Agroecology Virtual Research Environment as an example of collaboration between Livinb Labs and Research Infrastructures to foster agroecology transition

Jose Manuel Avila[1], Iria Soto[1], Danil Caro[1]

[1] LifeWatch ERIC, ICT Core, Seville, Spain
{josem.avila, iria.soto, daniel.caro}@lifewatch.eu

Abstract. The lack of innovative knowledge management systems is an important barrier to adopting agroecology practices. Digital innovation platforms have been demonstrated as a key resource to boost innovation in collaboration environments. This paper introduces the co-design and implementation of a modular Agroecology Virtual Research Environment (VRE) to provide evidence-based policymaking and problem-solving capacity to researchers, farmers, cooperatives, SMEs, entrepreneurs, and government bodies. Employing a co-design approach, the VRE was developed collaboratively with end-users, involving stages such as problem identification, idea generation, prototyping, testing, implementation, and scaling. The Agroecology VRE's initial phase includes a global platform that simplifies and digitizes collaboration through features like a search engine, marketplace, messaging, and resource repository. Future services will focus on customized tools for knowledge and data sharing, enhancing knowledge management in agroecology. By fostering collaboration between Living Labs and Research Infrastructures, the VRE aims to promote adopting agroecological practices, align with EU policies, and contribute to achieving the Sustainable Development Goals by 2030.

Keywords. Agroecology, collaboration, innovation platform, knowledge management, knowledge-based systems

1 Introduction and objectives

During the last decades, a changing pattern of innovation and collaborations has been detected and confirmed that science and innovation are increasingly global, multipolar, and networked (Royal Society, 2011). This trend has led to the proliferation of innovative, dynamic, and ubiquitous digital innovation platforms that can help users who are located seamlessly access data, software, and processing resources managed by diverse systems in separate domains through their web browsers (Abbate et al., 2019).

Digital Innovation platforms are pivotal in boosting creativity, fostering collaboration, and accelerating innovation in collaborative environments (Madanaguli et al., 2023). Living labs (LLs) unite diverse stakeholders, including researchers, businesses, communities, and policymakers. Digital innovation platforms provide a structured space for these stakeholders to interact, exchange ideas, and co-create solutions. Through open dialogue and engagement, innovation platforms enable the integration of various perspectives, leading to more comprehensive and effective innovation outcomes (Almirall et al., 2012). Moreover, digital innovation platforms are essential in extending living labs into the digital landscape, facilitating collaboration, knowledge sharing, and innovation. They come in various types and serve diverse user groups, creating dynamic digital ecosystems that drive entrepreneurship and innovation in both technical and socio-organizational domains (Baran and Berkowicz, 2021).

Numerous interpretations of digital innovation platforms are available. We can find the Virtual Research Environments (VRE) among the different digital platforms. A VRE can be defined as a platform in the form of a website designed to make it easier for users to find and securely access data and use it in innovative ways. A VRE provides seamless access to all services a data user needs to do data-related work and collaborate with the community to create new knowledge (Candela et al., 2013). Therefore, a VRE facilitates working with data more efficiently and improves user collaboration (e.g., end-users, policymakers, citizens, etc.). VREs typically provide a set of integrated tools and resources that support various aspects of the research process, including data collection, analysis, visualization, and

collaboration. VREs are among the goals that e-infrastructures provide; nowadays, a great variety of platforms fall under the scope of these needs (Calyam et al., 2021). VRE can vary from ad-hoc platforms with minimal access services to data held in external repositories to complex management systems with advanced services defined over a wide range of resources (**Erreur! Source du renvoi introuvable.**).

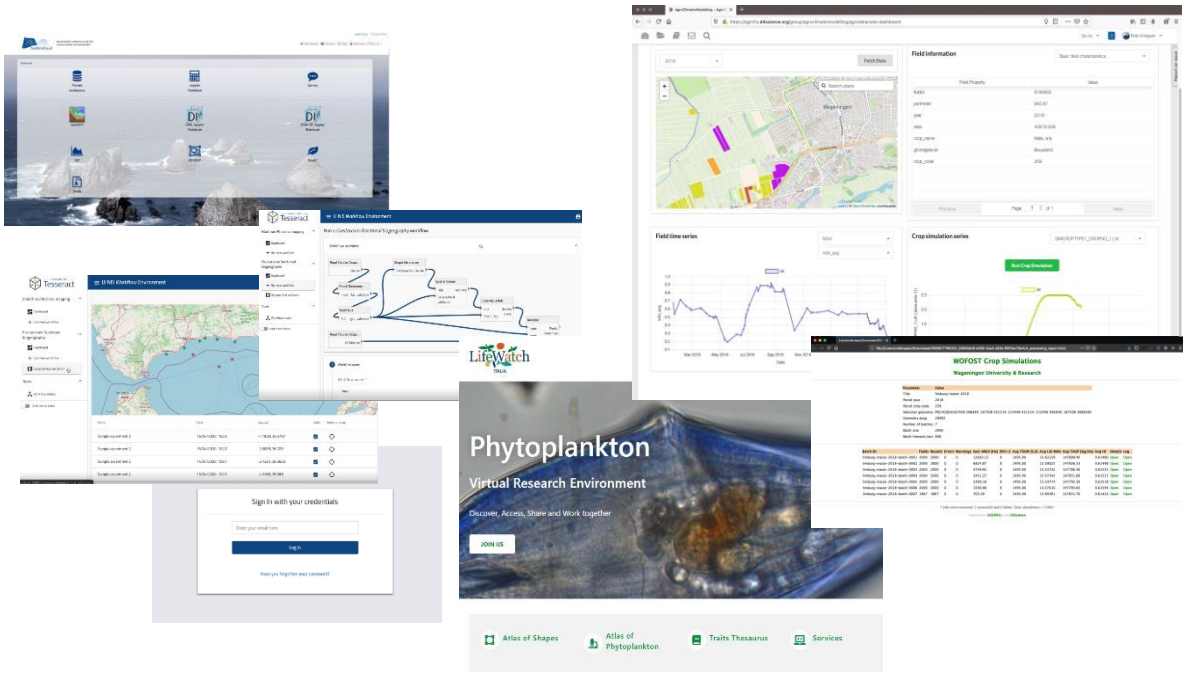

Fig. 1. Examples of VRE from LifeWatch ERIC, AGINFRA PLUS, SeaDataNet

With a VRE, users can store, find, access, visualize, analyze and share their data, reducing barriers to collaborative work. Therefore, in this case, a VRE can be used to answer scientific and managerial questions applied to agroecology. A VRE allows users to communicate what they are doing, locate it on a map and facilitate communication with other users who can be interested in your specific activity. Users can also analyze the shared data to improve their understanding of particular processes or make simulations to identify how specific scenarios, for example, climate change or management decisions, can affect their activity. Always in a secure environment, using the most advanced tools to guarantee data security and traceability (Ávila et al., 2021).

The e-Infrastructure for Biodiversity and Ecosystem Research (LifeWatch ERIC[1]) is a European distributed Research Infrastructure Consortium that supports the development of knowledge-based strategic solutions to advance environmental preservation. LifeWatch ERIC is developing sophisticated data management tools and services to accelerate biodiversity and ecosystem-based research by creating and managing VREs. This platform allows users to access various data sets, services, and tools. The absence of a cutting-edge knowledge management system for the widespread adoption of best agroecological practices is one of the major obstacles preventing the transition to agroecology systems (SCAR, 2023). Thus, a modular Agroecology VRE might be a crucial tool for overcoming the current difficulty surrounding data and information sharing, following FAIR principles, using an innovative methodology. This co-designed Agroecology VRE might facilitate the agroecological transition by improving the problem-solving capacity of researchers, farmers, cooperatives, SMEs and entrepreneurs and by providing evidence-based policymaking capacities for government and funding bodies.

This document provides a summary of the design and implementation of a VRE for Agroecology Living Labs (LLs) and Research Infrastructure (RIs), the co-design process and the first outcomes, providing

[1] https://www.lifewatch.eu/

the next steps for the provision of a tool that aims to boost collaboration on agroecology in Europe.

2 Method

The European Project ALL-Ready (Coordination and Support Action financed by Horizon 2020) has taken the initial steps toward developing this Agroecology VRE (Ávila et al., 2022). This project is based on the premise that Agroecology Living Labs and Research Infrastructures play a crucial role in Europe's shift to agroecology by fostering the innovation of best practices (Mambrini-Doudet et al., 2022). Therefore, ALL-Ready aims to design the framework for a future European Network of Living Labs and Research Infrastructures to accelerate the agroecology transition. ALL-Ready project has developed a Pilot Network of agroecology Research Infrastructures and Living Labs (Schwarz et al., 2022). This Pilot Network is the cornerstone for capacity building and exchanging information and data. Thus, the VRE created throughout this EU project will aid in fostering interaction between Living Labs and Research Infrastructures to build, test, and enhance agroecological systems. It will also provide knowledge management tools, including data harmonization, for comparison and interoperability (Ávila et al., 2021).

In ALL-Ready, Living Labs (LLs) and Research Infrastructures (RIs) are understood as instruments contributing to amplifying the transition to agroecology in Europe (Mambrini-Doudet et al., 2022). A Pilot Network of Living Labs and Research Infrastructures on agroecology will be established during the project. This Pilot Network will be the basis for sharing knowledge and data as well as capacity building. Therefore, a Virtual Research Environment for agroecology developed during the project can help to promote interaction between RIs and LLs to design, test and improve agroecological systems, and to provide knowledge management, including data harmonization to allow comparison and interoperability.

The development of the Agroecology VRE for living labs and research infrastructures has followed a comprehensive co-design approach, including end users from the beginning. This participatory method involves several steps that enable the creation of user-centered solutions that are practical, operational and effective. The different steps applied for co-designing the development of innovative tools for living labs and research infrastructures: identifying the challenges, generating ideas, prototyping, testing and feedback, implementation, and scaling up. For this co-design process, a specific Key User Group was created and composed of representatives from the Living Labs and Research Infrastructures of the Pilot Network. Collaborative working sessions such as workshops and training with discussion and brainstorming were applied to identify the tool's needs and requirements and several version releases. The platform was continuously improved based on an iterative approach and from users' feedback until an agreed and stable operational version was developed (Ávila et al., 2023).

3 Findings and Significance

As a potential use case, the Virtual Research Environment for agroecology would include data from LLs and RIs and other data sources. This information can help researchers, policymakers, advisors, etc., to collaboratively analyze data to provide advice and improve knowledge-based decision-making about agroecology. Therefore, this tool aims to contribute to a transition toward agroecology in Europe through collaboration between LLs and RIs.

Specifically, a Virtual Research Environment for agroecology can, for example, collect data about practices in agroecology, together with the methodological approach, contextual information and specific key performance indicators in different locations in Europe through the participation of existing LIs and RIs working on Agroecology. This approach will allow to:

- verify good practices based on established criteria,
- replicate practices in different locations,
- scale-up specific practices from experimental farms in Research Infrastructures to specific farms in Living Labs

- improve knowledge of agroecological practices,
- assess future scenarios on agroecological practices,
- help decision-making processes based on knowledge and data,
- keep citizens informed and involved

A VRE for agroecology might provide added value to different users such as farmers, the research community, public administration and citizens. In the short term, this tool might allow the community of users to share knowledge and data about agroecological practices. This tool can potentially provide added value to different users in the long term. For example, it can help farmers and farmer associations to enlarge their network, monetize their know-how or help to participate in funding calls, etc. Moreover, it can include a system for accounting for agroecology practices' environmental and socioeconomic benefits using LifeBlock (blockchain technology). The data collected can be used to provide knowledge-based decision-support systems for policymakers that might be used for designing incentivization systems or funders, who might use the data collected to design prioritization systems for open calls, for instance.

The VRE is composed of different layers. For an overview of agroecology, the Agroecology VRE must have a powerful data acquisition and integration layer that unifies access from the VRE tools to data from different sources. This layer is key and should be defined once the user community has confirmed the validity or interest of the data. Once this is defined, it is essential to ensure the usability of the information by the target audience: Researchers, Farmers, Policy Makers, and Citizens. For this purpose, the information collected must be accessible to different social actors in formats appropriate to each user profile and transformed into knowledge useful for different profiles (Jacobson et al., 2006). The VREs will ensure accessibility to information. To design the VREs, defining what "useful knowledge" is for each user profile is necessary. This is especially relevant in the case of biodiversity data, a field where research continues to be under-utilized in decision-making and implementation (Spierenburg, 2012). A unidirectional communication model for society is insufficient since decision-making is complex, iterative, and often selective in the information used (Young et al., 2014). Thus, specific workshops were planned to collect and identify users' needs.

In this first step of the Agroecology VRE, we have developed a global platform to standardize collaboration for innovation. The value proposal simplifies, digitalizes, and accelerates the collaboration process from searching for a partner to starting collaborating. It is a one-stop-shop including a search engine, marketplace, Living Lab and Research Infrastructure visualization, making requests, messaging, and resource repository. The collected and shared information can help Living Labs and Research Infrastructures actors promote interaction, networking, and widespread multiactor innovation. Therefore, this tool aims to contribute to a transition toward agroecology in Europe through collaboration between Living Labs and Research Infrastructures.

Customized tools for exchanging data and knowledge, knowledge management, and a knowledge hub that enables the end user to locate the source and connect with the particular context where the agroecological knowledge has been generated are the next steps in developing the agroecology VRE. Future services that have been selected include a knowledge-based decision support system, a blockchain-based system for accounting for the environmental and socioeconomic values of the agroecosystem services and modelling and simulation tools to help with the sustainable management of agroecosystem landscapes and services, among others.

3 Conclusions and Future Work

Innovative and co-designed digital tools can play a crucial role in advancing the agroecology transition by promoting collaboration between Agroecology Living Labs and Research Infrastructures. This interaction can create opportunities for capacity building, knowledge sharing, and networking among researchers, practitioners, and policymakers to foster a more sustainable and resilient food system.

In a first attempt, the Agroecology VRE has been designed to standardize collaboration for innovation by simplifying, digitizing, and accelerating the collaboration process, including a search engine, marketplace, messaging, and resource repository. The following steps will focus on data harmonization for comparison and interoperability. These functionalities' complexity makes them difficult to achieve

after effective collaboration has been launched. Researchers and technologists must contend with the diversity of data sources, semantic challenges, temporal and spatial variations, data quality issues, interdisciplinary collaboration, and ethical considerations. Addressing these complexities necessitates the application of advanced data management strategies, semantic web technologies, interdisciplinary engagement, and adherence to ethical and legal frameworks. The successful development of VREs that enable effective data harmonization holds great promise for advancing scientific discovery and innovation across a broad spectrum of research domains.

4 Acknowledgement

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000349 (ALL-Ready). Authors thank the contribution of all project partners and the representative of the Pilot Network of Living Labs and Research Infrastructure that participated in the design and implementation of the Agroecology Virtual Research Environment.

5 References

Ávila, JM., Sáenz-Albanés, A.J. Gónzález-Aranda, J. M. *Deliverable 6.3 VRE & Blockchain ("LifeBlock" & Artificial Intelligence-based) demonstrator*. ALL-Ready Project Grant Agreement No 101000349.

Ávila, J.M., Caro, D., Sáenz-Albanés, A.J. Gónzález-Aranda, J. M. *Deliverable 6.4 Two training workshops for VRE use and technical follow-up & upgrading*. ALL-Ready Project Grant Agreement No 101000349.

Abbate, T., Codini, A. P., & Aquilani, B. (2019). Knowledge co-creation in open innovation digital platforms: processes, tools and services. *Journal of Business & Industrial Marketing*, *34*(7), 1434-1447.

Almirall, E., Lee, M., & Wareham, J. (2012). Mapping living labs in the landscape of innovation methodologies. *Technology innovation management review*, *2*(9).

Baran, G., & Berkowicz, A. (2021). Digital platform ecosystems as living labs for sustainable entrepreneurship and innovation: A conceptual model proposal. *Sustainability*, *13*(11), 6494.

Calyam, P., Wilkins-Diehr, N., Miller, M., Brookes, E. H., Arora, R., Chourasia, A., ... & Gesing, S. (2021). Measuring success for a future vision: Defining impact in science gateways/virtual research environments. *Concurrency and Computation: Practice and Experience*, *33*(19), e6099.

Candela, L., Castelli, D., & Pagano, P. (2013). Virtual research environments: an overview and a research agenda. *Data science journal*, *12*.

Jacobson, S. K., Morris, J. K., Sanders, J. S., Wiley, E. N., Brooks, M., Bennetts, R. E., et al.. (2006). Understanding barriers to implementation of an adaptive land management program. *Conservation Biology*, *20*(5), 1516-1527.

Madanaguli, A., Dhir, A., Talwar, S., Clauss, T., Kraus, S., & Kaur, P. (2023). Diving into the uncertainties of open innovation: A systematic review of risks to uncover pertinent typologies and unexplored horizons. *Technovation*, 119, 102582.

Mambrini-Doudet, M., Göldel, B., Krzywoszynska, A., & Mcphee, C. (2022). *Deliverable 1.3 AgroEcoLLNet Vision and mission document, ALL-Ready Project Grant Agreement No 101000349*.

Royal Society (2011) *Knowledge, Networks and Nations: Global Scientific Collaboration in the 21st Century*. The Royal Society. The Royal Society.

SCAR (2023). *The Agroecology Partnership's SRIA-The Strategic Research and Innovation Agenda for the candidate European partnership*. Standing Committee on Agriculutural Research, February 2023.

Schwarz, G., Hobeika, M., Stojacic, I., Göldel, B., Canio-Perez, Deliverable 4.1 Report on the added value of the European Network. ALL-Ready Project Grant Agreement No 101000349.

Spierenburg, M. (2012). Getting the message across biodiversity science and policy interfaces–a review. *GAIA-Ecological Perspectives for Science and Society*, *21*(2), 125-134.

Young, J. C., Waylen, K. A., Sarkki, S., Albon, S., Bainbridge, I., Balian, E., et al.. (2014). Improving the science-policy dialogue to meet the challenges of biodiversity conservation: having conversations rather than talking at one-another. *Biodiversity and Conservation*, *23*(2), 387-404.