

Communication strategy and plans for research infrastructures: the EPOS case

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Abstract

Strategic research communication has found an increasing recognition in recent years. Research infrastructures (RIs) are called upon to effectively communicate the scientific research they foster in order to ensure that they attract users and their findings may influence both policy-makers and society at large. Not to mention that many funding bodies are making communication a requirement when it comes to allocating research funds. The current paper reflects on the experience of developing a communication strategy for the European research infrastructure EPOS (European Plate Observing System) and highlights some challenges and best practices to set up and maintain the critical links between people, ideas and information that are vital for the success of every communication plan.

The complex nature of the EPOS RI revealed a series of challenges and opportunities that need to be fully embraced if EPOS research findings are to have maximum possible impact and demonstrate their worth for all stakeholders involved. We started with an in-depth analysis of the EPOS mission, vision and value proposition, then moved on to identifying weaknesses and strengths to build on and eventually envisage pathways for improving internal and external communication and further engaging the different EPOS communities and stakeholders.

Keywords: Communication strategy; Research infrastructures; EPOS Case

1. Introduction

The European Plate Observing System (EPOS) is a pan-European Research Infrastructure governed by a Consortium (EPOS-ERIC, EU Regulation No 1291, 2013) committed to enabling excellent science through the integration, access, use and re-use of solid Earth science data, research products and services, as well as by promoting physical access to research facilities. Its governance model relies on a federated approach to engage scientific communities, committed to ensure the data and service provision through nine Thematic Core Services (TCS) and

one Candidate TCS into its novel e-infrastructure, the Integrated Core Service Central Hub (ICS-C) governed by the ERIC [Cocco et al., 2022, in this same volume). The scientific communities involved in EPOS decided since the conception phase of the Research Infrastructure (hereinafter RI) to design and implement a single RI for the whole solid Earth science sector in full awareness of the challenges to tackle and the opportunities to effectively enable cross-disciplinary research in Earth sciences.

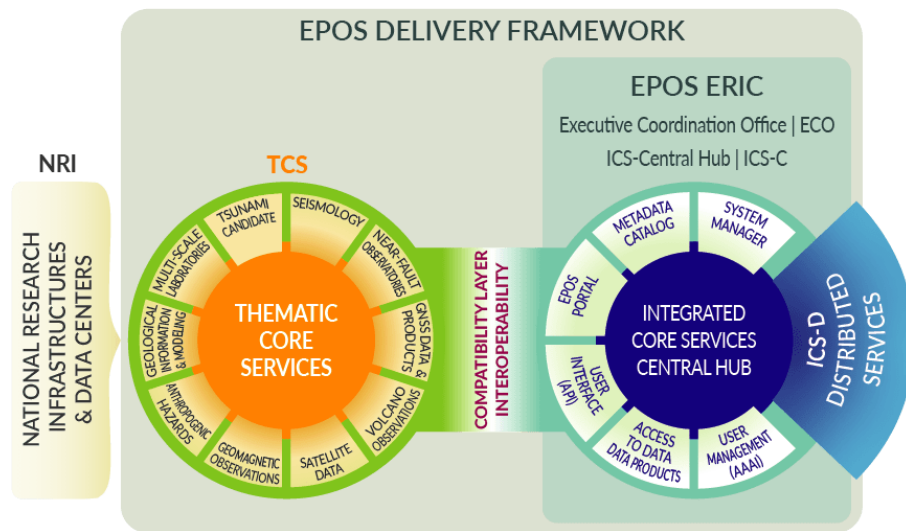


Figure 1. The EPOS architecture relies on key elements designed to ensure the EPOS data and service provision: namely, National Research Infrastructures (NRIs), Thematic Core Services (TCS) and Integrated Core Services (ICS) composed of the central hub (ICS-C) and distributed core services (ICS-D). The EPOS RI is coordinated by EPOS ERIC and designed to ensure a sustainable data and service provision.

Taking into account the complex EPOS' architecture (Figure 1), internal and external communication with all stakeholders is necessary and strategic. Professional communication is all the most necessary given that EPOS' vision and mission both embed a great impact on science, economy and society at large. Solid Earth science offers answers on how to maintain Earth a safe, prosperous, and habitable planet, hence potentially addressing many of the 17 United Nations Sustainable Development Goals (UN-SDGs). Through the integration of data, models, and facilities, EPOS will allow the Earth science community to make a step change in developing new concepts and tools for key answers to scientific and socio-economic questions concerning geo-hazards and geo-resources as well as Earth sciences' applications to the environment and to human welfare.

EPOS is a distributed research infrastructure involving 25 countries from the European and Mediterranean region, 14 of which have formally joined EPOS ERIC and 21 are involved in the data and service provision [Cocco et al., 2022]. Nearly 140 research organizations are engaged in EPOS, 65 of which are formally involved in the thematic communities responsible for the data, metadata and service provision [Atakan et al., 2022]. These numbers give an idea of the pan-European dimension of the distributed EPOS RI, as well as of the community building behind this science-oriented initiative. This also emphasizes the importance of an effective structured communication relying on shared planning and the adoption of effective tools and appropriate languages.

EPOS is becoming one of the major players in Europe in providing data and services for Earth sciences, and good communication can have enormous potential for empowering researchers, students and citizens in the much invoked and more than ever necessary dialogue between science, technology and society. EPOS is proposing a federated approach to the integration of scientific data fostering FAIR (Findable, Accessible, Interoperable and Reusable) data management in solid Earth science [Cocco et al., 2022; Bailo et al., 2022]. The long-term sustainable operation of the EPOS distributed RI requires an effective plan to engage human resources and skills to be included through time in the governance and organizational structures [Saleh-Contell et al., 2022]. This emphasizes the need of structuring both the internal communication to have the right people at the right time and place as well as the external communication to engage scientists and disseminate the content of the EPOS delivery framework.

EPOS is based on an Open Science approach, seeking collaboration, transparency and fairness; its main goal is to facilitate the integrated use of data, data products, and facilities from the solid Earth science community in Europe. This approach must be reflected in the communication strategy as well. That is why between September 2019 and March 2020 a communication plan has been devised, which is now being implemented. The EPOS communication plan indicates the path to make research results fully accessible to Earth scientists, national research infrastructures, ICT (Information & Communication Technology) experts, decision-makers, and the public to develop new concepts and tools for accurate, durable, and sustainable answers to societal questions concerning geo-hazards and those geodynamic phenomena (including geo-resources) relevant to the environment and human welfare.

This paper describes the case study of the development and adoption of the EPOS communication plan based on a true alliance between science communicators, researchers and technicians with the hope it will inspire other scientists, communication professionals, scholars and practitioners to take the same path.

2. Principles and methods

An effective and useful communication plan provides the guidelines to envisage, structure and manage external and internal communication activities for the various identified audiences. It includes strategic objectives, messages, target audiences, types of media, assigned roles, and resources. It must adapt to the rhythm marked by the changes in the organization and the needs of the communities and stakeholders. The communication officers must be able to interpret and adopt the plan, to anticipate the needs and take on the challenges that will gradually come up, to develop new tools and messages, while remaining faithful to the original structure, objectives, audiences and stakeholders identified as strategic.

With these clearly defined principles in mind, a co-design and participatory approach was adopted to write and implement the EPOS communication plan. In developing the communication plan, representatives of the entire community of EPOS together with experts in science communication were involved according to their interest, expertise and role. The spirit that drove the working team was to make sure that the EPOS communication strategy benefitted from both the best international practices and the real needs of the research community.

The work was divided into work packages. Periodic, collective meetings allowed to update everyone on the work done, check progress and deal with any critical issues. All the documentation, reports, discussions were progressively made available to the entire team.

Given that EPOS addresses a very diverse community – with various objectives, methods, perspectives, languages – the communication had to be aimed at a multi-stakeholder audience [Kalmár and Stenfert, 2020]. This is in line with the recent trends in science communication, where communication itself is intended as a collaborative effort embedded in a complex environment, and as such may cause a power shift in society, achieve mutual learning and make sense of today's challenges.

EPOS does not intend communication as a mere unidirectional transfer of information to various audiences. Rather, communication must become an important tool for strengthening the consortium through awareness and trust, for building its management capacity and increasing the sense of belonging and dedication of the community to the shared EPOS' vision and mission. Achieving these goals requires a well-structured internal communication, as it will be discussed later on in this article. Furthermore, external communication should also enhance users' engagement and the exploitation strategy of the research infrastructure, producing a significant structural change and increasing awareness of the role of public research and its protagonists. Figure 2 illustrates the different communication frameworks identified to implement and adopt the EPOS ERIC strategic communication plan.

Aware of this frame, the team who worked on the communication plan was composed of representatives of all these various components. Communicators of science with different specializations (theory and practice of science communication, journalism, social media, training, web development, leadership and management in scientific environments, etc.), researchers and technicians dealing with solid Earth science data, research products and services, IT experts in charge of the development of the e-infrastructure and the Integrated Core Service Central Hub, and representatives of the EPOS managerial bodies.

The EPOS Communication Plan, currently under implementation through the new Communication Office at the EPOS ERIC headquarters in Rome, is an emblematic example of the *Quadruple Helix model* [Carayannis and Campbell, 2009], in which media and culture based public relations are also added to the traditional triplet made of academia/universities, industry/business, state/governments.

The principles on which the plan is based fit perfectly into what Jensen and Gerber [2020] call “evidence-based science communication” as it puts the experience of science communicators – who work at the border where practitioners and scholars meet – together with the expertise of the professionals in charge of the infrastructure. Evidence-based science communication is still a relatively unexplored land and further reflection and discussion are certainly needed. We, therefore, invite the more experienced scholars to exercise constructive criticism, finding areas for improvement. This would be consistent with the spirit of Open Science and mutual learning in which the initiative was born and developed, and will benefit the entire community of science communicators and researchers.

3. Background

Before getting to the heart of the communication strategies, it was useful to reflect on and discuss the EPOS’ vision, mission and values in order to strengthen these key messages, making them coherent with the communication framework.

In line with the core objectives of the communication plan and with the best practices in the field [Albrecht, 2006; Kotter, 1996], an accessible and to the point version of the EPOS vision has been implemented in order to strengthen EPOS’ key messages, rendering them unambiguous and appealing to the internal communities, the public and other external target audiences.

3.1 EPOS vision

“To ensure sustainable and universal use and re-use of multidisciplinary solid Earth science data and products fostering state-of-the-art research and innovation.”

The mission statement was shared with the EPOS’ community since the design and preparatory phase of the research infrastructure. The different areas of expertise of the team engaged and committed to implement the EPOS’ communication plan allowed the rephrasing of the mission statement, which had to be concise, outcome-oriented and inclusive to be shared by the entire EPOS’ community. It has been therefore collectively decided to adopt the following mission statement:

3.2 EPOS mission

“To establish and underpin a sustainable and long-term access to solid Earth science data and services, integrating diverse European Research Infrastructures under a common federated framework.”

Together, mission and vision guide strategy development, help communicate the organization’s purpose, and inform the goals and objectives set to determine whether the strategy is on track. Strategy begins with goals, which naturally follow from an entity’s mission and vision. But for very practical reasons, goals cannot stand in isolation. They are backed up by a feeling about the external environment and the organization’s inner capabilities. The strategic choices available to each organization derive from the process of looking outside for Opportunities and Threats and inside for Strengths and Weaknesses. A SWOT analysis was, therefore, carried out to complete the picture framed with the EPOS’ vision and mission definition.

What makes SWOT especially compelling is that it can help EPOS take precautions in case threats emerge, advance quickly and capitalize on opportunities, further sustain and develop internal strengths and work on improving its weaknesses. A thorough analysis has identified clear vision and effective planning, innovative approach to data science, sharing multidisciplinary data research results, federated governance, ESFRI landmark and ERIC establishment as EPOS’ main internal strengths. As for the internal aspects to be improved the following elements have been pointed out: complex architecture, maintenance of TCS-ICS interaction, user strategy, automated ingestion of TCS metadata into ICS, tools and skills for communication.

Looking outside for opportunities to capitalize on, EPOS can take advantage of: European ever-increasing needs for transnational cooperation to deal with societal challenges [Marti et al., 2022, this volume], e-science innovation to foster open data science trends, reaching beyond the world of academia and extending cooperation to industry. When it comes to external factors outside its control, EPOS needs to carefully monitor: long-term governmental

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commitment, financial viability and long-term sustainability, dependence on harmonized national contributions, compliance with a global legal framework for data sharing, commercial competitors for service operation and data preservation.

After having laid out EPOS' mission and vision and analyzed its strengths, weaknesses, opportunities and threats, it is possible to have a clearer understanding of what its goals are. EPOS's communication goals for internal and external audiences can be summarized as follow:

- Foster the exploitation of the contents of the EPOS Delivery Framework
- Increase EPOS' impact and visibility by communicating scientific perspectives, innovation and added values for science and society
- Promote international cooperation by positioning EPOS in a global dimension
- Engage users, stakeholders, national authorities, and
- Build-up interest and trust from stakeholders and society at large.

Analyzing the journey of EPOS from its conception to the present days (Figure 2) has been extremely important for two reasons: first because its long and rather extraordinary history and progress in its lifecycle can be a strong message to be delivered through both external and internal communication. Secondly, because the transition from the current stage of the RI to the fully operational phase in 2023 requires the exploitation of a structured communication through key messages, effective tools and continuous interactions with selected target audiences.

The EPOS journey started in 2002, successfully passed the Preparatory and Implementation Phases, and is bound to the Operational Phase in 2023 (Figure 2).



Figure 2. EPOS timeline and progress in the lifecycle of the Research Infrastructure during nearly two decades.

The EPOS Preparatory Phase (PP) ran from 2010 to 2014 and was funded under the European Commission FP7 Work program. During this phase, the conditions for the integration of existing and future RI were created and the EPOS architecture was built. The Implementation Phase (2014-2019) was marked by the establishment of the ERIC, and the subsequent implementation of a technical, legal, and financial framework for all its components. The EPOS communication strategy at this stage focused on the engagement of a broader range of stakeholders, including other RI, European Commission bodies and feedback user groups, while strategies to engage the private sector and society have been discussed and envisioned. The latter will be further explored and expanded during the currently on-going EPOS Sustainability Phase (EPOS SP) European project.

The transition from the Implementation Phase to the Operational Phase has been recognized as a delicate stage that cannot be done instantaneously. A three-year period has been dedicated to this transition (2020-2023), corresponding to the current Pilot Operational Phase (EPOS POP) that aims to consolidate a sustainable operation of the EPOS RI. Indeed, to tackle the challenge of keeping the communities engaged and committed to supporting the EPOS integration plan, while strengthening the financial viability of the RI, the Pilot Operational Phase (POP) has been designed according to the Strategic Plan 2020-2022 to coordinate this peculiar stage of EPOS' lifecycle.

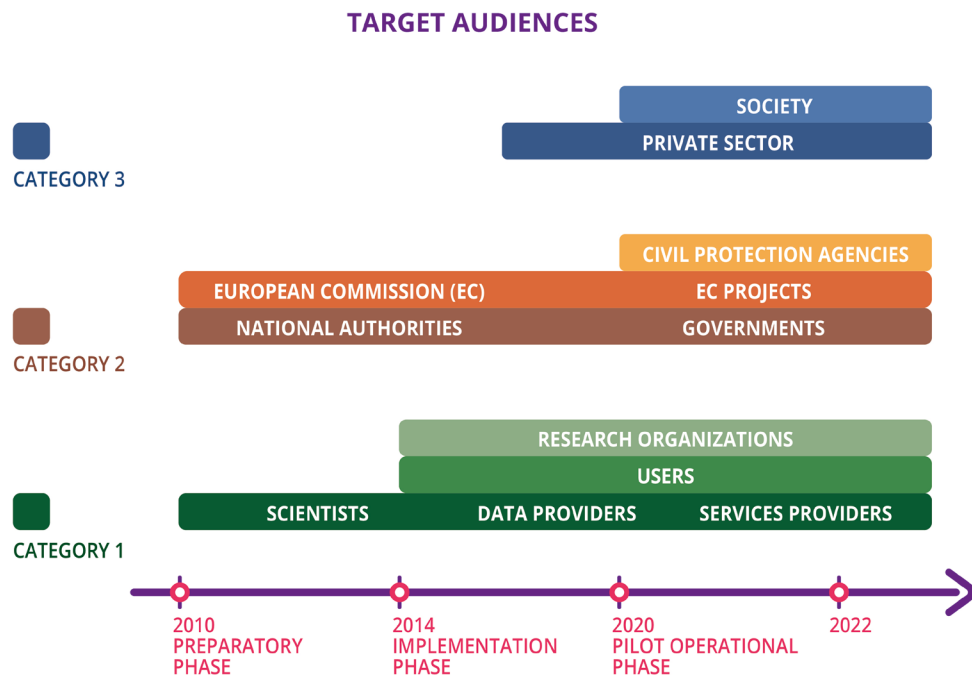


Figure 3. EPOS stakeholder categories (highlighted with colors) and target audiences identified since the EPOS preparatory phase and engaged at different times according to the communication strategy.

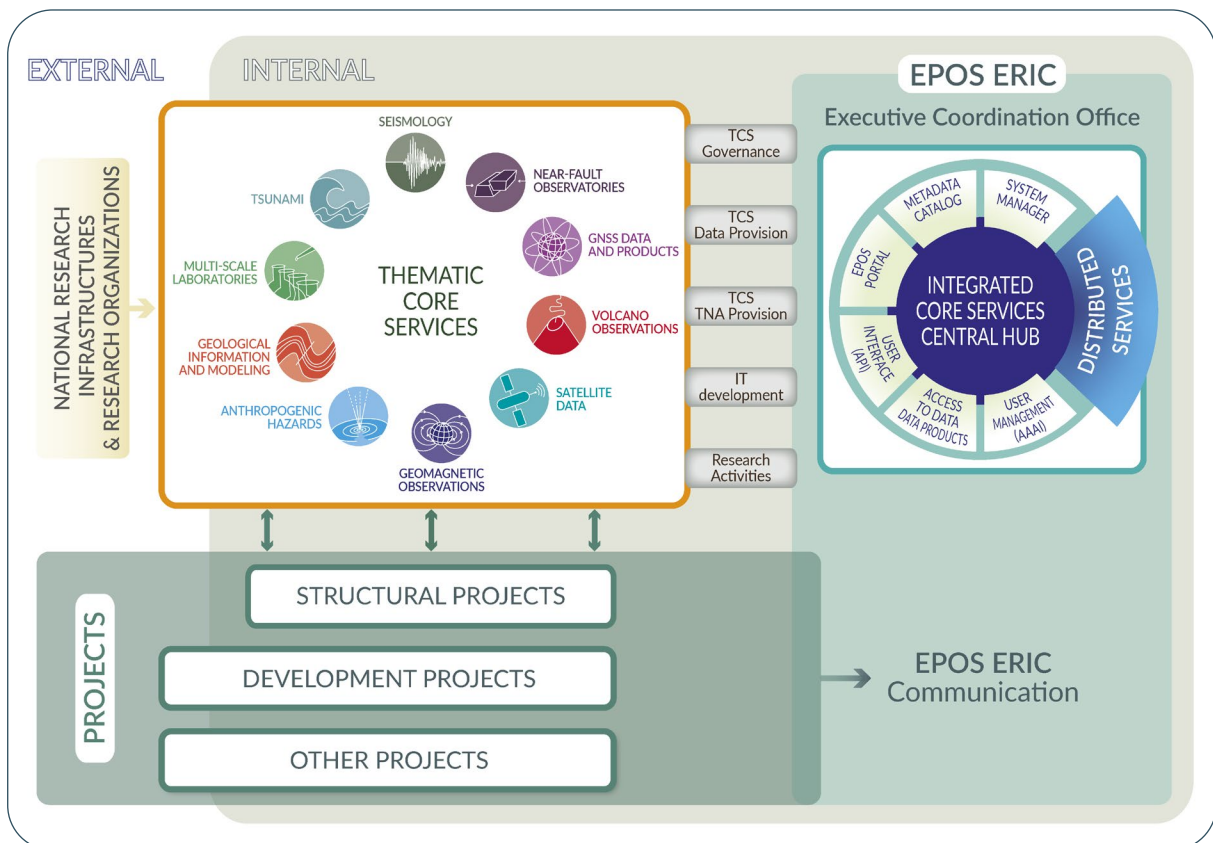


Figure 4. Diagram showing the internal and external communication perimeters and the involved key elements of the EPOS architecture and organizational structure. EPOS ERIC, with the ECO and the ICS-C, the TCS and internal structural projects (likely coordinated by EPOS ERIC) characterize the internal communication. Relationships between TCS and EPOS ERIC are illustrated in the figure. External communication involves NRI, national and international research organizations and other research projects.

The full establishment of the Executive Coordination Office of EPOS ERIC, and in particular of the EPOS ERIC Communication Unit during this stage has been foreseen in the communication plan as a necessary step to have the adequate skills and human resources available to address the envisioned tasks.

Having established the basic principles and values, the EPOS ERIC Communication Plan has been structured to address the following issues:

- Internal communication as a tool to improve management, strengthen cohesion in the community, share experiences and knowledge.
- External communication for different stakeholders and audiences
- Relation between data sharing and communication
- Training.

The communication actions have been organized in different phases involving different audiences (Figure 3) and clearly separated between internal communication, aimed at the members within the vast community of EPOS Delivery Framework (internal users), and external communication, aimed at target audiences (Figures 3 and 4). Understanding and defining these two spaces unambiguously is essential for a distributed research infrastructure with a complex architecture as EPOS, since the boundaries between internal and external communication characterize the interactions and the engagement strategies necessary to ensure exploitation, participation and the sharing of information to foster trust and awareness.

4. Internal communication

Internal communication is first of all the exchange of information between the members of an organization or between the functional components of the organization. Yet it does not remain confined to the field of mere information. Through efficient internal communication, a strong organization culture can be built, where everyone feels valued and empowered. Greater self-determination of personnel, creation and strengthening of a sense of belonging to a common home, the overcoming of conflicts, the reduction of the distance between the various components and between the components and the management, the mutual understanding, the sharing of contents, objectives, language, a greater coordination of initiatives are among the most important objectives of internal communication [Interact, 2018]. Internal communication is essential to enable effective governance of an enterprise because it ensures awareness of on-going processes and alignment between involved actors in charge of coordinating activities and workflows.

While the need of internal communication is acknowledged and its objectives are clear, it can be difficult to achieve it in practice, and in fact it is lacking in numerous scientific institutions, and it is a challenge to be tackled for a complex and articulated reality such as EPOS.

EPOS relies on a federated approach to integrate solid Earth science data according to the architecture shown in Figure 1. This federated approach relies on the construction of the Thematic Core Services (TCS), where data and metadata are generated, quality-controlled and standardized, as well as of the Integrated Core Services (ICS) where data and metadata can be integrated and used. The EPOS Delivery Framework is composed of the data integration system represented by the TCS and the ICS (TCS-ICS system) as well as EPOS ERIC (see Figure 1 and 4). Its federated approach and pan-European dimension is what makes EPOS unique since it involves different European countries, diverse national and international initiatives, and numerous data and service providers belonging to many different research organizations. Internal communication assumes an essential role to ensure effective governance, awareness and trust among data, service providers and EPOS ERIC as well as to share resources and skills to maintain the envisioned roadmap for the RI operation.

In EPOS, internal communication is the communication that takes place within the Delivery Framework, while external communication refers to stakeholders and everything that takes place outside this framework, including, for example, communication to users who access data and services made available by EPOS. Therefore, internal communication concerns the communication within EPOS ERIC according to its organizational structure, among the key components belonging to the ERIC framework (namely, the ECO and the ICS) as well as between EPOS ERIC and the TCS and among and within TCS as illustrated in Figure 4.

EPOS ERIC is responsible for the coordination and management of the research infrastructure, as well as for its long-term sustainable operation. EPOS coordination includes governance-related communication with the General

Assembly and the External Advisory Boards. Communication between EPOS ERIC and the TCS as well as between the partners involved in the structural and development projects and the research organizations engaged by TCS needs to be strengthened and structured and this is the main goal of the communication plan. The communication internal to TCS is also essential in order to keep the communities engaged, harmonize and promote the participation of involved research organizations as well as to reinforce the awareness of the EPOS added value for the communities.

The assessment of the impact of internal communication is also useful to implement external communication, because scientists, researchers, technicians, academics and in general all those who fall into the “internal” community are also part of the Earth science community and society [Cerrato et al., 2018]. Research, science, technology are complex systems that cannot in any way be considered detached entities, especially due to the body of values of society itself in which science and technology develop [M.C. Evan, 2018]. The boundary between external and internal communication needs to be well identified, monitored and managed with care because a given target audience can be engaged through both the communication frameworks. This implies harmonizing and synchronizing the different communication initiatives undertaken in each framework.

5. External communication

Society is not a compact block, but a heterogeneous entity formed of different audiences with specific needs. In recent years communication in the public sector has changed profoundly [Bucchi and Trench, 2014]. The original overall communication function was to inform and to influence, and was performed in a top-down way, mostly through mass communication, where citizens were not given any chance to take an active part. Now “public sector communication has become a much more diverse and multipurpose activity – an activity that is based on and mobilized by a wider set of principles” in order “to reinvent and craft more efficient, accountable, and responsive organizations” [Friedriksson and Pallas, 2018].

Being a scientific organization supported by public funds, EPOS is morally and legally bound to be open and transparent and must be able to listen and to respond to the voices of a variety of stakeholders, other organizations, citizens, experts, and national authorities. The context of communication activities for EPOS is indeed unique for the following characteristics: (i) EPOS’ audience is large, diverse and evolving, (ii) EPOS’ service proposition is large, diverse, complex and evolving, (iii) EPOS resources depend on the participation of the communities and on governments’ commitment.

Creating efficient and effective external communication is a great challenge. Yet, communication can be a crucial element in the long-term sustainability of EPOS. It is also important to underline the often underestimated link between internal and external communication. If internal communication works well, internal staff will be well informed and empowered, and can become ambassadors towards the external, through social media, direct contacts with stakeholders, etc. They will thus have a significant impact on external communication and enhance EPOS’ trust and reputation.

EPOS external communication refers to all audiences who are not directly committed to operate the Delivery framework. Its scope is broad, and it encompasses a huge variety of audiences, needs, methods and communication tools, skills, practices, as well as specific strategies for each case. The target audiences identified in EPOS for the external communication are:

- Researchers, Master and PhD Students, Users
- Policy makers and national authorities, including Environmental and Civil Protection Agencies
- Private sector and industry
- Media
- Society.

Researchers, master and PhD students, users can benefit from EPOS’ unique data collection and services on solid Earth science, from career development opportunities within a European network and in a collaborative environment. They are a well-known audience and are reached through dedicated communication initiatives and tools, such as websites, newsletters and social media.

National Authorities have been a key target audience since the beginning of the EPOS Preparatory Phase. Specific actions have been undertaken to keep them involved not only through participation in the EPOS ERIC General Assembly. In the framework of the EPOS Sustainability Phase project (EPOS SP) a National Authorities Consultation

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Board (NACB) has been established. The representatives of 14 countries are formally involved in the EPOS ERIC General Assembly, the decision body and the main financial contributor to the EPOS RI. The representatives of further 9 countries are engaged in the NACB. This board is expected to be maintained as a key element to sustain communication with this target audience and to address the long-term sustainability of the EPOS RI.

Further to national authorities, other funding and Civil Protection agencies are also key target audiences in EPOS. Interactions with them are going on to prepare for their engagement in the EPOS delivery framework. Yet EPOS has a lot to offer to them: sharing data and services to promote and facilitate the scientific support to evidence-based policy making, advice on how to support research and manage RIs, practices for Open Science and data management, a reliable source of information and data, a strong connection with the solid Earth science community, practices for delivering information on hazard and risk to different stakeholders, access to products associated with hazard and risk, policies and rules. A specific section on the website will be set up, along with periodic policy briefs, personal meetings, short videos of supportive policy makers, existing channels with Environmental and Civil Protection Agencies and tailored training events. These activities belonging to external communication require a strong and effective communication with involved TCS, corroborating the relevance of harmonizing and synchronizing internal and external communication.

The EPOS relationships with industry are also important and need to be preserved and further strengthened. In general, stakeholders from the private sector can be users, suppliers or customers of the RI. Formal relationships exist as those related to induced seismicity and anthropogenic hazards, a relevant issue related to the exploitation of geo-resources. In this case, industry is a supplier of data concerning the monitoring of geo-resource sites and a user of services concerning anthropogenic hazards. The EPOS ERIC communication unit and the EPOS community are working to strengthen awareness of potential benefits deriving from an active partnership between EPOS RI and stakeholders from the private sector. Several pilot initiatives have been undertaken, also in the framework of European projects (such as EPOS SP), in order to strengthen relationships and implement good practices and case studies to be disseminated and replicated to foster new collaborative frameworks. Further activities are envisioned in the communication plan, such as participation in fairs and conferences, the collaboration with field intermediaries (Industry Liaison Officers, Knowledge and Innovation Communities, Industrial Associations) as well as an industry dedicated area on the website. The creation of dedicated communication channels that will help EPOS develop more efficient and tighter relationships with the industry and private sector will be considered. By involving the private sector more actively, EPOS will make an important step forward in achieving long-term sustainability, while also maximizing the impact of its activities.

Media are the mediator towards all the other audiences. For the media, EPOS represents a reliable source of information and data, a source of engaging stories, a strong connection with the solid Earth science community which can be translated into newsworthy information and answers to their queries. Media can be reached by a section on the website, social media, the Press Office constant activity, and special events. Communication with the media will be implemented in the EPOS operational phase coherently with the strategic approaches to engage society.

Society is a variety of publics, all with their attitudes, expectations, knowledge, fears, and visions of the future. Understanding science in modern society and its contributions to decision-making requires literacy, awareness and preparedness, which can be strengthened through the communication of scientific information with appropriate lay language and tools. EPOS can be a reliable source of information and data and also offer engaging stories and a direct connection with the solid Earth science community. EPOS can support education, putting at disposal a vibrant scientific community and insights into ongoing research and data science. To open a dialogue with society EPOS can use all possible channels, such as a section on the website, social media, special events (festivals, open days, etc.), education materials, workshops for students and teachers, citizen science projects, discussion games and other participatory activities. All this is envisioned in the EPOS communication plan towards the external public, it will be implemented gradually, involving different sectors of the public and providing the appropriate tools to the personnel involved in the communication initiatives.

External communication is important to describe the contents of the EPOS delivery framework as well as to engage the public, allowing it to influence and be influenced by the use of the EPOS RI. The communication and dissemination of the contents of the EPOS delivery framework to a widely heterogeneous audience of citizens is an overwhelming challenge, that will be tackled in the near future in full awareness that it requires effective and dedicated planning and tools. External communication with private sector, decision-makers and society at large requires addressing ethical issues through ethical guidelines to preserve credibility, trust and impartiality for public good.

Communication with society at large is, therefore, scheduled for a later phase. Yet it is good to start planning and training the people who will take care of it immediately at the inception of the communication actions. Furthermore,

some of the actions that are intended for internal communication will also have an external impact, since EPOS is not a sealed system and needs a lot of support in order to arrive at the Operational Phase as structured as possible.

Besides having different attitudes, expectations and knowledges, stakeholders vary in their interest in EPOS, being either passive users of its services, or active users, engaged providing data and services to the RI. In addition, their influence in EPOS can also be classified as passive or active according to their level of engagement and influence on the decision-making process within the RI.

National governments that become members of EPOS ERIC, for instance, are actively *engaged* in the EPOS framework, thus having both an active interest and influence in the Research Infrastructure. On the contrary, a large portion of society will have a passive influence and interest in EPOS. This category, which includes citizens who are *informed* by EPOS, requires a targeted and specific communication approach.

6. Data science and communication

Tim Berners-Lee, the inventor of the world wide web, said in his famous TED Talk *The next web*, in [2009]:

Now, I want you to put your data on the web. Turns out that there is still huge unlocked potential. There is still a huge frustration that people have because we haven't got data on the web as data. (...) I want you to think about a world where everybody has put data on the web and so virtually everything you can imagine is on the web and then calling that linked data.

This is the environment in which EPOS develops: the web has made billions of linked documents available, now it's the time for data sharing. EPOS is here precisely for this and the communication plan facilitates the exploitation of this potential.

In communication, it is necessary to find elements of uniqueness or novelties that distinguish the object to be communicated from the rest and trigger the interest of the media and the publics. These elements should be translated in unique and clear messages, which represent the key assets of the organization, and must be reiterated at every occasion. EPOS offers many ideas for developing effective and meaningful messages for many different audiences. The very fact that it has such a long history and many years ahead of innovative development is an element that must be enhanced in internal and external communication.

In addition to its long and complex history, the uniqueness of EPOS lies in the fact that a research structure has been created for the first time to offer open data and products for all solid Earth science, through a European and federated approach.

EPOS offers harmonized petabytes of data on all solid Earth science for the same time span. This has never been done before and it represents an excellent opportunity for young scientists and for collaborations with the private sector. This level of complexity and interoperability has never been achieved before at European scale in any scientific field.

The realization of the fully operational phase represents both a technical and a cultural challenge that must be fully seized by all communication activities. Here we want to highlight some aspects that could be common to other similar initiatives:

7. Integrating national research structures

EPOS integrates European solid Earth science research into a single, sustainable, permanent and distributed infrastructure, optimizing access to data and offering a wide variety of powerful modeling tools. This new environment is expected to foster innovative research, taking full advantage of Big Data analytics.

7.1 Innovative approach to data science

EPOS has been developed as a novel e-infrastructure for promoting FAIR data management and is currently working to create data interoperability: integrated metadata and interoperability services.

7.2 Sharing multidisciplinary data and research results

The strengths of EPOS' approach include cost reductions in the use of research infrastructure, trust-building and development of a common understanding among researchers, as well as standardization of data collection, coordination of research methods and open access to research data.

7.3 Harmonized data quality management across TCS

The long-term sustainability of EPOS, as that of many RIs, involves the generation and exploitation of data, products – including software – and services. EPOS produces and is dependent on rapidly increasing amounts of data. The data it produces need to be made open and easily available to researchers, across a wide range of fields. To render this goal feasible, the data need to be managed, stored and preserved in a cost-efficient way, with appropriate quality and safety assurances, fostering access across borders. Thus e-science solutions for enabling access, storage, preservation and curation of large amounts of data are made available with EPOS.

7.4 Community building and knowledge transfer

Community building and training, dissemination of results and knowledge transfer to end-users are increasingly taken up with EPOS, highlighting the importance of both data and infrastructure-sharing. Data infrastructure enables researchers and other stakeholders from research, education, society and business to use, re-use and exploit data for the benefit of science and society.

8. Engaging the community with a training program

Consistent with the federated approach of EPOS, the Communication Unit has been structured as a hub, with a central office in Rome and a Communication Team made up of representatives from all communities corresponding to the TCS and ICS. The Communication Team is an essential link with the communities: it must be an active part of communication and should not be used in an instrumental and passive way. For this reason, it is important for all members of the Communication Team to acquire the necessary skills, to be aware of the communication plan that will be adopted and to participate in its evolution.

A specific training programme will be proposed to the representatives of the communities who will be part of the Communication Team in each TCS and ICS, supporting and collaborating with the central Communication Office. This training programme is communication-focused and goes beyond the training offered to researchers within the EPOS SP Project on how to use the platform and better understand data usage.

Training in research communication is necessary to equip researchers- involved in communication programmes, public engagement activities or acting as the relation with the media- with techniques and competences that allow them to successfully run the activities, take into account the public views while respecting scientific knowledge, and ensuring a constructive outcome for the benefit of science and society [Newman, 2020; Cerrato, 2020].

The courses will be highly professional and can be considered as a reward, or at least as tangible public recognition for their commitment to internal and external communication. In addition, skills in research communication and commitment to outreach and public engagement activities are now an element assessed for career progression, for the evaluation of grant proposals, for the selection in research job positions. These courses will allow participants to acquire skills today deemed necessary in any profession in the field of research, and will therefore represent a valuable element for their career. For this reason, we recommend facilitating and encouraging the presence of young researchers, rather than senior ones, in the Communication Team of each TCS and ICS.

The courses will present settings and materials, so to best assist participants in using existing formats or designing new ones, tailored specifically for the needs of the EPOS communication plan. They will include a theoretical background and practical workshops leading to the development of concrete programmes.

9. Conclusions

The whole communication plan must be understood as a living document, “To become sustainable over time, European research infrastructures must increase their visibility, both individually and collectively. For this, their communication must become more effective and consistent” [Costa Abecasis and Pintar, 2020]. Working on the EPOS Communication Plan meant identifying the guidelines to envisage, structure and manage future external and internal communication activities for the various identified audiences. It included strategic objectives, messages, reference audiences, types of media, assigned roles, and resources.

However, different research topics deriving from the different thematic areas tackled by EPOS will require different communication approaches in order to be effective. Our plan revealed that in order for EPOS to be able to disseminate scientific information to society and the wide public it needs first to become stronger internally. One way of reinforcing the internal communication could be setting up a *Communication Community of Practice* that provides ongoing support to those involved in communicating research. A community of practice has the advantage of supporting researchers both with ideas and resources, and what’s most important, it will also nurture a strong sense of belonging to a community that shares a common concern for communication. Moreover, developing strong partnerships with research final users, other research organizations, knowledge intermediaries as well as other stakeholders will prove crucial for effective communication.

One of the challenges for the communication and dissemination of the EPOS delivery framework is to cultivate and promote bidirectional communication between the TCS and the communities. TCS represent an innovation in the operation of the EPOS distributed RI that can yield an added value to data sharing and to the provision of data and service for solid Earth science. At this stage of the EPOS lifecycle, it is crucial to consider that the engagement and the communication with national and international research organizations need to be harmonized, and strengthened where necessary, in a suitable governance model preserving the centrality of TCS.

Another thorny aspect to consider when devising a strategic communication plan is risk communication and the ethical issues it triggers. Ethical issues emerge whenever a decision or action has the potential to affect another person [Sellnow et al., 2008] and we strongly recommend writing a Code of Ethical Communication and making it public to all members of the organization.

On the risk side, risk communication planning needs to acknowledge that decision-making is difficult, because there are often trade-offs to be made among competing objectives and perspectives.

Risk communication has been defined as any two-way communication between stakeholders about the existence, nature, form, severity, or acceptability of risks [Muralikrishna, Valli Manickam, 2017]. It is vitally important to know and understand what the basic rules of risk communication are and to ensure that communication among various stakeholders is part of the risk communication strategy. An accurate stakeholder analysis will provide useful information and tools for consideration in decision-making and communication processes. EPOS will manage risk communication through an approach designed to respect the roles and commitments of involved research organizations at national and regional level as well as the roles of international organizations and communities engaged in TCS. This requires to share with the involved communities the approach and the contents of risk communication as well as to implement suitable communication protocols with other stakeholders on issues related to geo-hazards and risks.

As outlined by the European Commission, research infrastructures already actively engage their thematic communities. However, their long-term sustainability also demands the engagement with society and a variety of stakeholders whose financial and strategic support might derive from their understanding of the significance and the benefits of the services delivered by the research infrastructures.

The EPOS Communication Plan aims to provide the research infrastructure with tools and guidelines to design communication strategies that will allow EPOS to effectively engage all its stakeholders. This is a roadmap traced to favor context-appropriate communication, in view of increasing EPOS’ visibility and impact on its target audiences, and at the same time creating a fertile land for international collaboration or other growth opportunities.

The EPOS Communication Plan reflects the evolving nature of a complex, distributed infrastructure. Therefore, the current plan is to be considered an important starting point of EPOS’ communication journey, but not its final destination. Continuous monitoring, evaluation and adjustment to emerging future scenarios are fundamental for the success of all EPOS communication activities.

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