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IMPROVING MULTIDISCIPLINARY ACCESS TO ERIs

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ABSTRACT

Improving multidisciplinary access to ERIs and teams of researchers from different backgrounds to work together remains a priority to face the most critically environmental problems. A single or separate disciplinary approach within an ERIs is unlikely to have all of the expertise necessary to address complex problems that can make a significant impact on society or use the whole ERIs potential. Improving the multidisciplinary access to ERIs, help to ensure that both anticipated and unanticipated users can find, obtain, evaluate, understand, compare, and use legacy data in new ways or performing complementary experiments to a better understanding of the underlying problems.

The present white paper provide some specific insights on how to build capacity for multidisciplinary research within the ERIs and the patforwards to improve the multidisciplinary access to ERIs including ERIs reforms and principals for building interdisciplinary access to ERIS.

The purpose of this white paper

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INTRODUCTION

Strong investment in research and innovation is needed to address pressing societal challenges such as climate change, ecosystem resilience and sustainability, health and ageing population, or the move towards a resource efficient society. It is widely recognized that Europe and the world is undergoing a period of profound ecosystem changes and that climate change and global change still remain the most difficult societal challenges to confront. Environmental Research infrastructure (ERIs) plays a vital role in addressing these challenges. They provide all necessary instruments for scientists in their quest for understanding the underlying principles of the global change and its effects. The multidisciplinary access to a national facility was to be based solely on the merits of the proposed research[1], and operating costs were to be covered by the facility. Among the advantages of this scheme were the following:

- Maximizing the scientific output of the facility, and advancing the frontiers of universally accessible knowledge.
- Reinforcing solidarity within the research community, and rewarding excellence regardless of factors seen as extrinsic to pure science (e.g., economic imbalances, geopolitical strife).
- Promoting balance and reciprocity in a global system where all scientists could compete, on an equal footing, for use of the best facilities anywhere in the world.
- Simplifying facility operations by not having to keep track of, and manage, utilization quotas.

Although the advantages of the access scheme, the societal needs do not only require answers to the why, but also needs answers to how to solve complex societal problems. In other words a there is a for multidisciplinary solutions, i.e., a focus on integrated rather than disciplinary science and a strengthening of the interface with decision makers. Thus new challenges require new perspectives to be taken, and hence adapting and adjusting the ERIs related. This is especially the case in the field of environment and climate related aspects. Stronger interaction and cooperation between ERIs, Users and providers from industry and public services builds bridges between the public private sector and aid increase knowledge and technology transfer from science to industry and public services and help drive innovation. As such, investing in built ERIs provides increased capacity for the delivery of various services required to face urgent multidisciplinary environmental challenges facing humans on a global scale. Hence realizing the full benefit of the ERIs, investments requires more than the effective deployment of sensors, access policy or to conduct innovative research and development. Improving the multidisciplinary acces to ERIs, help to ensure that both anticipated and unanticipated users can find, obtain, evaluate, understand, compare, and use legacy data in new ways or performing complementary experiments to a better understanding of the underlying problems.

The white paper will provide some specific insights on how to build capacity for multidisciplinary research within the ERIs and the patforwards to improve the multidisciplinary access to ERIs.

Multidisciplinary research is definitely a buzzword of our time

To unravel the new era of science, one characterized by multidisciplinary research, we need to know what we are dealing with. This more broad approach to scientific research has developed from the need to answer complex questions at the ERIs, which a single discipline is unable to handle, such as

[1] In assessing merit, the capabilities of the researchers could be taken into account, along with the intrinsic importance of the proposed measurements and the chances of a successful outcome.

in natural resource management, ecosystem resilience and sustainability, or climate change for example... Multidisciplinary research is definitely a buzzword of our time; it regularly decorates the pages of funding proposals and scientific reports. However, after the applications are sent, funding is provided, and papers are published, how do we know that the work was actually multidisciplinary, or even close to it? The conditions necessary for successful or even functioning multidisciplinary research are not easily met. To date researchers failed to meet condition enabling multidisciplinary research at the ERIs : groups in which new insights were not developed by working together or covering at least two domains (cf. atmosphere, ecology, biodiversity…) but rather, each researcher remained isolated in their comfortable corner nurturing the well-established reality of their own.

Most of the time the complicated research problems at the ERIs cannot be solved by a particular discipline and it necessitates the collaboration of people of diverse expertise across a range of discipline together to achieve the research goal. This is even the essence of a research infrastructure. Many a times any individual research member or an individual discipline often develop a shaft dream and may feel difficult to imagine beyond the routine knowledge. By making a collaborative team of multidisciplinary experts at the given ERIs it becomes conceivable to think beyond the routine knowledge. Therefore, multidisciplinary research connects the members of diverse expertise to solve a particular research problem.

As Janssen and Goldsworthy (1996)[2] put it: " …what multidisciplinary research means and how it can be put into practice is not always clear." At this point, it is good to refer to the definition of our buzz word, though before jumping into that, it is first useful to know what the term discipline means. According to Janssen and Goldsworthy (1996) a discipline has a close institutional order, has its own professional standards, publication outlets, and education programs. It also gives a scientist an identity, in which the principle of scientific reduction is a central attribute. This means that each discipline is expressed through a certain set of norms and values, which are constructed on the basis of the field specific reduction and the underlying assumptions of the reality.

Going into defining multidisciplinary research leads us to knowledge associated with several academic disciplines. In practice, multidisciplinary teams are composed of individuals coming from various disciplines. This means that they may not share the initial set of norms and values, and a time-consuming task of developing new norms for the team must take place. This task requires skills and flexibility both from leaders and team members. A solid foundation for building the new norms is a problem-solving orientation of the team and a clear-shared goal (Janssen and Goldsworthy (1996).

Multidisciplinary research at the ERIs level has many forms, which develop according to the level of integration in the research group and the purpose of the study – whether the goal is to focus on a broad topic or just to get a better answer to old questions. This means that many levels of research at the ERIs level can be put under the term "multidisciplinary". When experts from different fields work together on a common subject within the boundaries of their own discipline, they are said to adopt a multidisciplinary approach. However, if they stick to these boundaries they may reach a point where the project cannot progress any further. They will then have to bring themselves to the fringes of their own fields to form new concepts and ideas-and create a whole new, interdisciplinary

[2]Janssen, W and Goldsworthy P. (1996), Multidisciplinary Research for Natural Resource Management: Conceptual and Practical Implications, Agricultural Systems 51, 259-279.

field. A trans-disciplinary team is an interdisciplinary team whose members have developed sufficient trust and mutual confidence to transcend disciplinary boundaries and adopt a more holistic approach.

All in all, every group has its own characteristics, which are defined by the people in the group. When we have a group, we need to know where we are headed, thus we need a goal. A clear goal is a must. Then we decide ourselves to what extent we are ready to dive into the open space between our disciplines, and how active we are in building the bridges among us. ERIs, should have a clear multidisciplinary access strategy goal towards a better understanding of the complexity of the system. Only research excellence and integration of the data will tell whether these are defined clearly enough to ease the collaboration within our group and to meet the challenges in multidisciplinary research.

Challenges

If interdisciplinary research at the ERIs level is so important, why doesn't everybody do it? The barriers are both practical and institutional. Important methodological and conceptual gaps, and links between fields or disciplines, will helps define the nature of the problems that researchers must overcome in order to integrate concepts and methods from other fields in their practice at ERIs. Such work is relevant for understanding why interdisciplinary access to ERIs is difficult and what it might need to succeed. However the question of why interdisciplinary is difficult is one that also pertains to the broader structure or system of problem-solving practices within a field, and the role particular methods, conceptual frameworks and other scientific resources, like models, experimental practices, and cognitive practices of handling them, play within these. Our experience suggests that bridges and barriers to conducting multidisciplinary at ERIs begin at the individual or personal level.

Three categories of personal characteristics that foster bridges and barriers in interdisciplinary research: vision, devotion, and problem solving. An individual's vision factors into issues of risk taking, flexibility, a common vision, creativity, and cross-disciplinary thinking. Similarly, the willingness of researchers to craft their disciplinary focus around a complex common problem signifies a level of flexibility necessary to mutual problem definition. Creativity and the ability to think across disciplines within the ERIs also constitute vision characteristics that can facilitate team-based problem definition, research design, and analyses.

Devotion to the interdisciplinary process is a second important category of individual issues. Devotion includes a researcher's commitment, professionalism/accountability, and patience. Interdisciplinary research requires team members to be committed to providing data and results to other team members to advance the objectives of the group in addition to those of the individual. This pull between one's disciplinary and interdisciplinary activities may become a tension in many ERIs despite the policy access of data. Often a team member's completion of a specific task depends upon another team member completing his or her tasks. Thus, patience with the progress of the interdisciplinary project becomes a valuable asset toward the accomplishment of interdisciplinary objectives.

Problem-solving orientation constitutes a third category of individual bridges and barriers to the interdisciplinary process. Problem solving includes issues of conflict management, communication strategies at the ERIs, and experience. Similar to group dynamics elsewhere, proactive communication when problems arise can avert the conflicts and challenges associated with interdisciplinary design.

Our objective here is not to try to differentiate the degree of meshing among the disciplines and to make judgments as to whether a specific issue should be referred to as inter, multi- or pluri-

disciplinary at the ERIs. Rather, our concern is that meeting today's environmental challenges almost always has some level of intermeshing of disciplines (Kajikawa et al., 2014)[3]. The difficulty of distinguishing the form of intermeshing in no way takes away from the recognition that incorporating the perspectives of different disciplines is important. Current investigations show increasing trends towards the integration of more interdisciplinary within sustainability research (Schoolman et al., 2012)[4]. Furthermore, it is critical to accept that only the experts from different disciplines are actually able to ascertain whether their disciplines are pertinent for a specific investigation.

Principles for a successful multidisciplinary access to ERIs

Solving the most critically important environmental problems often requires teams of researchers from different backgrounds to work together at the ERIs with its multitude of data sources and its instrumentation across domains. A single laboratory/groups is unlikely to have all of the expertise necessary to address complex problems that can make a significant impact on society. ERIs should develop aggressive policy multidisciplinary access that stimulated merging of fields that makes otherwise impossible goals achievable, often in a timelier manner. Such a strategy has led in the past many granting agencies, academic and commercial institutions to encourage the development of inter-disciplinary teams[5,6]. Doing so would increase in the quantity and quality of publications combining the work of authors with diverse backgrounds and would make ERIs more than ever a strategic tool for policymakers at the EU level and in the world. While the idea of assembling the best-of-the-best ERIs to address an important problem in society is of merit, the practical aspects of working together can be challenging. Ensuring success hinges on effective ERIs communication – knowing what and how best to convey thoughts and opinions to attract multidisciplinary scientific communities. ERIs have different governance access policy and interests, but still need to set clear strategy by implementing cohesive principals such:

Learning the language - one of the biggest challenges in working together at the ERIs is building a communication strategy that is aligned with all researchers. Each research discipline, and often each laboratory, has unique 'language'. Occasionally, the same terms can be defined completely differently depending on the discipline or even from one research group to another. Commonly used jargon and terms should be clearly defined and collaborators that are relatively new to your field may require more thorough explanations. Thus, patience in explaining concepts and the added value of complementarities of disciplines within and ERIs are required.

Addressing differences in operation – the way laboratories operate inside an ERIs can differ significantly. For example, atmosphere scientists, earth science, ecosystem and biodiversity scientists have different approaches to drive research projects. To address these differences, a simple communication strategy should be developed at the beginning of the collaboration/project. In other words the project leader should discuss clearly the goal of the proposal, the needed expertise and discuss - bridge the differences between the researchers. Communication is the key to developing a productive team.

[3]Kajikawa,Y.,Tacoa,F.,Yamaguchi,K.,2014.Sustainabilityscience:the changing landscape of sustainability research. Sustain. Sci.9,431–438.

[4] Schoolman, E. D., Guest, J. S., Bush, K. F., & Bell, A. R. 2012. How interdisciplinary is sustainability research ? Analyzing the structure of an emerging scientific field. Sustainability Science, 7, 67–80.

[5]Adams J. The rise of research networks. Nature 490(7420), 335–336 (2012

[6] Dozier AM, Martina CA, O'Dell NL et al. 2014. Identifying emerging research collaborations and networks: method development. Eval. Health Prof. 37(1), 19–32.

Making an operational plan - Solidify critical discussions by creating a policy document for the collaboration at of the project. Each project leader should sign off on this agreement. If documents not created, researchers tend to forget the agreed-upon collaboration principles, which can potentially lead to problems during the course of the project. Some of the points of discussion that should be included in a policy document are:

- How can the project results be communicated between the different research groups?
- What are the privacy issues for each party?
- What are the different timelines of each group's contribution to the team effort, and how will milestones and expectations be managed?

Outlining the principles of engagement and reporting can form the groundwork for productive communication and discovery of novel advances within the ERIs.

Share the credit - Develop a system to provide appropriate credit to all researchers who participate in the project. If the outcome of the study leads to a paper, how will authorship be organized? Who will be responsible for writing the manuscript(s), and what will be their emphasis? If there are patents created, who is included on the patent? Some of us have experienced a PI who wants all of the credit but does very little work. The allocation of credit should be discussed early among all the contributors. This discussion should extend to trainees in addition to PIs and will often be initiated by the latter. Much overlap exists with respect to the reasons the PIs and trainees are involved in a given research collaboration. For instance, both PIs and trainees are united by the common drive to disseminate high-impact, quality data, but there are usually additional interests that may differ between the parties involved, such as a PI who is preparing his or her promotion package and needs to publish papers in certain types of journals. If these are considered, it will likely improve the collaborative experience for all, and importantly, increase productivity and impact.

Consider the trainees involved in conducting the work. Authorship is of great importance to them as well, for instance, for completing a degree or building one's curriculum vitae. Collaborators should discuss who will be credited with authorship and the order of names appearingon the different published works that arise as a result of combined efforts. Although this can be an uncomfortable topic and is undoubtedly a challenge to decide early in the process, ensuring constant and consistent communication on where individuals stand on authorship, particularly as the projects evolve, avoids unnecessary worry and eliminates misguided expectations on all parts. Remember, as with any endeavor, if individuals know the reward, they will adjust their expectations and be more motivated to do the work.

What we learned

according to the showcases of the different ERIs that we tested as part of ENVIRI plus project (Fig. 1), we noted that the selected aceess pilot programme show cases :

- Straightened ERIs visibility at the international level, which could not have happened without a successful advertising procedure, communication tools and international review panel.
- offered unique opportunities for combining advanced instrumentation at the interface of atmospheric and bio-ecological domains.
- Simulated personnel readiness & simulation equipment readiness.
- Promoted inter-disciplinary research projects that not only draw on the knowledge from disciplines but to pool the resources and expertise from the two domains.

- Stimulated thought and provided significant insights into both fundamental and domain-specific issues.

Hyytiälä SMEAR II, Finland

La Reunion multi-disciplinary platform, France

SOERE-ACBB multi-disciplinary platform, France

Mt Etna INGV Observatory, Italy

Use case platform	Type, location	ENV research domain	Involved RI(s)
SMEAR II- HYYTIÄLÄ (Finland)	Single site, Boreal forest	ATMO, BIO	ACTRIS, ANAEE, ICOS, eLTER
OSU-R (La Réunion, France)	Multiple site, Southwestern Indian Ocean, mountains	ATMO, BIO, MARINE, SOLID	ACTRIS
SOERE-ACBB (France)	Single site, meadow	ATMO, BIO	ANAEE, ICOS
ETNA INGV (Italy)	Multiple site, volcanoes	ATMO, SOLID (BIO, MARINE)	EPOS

Figure 1. ENVRIplus trans-disciplinary pilot access programme

On the other hand the aceess pilot programme show cases examples showed that applicants still strongly need to contribute to effective multidisciplinary/cross domain-access and overcome classical standard transnational approach such as :

- Communication between the applicant and the site PI-managers in advance should be more formalized to increase the quality of the proposals
- Cultural - educational problems hindering to create comprehensive research questions which not only related to simple academic exercise but also it requires time and resources
- Learn the language - building a communication strategy that is aligned with all researchers
- Address differences in operation - develop useful shared reporting tools to bridge the differences between ERIs
- Roadmapping design exercises can stimulate the communities to think strategically about their future goals and requirements; can enhance interdisciplinary approaches to complex scientific challenges.

Insights for building interdisciplinary access to ERIs

This section presents the specific insights that are potentially valuable to anticipate the design and to conduct multidisciplinary access to ERIs such as:

The need for frameworks that promote integration - Integration is a defining feature of interdisciplinary research at the ERIs. Despite the central role of integration in interdisciplinary research, it remains a major conceptual and methodological challenge. Although frameworks have been proposed to facilitate interdisciplinary research, frameworks that promote 'broad' interdisciplinary and integration within an ERI are rare despite being particularly relevant to the effective application of environmental approaches. Our experiences here have shown that the environmental domains of Knowledge and learning, which could potentially stimulated diverse ways of thinking about the climate change-water-sustainability-health-nexus, are still missing. Achieving such a goal would, indeed, encourage methodological diversity, and inspire learning which may result in integrated research outputs and a

more fulsome understanding of the linkages among environmental domains than would have been achieved using disciplinary research.

The need to emphasize learning-by-doing - Our experiences here showed that doing research at the intersection of environmental domains, although not totally optimal, have underscored some of the the value of "learning-by-doing" i.e., an iterative process of learning from experience, in interdisciplinary research processes[7]. Learning-by-doing is emphasized in certain research methodologies (e.g., action-research) and fields (i.e., natural resource management) but it is not explicitly emphasized nor promoted in relation to interdisciplinary research at the ERIs.

The benefits of examining research questions at multiple scales - The value of examining research questions across multiple scales- domains, i.e., 'zooming in and zooming out' in relation to the study topic(s), became evident over the course of our research activities. We learned that by considering the links between environmental domains at different scales, individual person, and community. An added benefit of zooming in and out in the context of interdisciplinary research at the ERIs is that this process can enable the identification of cross-scalar connectedness and relationships which tend to be overlooked but can be very relevant to informing multi-level policy and action. Explicitly exploring research questions and synthesizing knowledge across multiple scales of analyses at the ERIs is a distinct form of integration, and warrants further attention as a central facet of environmental approaches to public environmental problems that reflect interdisciplinary, systems thinking, and seek to embrace context, uncertainty, and diversity. It is worth noting here that although we identified meaningful benefits from explicitly considering our research question (i.e., 'what are the links among domains, and societal challenges?') at multiple scales.

Conclusion

The benefits of multidisciplinary access to an ERIs are vast. Within an ERIs, the researchers should work in synergy, complementing one another to complete the essential toolset necessary to achieve the end goal. The merging of diverse fields can yield breakthroughs in a speed unachievable if those contributors were to work independently. The value of multidisciplinary access within and ERIs extends to training highly qualified personnel and expanding the breadth of knowledge of even the most seasoned expert involved, which can spill over and enhance other research endeavors underway or in the future. Like many undertakings with great potential, multidisciplinary access in a ERIs can be one of high risk of failing in addition to high reward. Effective team management, governance and open communication from the very first discussion will maximize the likelihood of success and productivity of the ERIs. Achieving multidisciplinary access to an ERIs can enhance their strategically roles and shape national priorities towards major challenges such as threats posed by unsustainable land-management practices.

[7] Gibbs G (1988) Great Britain, and Further Education Unit, Learning by doing: a guide to teaching and learning methods. [London]: FEU.