person who manage and ensure that the IT capacity meets current and future business requirements in a cost-effective manner.

Carry out Backup: Replicate data to an additional data storage so it may be used to restore the original after a data loss event. A special type of backup is a long term preservation.

Catalogue service: Oversight service for cataloguing curated datasets.

Check Quality: Actions to verify the quality of data.

Citation: from the ENVRI RM perspective, citation is defined as a pointer from a publication to:

- data source(s)

- and/or the owner(s) of the data source(s)

- a description of the evaluation process, if available

- a timestamp marking the access time to the data sources, thus reflecting a certain version

Citizen (synonyms: General Public, Media): An active role, a person, who is interested in understanding the knowledge delivered by an environmental science research infrastructure, or discovering and exploring the Knowledge Base Glossary enabled by the research infrastructure.

Citizen Scientist: An active role, member of the general public who engages in scientific work, often in collaboration with or under the direction of professional scientists and scientific institutions (also known as amateur scientist).

Community: A collaboration which consists of a set of roles agreeing their objective to achieve a stated business purpose.

Concept: Name and definition of the meaning of a thing (abstract or real thing). Human readable definition by sentences, machine readable definition by relations to other concepts (machine readable sentences). It can also be meant for the smallest entity of a conceptual model. It can be part of a flat list of concepts, a hierarchical list of concepts, a hierarchical thesaurus or an ontology.

Conceptual Model: A collection of concepts, their attributes and their relations. It can be unstructured or structured (e.g. glossary, thesaurus, ontology). Usually the description of a concept and/or a relation defines the concept in a human readable form. Concepts within ontologies and their relations can be seen as machine readable sentences. Those sentences can be used to establish a self-description. It is, however, practice today, to have both, the human readable description and the machine readable description. In this sense a conceptual model can also be seen as a collection of human and machine readable sentences. Conceptual models can reside within the persistence layer of a data provider or a community or outside. Conceptual models can be fused with the data (e.g. within a network of triple stores) or kept separately.

Coordination Service: An oversight service for data processing tasks deployed on infrastructure execution resources.

Data Acquisition Community. A community, which collects raw data and bring (streams of) measures into a system.

Data Acquisition Subsystem: A subsystem that collects raw data and brings the measures or data streams into a computational system.

Data Analysis: A functionality that inspects, cleans, transforms data, and provides data models with the goal of highlighting useful information, suggesting conclusions, and supporting decision making.

Data Assimilation: A functionality that combines observational data with output from a numerical model to produce an optimal estimate of the evolving state of the system.

Data Broker: Broker for facilitating data access/upload requests.

Data Cataloguing: A functionality that associates a data object with one or more metadata objects which contain data descriptions.

Data Citation: A functionality that assigns an accurate, consistent and standardised reference to a data object, which can be cited in scientific publications.

Data Collection: A behaviour performed by a *Data Collector* that control and monitor the collection of the digital values from a *sensor* instrument or a human sensor, such as a *Measurer* or a *Observer*, associating consistent time-stamps and necessary metadata.

Data Collector: Active or passive role, adopted by a person or an instrument collecting data.

Data Consumer: Either an active or passive role, which is an entity who receives and use the data.

Data Curation Community: A community, which curates the scientific data, maintains and archives them, and produces various data products with metadata.

Data Curation Subsystem: A subsystem that facilitates quality control and preservation of scientific data.

Data Curator: An active role, which is a person who verifies the quality of the data, preserve and maintain the data as a resource, and prepares various required data products.

Data Discovery & Access: A functionality that retrieves requested data from a data resource by using suitable search technology.

Data Exporter: Binding object for exporting curated datasets.

Data Extraction: A functionality that retrieves data out of (unstructured) data sources, including web pages, emails, documents, PDFs, scanned text, mainframe reports, and spool files.

Data Identification: A functionality that assigns (global) unique identifiers to data contents.

Data Importer: An Oversight service for the import of new data into the data curation subsystem.

Data infrastructure: a collection of data assets, organisations that operate and maintain them and guides describing how to use and manage the data. A data infrastructure is sustainably funded and has oversight that provides direction to maximise data use and value by meeting the needs of society. Data infrastructure includes technology, processes and organisation.

Data management: a process development and execution of architectures, policies, practices and procedures in order to manage the data lifecycle needs of a specific research community.

Data management plan (DMP): a formal document that outlines how data are to be handled both during a research project and after the project is completed.

Data Mining: A functionality that supports the discovery of patterns in large data sets.

Data Originator: Either an active or a passive role, which provide the digital material to be made available for public access.

Data Processing Control: A functionality that initiates the calculation and manages the outputs to be returned to the client.

Data Processing Subsystem: A subsystem that aggregates the data from various resources and provides computational capabilities and capacities for conducting data analysis and scientific experiments.

Data Product Generation: A functionality that processes data against requirement specifications and standardised formats and descriptions.

Data Provenance: Information that traces the origins of data and records all state changes of data during their lifecycle and their movements between storages.

Data Provider: Either an active or a passive role, which is an entity providing the data to be used.

Data Publication: A functionality that provides clean, well-annotated, anonymity-preserving datasets in a suitable format, and by following specified data-publication and sharing policies to make the datasets publically accessible or to those who agree to certain conditions of use, and to individuals who meet certain professional criteria.

Data Publication Community: A community that assists the data publication, discovery and access.

(Data Publication) Repository: A passive role, which is a facility for the deposition of published data.

Data Publishing Subsystem: A subsystem that enables discovery and retrieval of data housed in data resources.

Data Quality Checking: A functionality that detects and corrects (or removes) corrupt, inconsistent or inaccurate records from data sets.

Data Service Provision Community: A community that provides various services, applications and software/tools to link, and recombine data and information in order to derive knowledge.

Data State: Term used as defined in ISO/IEC 10746-2. At a given instant in time, data state is the condition of an object that determines the set of all sequences of actions (or traces) in which the object can participate.

Data Storage & Preservation: A functionality that deposits (over long-term) the data and metadata or other supplementary data and methods according to specified policies, and makes them accessible on request.

Data Store Controller: A data store within the data curation subsystem.

Data Transfer Service: Oversight service for the transfer of data into and out of the data curation subsystem.

Data Transmission: A functionality that transfers data over communication channel using specified network protocols.

Data Transporter: Generic binding object for data transfer interactions.

Data Use Community: A community who makes use of the data and service products, and transfers the knowledge into understanding.

Data Use Subsystem: A subsystem that provides functionalities to manage, control, and track users' activities and supports users to conduct their roles in the community.

Describe Service: Describe the accessibility of a service or process, which is available for reuse, the interfaces, the description of behaviour and/or implemented algorithms.

Design of Measurement Model: A behaviour that designs the measurement or monitoring model based on scientific requirements.

Do Data Mining: Execute a sequence of metadata / data request --> interpret result --> do a new request

e-Infrastructure: a combination and interworking of digitally-based technology (hardware and software), resources (data, services, digital libraries), communications (protocols, access rights and networks), and the people and organisational structures needed to support modern, internationally leading collaborative research be it in the arts and humanities or the sciences.

Educator (synonym: Trainer): An active role, which is a person who makes use of the data and application services for education and training purposes.

Engineer (synonym: Technologist): An active role, which is a person who develops and maintains the research infrastructure.

Environmental Scientist: An active role, which is a person who conduct research or perform investigation for the purpose of identifying, abating, or eliminating sources of pollutants or hazards that affect either the environment or the health of the population. Using knowledge of various scientific disciplines, may collect, synthesize, study, report, and recommend action based on data derived from measurements or observations of air, food, soil, water, and other sources.

ENVRI Reference Model: A common ontological framework and standards for the description and characterisation of computational and storage systems of ESFRI environmental research infrastructures.

Experiment Laboratory: Community proxy for conducting experiments within a research infrastructure.

Field Laboratory: Community proxy for interacting with data acquisition instruments.

Final review: Review the data to be published, which will not likely be changed again.

Free text annotation: to add a short explanation or opinion to a text or drawing (equivalent to the dictionary definition of annotation).

Instrument Controller: An integrated raw data source.

Knowledge Base: (1) A store of information or data that is available to draw on. (2) The underlying set of facts, assumptions, and rules which a computer system has available to solve a problem.

Knowledge infrastructure: robust networks of people, artifacts, and institutions that generate, share, and maintain specific knowledge about the human and natural worlds.

Mapping Rule: Configuration directives used for model-to-model transformation.

(Measurement Model) Designer: An active role, which is a person who design the measurements and monitoring models based on the requirements of environmental scientists.

Measurement result: Quantitative determinations of magnitude, dimension and uncertainty to the outputs of observation instruments, sensors (including human observers) and sensor networks.

Measurer: An active role, which is a person who determines the ratio of a physical quantity, such as a length, time, temperature etc., to a unit of measurement, such as the meter, second or degree Celsius.

Metadata: Data about data, in scientific applications is used to describe, explain, locate, or make it easier to retrieve, use, or manage an information resource.

Metadata Catalogue: A collection of metadata, usually established to make the metadata available to a community. A metadata catalogue has an access service.

Metadata Harvesting (Publishing Community Role): A behaviour performed by a metadata harvester to gather metadata from data objects in order to construct catalogues of the available information. A functionality that (regularly) collects metadata (in agreed formats) from different sources.

Metadata Harvester (Publishing Community Role): A passive role performed by a system or service collecting metadata to support the construction/selection of a global conceptual model and the production of mapping rules.

Metadata State:

- raw: are established metadata, which are not yet registered. In general, they are not shareable in this status

- registered: are metadata which are inserted into a metadata catalogue.

- published: are metadata made available to the public, the outside world. Within some metadata catalogues registered.

Passive Role: A passive role is typically associated with a non-human actor.

Perform Mapping: Execute transformation rules for values (mapping from one unit to another unit) or translation rules for concepts (translating the meaning from one conceptual model to another conceptual model, e.g. translating code lists).

Persistent Data: Term (data) used as defined in ISO/IEC 10746-2. Data is the representations of information dealt by information systems and users thereof. Data which are persistent (stored).

Perform Measurement or Observation: Measure parameter(s) or observe an event. The performance of a measurement or observation produces measurement results.

PID Generator: A passive role, a system which assigns persist global unique identifiers to a (set of) digital object.

PID Registry: A passive role, which is an information system for registering PIDs.

PID Service: External service for persistent identifier assignment and resolution.

Policy Maker (synonym: Decision Maker): An active role, a person, who makes decisions based on the data evidences.

Process Control: A functionality that receives input status, applies a set of logic statements or control algorithms, and generates a set of analogue / digital outputs to change the logic states of devices.

Process Controller: Part of the execution platform provided by the data processing subsystem.

Process Data: Process data for the purposes of:

- converting and generating data products

- calculations: e.g., statistical processes, simulation models

- visualisation: e.g., alpha-numerically, graphically, geographically

Data processes should be recorded as provenance.

Provenance: The pathway of data generation from raw data to the actual state of data.

Publish Data: Make data public accessible.

Publish Metadata: Make the registered metadata available to the public.

QA Notation: Notation of the result of a Quality Assessment. This notation can be a nominal value out of a classification system up to a comprehensive (machine readable) description of the whole QA process.

Quality Assessment (QA): Assessment of details of the data generation, including the check of the plausibility of the data. Usually the quality assessment is done by predefined checks on data and their generation process.

Query Data: Send a request to a data store to retrieve required data.

Query Metadata: Send a request to metadata resources to retrieve metadata of interests.

Observer: An active role, which is a person who receives knowledge of the outside world through the senses, or records data using scientific instruments.

Raw Data Collector: Binding object for raw data collection.

Reference Mode: A reference mode is an abstract framework for understanding significant relationships among the entities of some environment.

Register Metadata: Enter the metadata into a metadata catalogue.

Research Infrastructure: means facilities, resources and related services that are used by the scientific community to conduct top-level research in their respective fields and covers major scientific equipment or sets of instruments; knowledge-based resources such as collections,

archives or structures for scientific information; enabling Information and Communications Technology-based infrastructures such as Grid, computing, software and communication, or any other entity of a unique nature essential to achieve excellence in research. Such infrastructures may be "single-sited" or "distributed" (an organised network of resources) [**41**].

Resource Registration: A functionality that creates an entry in a resource registry and inserts resource object or a reference to a resource object in specified representations and semantics.

Role : A role in a community is a prescribing behaviour that can be performed any number of times concurrently or successively.

Science Gateway: Community portal for interacting with an infrastructure.

Scientific Modelling and Simulation: A functionality that supports the generation of abstract, conceptual, graphical or mathematical models, and to run an instance of the model.

Scientist (synonym: Researcher): An active role, which is a person who makes use of the data and application services to conduct scientific research.

(Scientific) Workflow Enactment: A specialisation of Workflow Enactment, which support of composition and execution a series of computational or data manipulation steps, or a workflow, in a scientific application. Important processes should be recorded for provenance purposes.

Security Service: Oversight service for authentication and authorisation of user requests to the infrastructure.

Semantic Annotation: link from an information object (single datum, data set, data container) to a concept within a conceptual model, enabling the discovery of the meaning of the information object by human and machines.

Semantic Broker: Broker for establishing semantic links between concepts and bridging queries between semantic domains.

SV Community Behaviour: A behaviour enabled by a *Semantic Mediator* that unifies similar data (knowledge) models based on the consensus of collaborative domain experts to achieve better data (knowledge) reuse and semantic interoperability.

Semantic Laboratory: Community proxy for interacting with semantic models.

Semantic Mediator: A passive role, which is a system or middleware facilitating semantic mapping discovery and integration of heterogeneous data.

Sensor: A passive role, which is a converter that measures a physical quantity and converts it into a signal which can be read by an observer or by an (electronic) instrument.

Sensor Network: A passive role, which is a network consists of distributed autonomous sensors to monitor physical or environmental conditions.

Service: Service or process, available for reuse.

Service Consumer: Either an active or a passive role, which is an entity using the services provided.

Service Description: Services and processes, which are available for reuse, be it within an enterprise architecture, within a research infrastructure or within an open network like the Internet, shall be described to help avoid wrong usage. Usually such descriptions include the accessibility of the service, the description of the interfaces, the description of behavior and/or implemented algorithms. Such descriptions are usually done along service description standards (e.g. WSDL, web service description language). Within some service description languages, semantic descriptions of the services and/or interfaces are possible (e.g. SAWSDL, Semantic Annotations for WSDL)

Service Provider: Either an active or a passive role, which is an entity providing the services to be used.

Service Registry: A passive role, which is an information system for registering services.

Setup Mapping Rules: Specify the mapping rules of data and/or concepts.

Specification of Investigation Design: This is the background information needed to understand the overall goal of the measurement or observation. It could be the sampling design of observation stations, the network design, the description of the setup parameters (interval of measurements) and so on... It usually contains important information for the allowed evaluations of data. (E.g. the question whether a sampling design was done randomly or by strategy determines which statistical methods that can be applied or not).

Specification of Measurements or Observations: The description of the scientific measurement model which specifies:

- what is measured;

- how it is measured;

- by whom it is measured; and

- what the temporal design is (single /multiple measurements / interval of measurement etc.)

Specify Investigation Design: specify design of investigation, including sampling design:

- geographical position of measurement or observation (site) -- the selections of observations and measurement sites, e.g., can be statistical or stratified by domain knowledge;

- characteristics of site;

- ·   preconditions of measurements.

Specify Measurement or Observation: Specify the details of the method of observations/measurements.

Stakeholder (synonyms: Private Investor, Private Consultant): An active role, a person, who makes use of the data and application service for predicting market so as to make business decision on producing related commercial products.

Storage: A passive role, which is memory, components, devices and media that retain digital computer data used for computing for some interval of time.

Storage Administrator: An active role, which is a person who has the responsibilities to the design of data storage, tune queries, perform backup and recovery operations, raid mirrored arrays, making sure drive space is available for the network.

Store Data: Archive or preserve data in persistent manner to ensure continuing accessible and usable.

Subsystem: a set of capabilities that collectively are defined by a set of interfaces with corresponding operations that can be invoked by other subsystems. Subsystems can be executed independently, and developed and managed incrementally.

Technician: An active role, which is a person who develop and deploy the sensor instruments, establishing and testing the sensor network, operating, maintaining, monitoring and repairing the observatory hardware.

Track Provenance: Add information about the actions and the data state changes as data provenances.

Unique Identifier (UID): With reference to a given (possibly implicit) set of objects, a unique identifier (UID) is any identifier which is guaranteed to be unique among all identifiers used for those objects and for a specific purpose.

User Behaviour Tracking: A behaviour enabled by a Data Use Subsystem that to track the Users. User Behaviour Tracking is the analysis of visitor behaviour on a website. The analysis of an individual visitor's behaviour may be used to provide options or content that relates to their implied preferences; either during a visit or in the future visits. Additionally, it can be user to track content use and performance.

User Group Work Supporting: A behaviour enabled by a Data Use Subsystem that to support controlled sharing, collaborative work and publication of results, with persistent and externally citable PIDs.

User Profile Management: A behaviour enabled by a Data Use Subsystem that to support persistent and mobile profiles, where profiles will include preferred interaction settings, preferred computational resource settings, and so on.

User Working Space Management: A behaviour enabled by a Data Use Subsystem that to support work spaces that allow data, document and code continuity between connection sessions and accessible from multiple sites or mobile smart devices.

User Working Relationships Management: A behaviour enabled by a Data Use Subsystem that to support a record of working relationships, (virtual) group memberships and friends.

Virtual Laboratory: Community proxy for interacting with infrastructure subsystems.

Virtual Research Environment (VRE, synonyms:Science Gateway, Collaboratory, Digital Library, Inhabited Information Space, Virtual Laboratory): a web-based working environment tailored to serve the needs of a research community. A VRE is expected to provide an array of commodities needed to accomplish the research community's goal(s); it is open and flexible with respect to the overall service offering and lifetime; and it promotes fine-grained controlled sharing of both intermediate and final research results by guaranteeing ownership, provenance and attribution