

Living Labs as a Method of Knowledge Value Transfer in a Natural Area

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Abstract. The Protected areas are clearly defined geographical spaces, recognised as such and dedicated to the long-term conservation of nature, with associated ecosystem services and cultural values. They provide environmental, social and economic benefits to society, which can be enjoyed at local, regional and international levels and support the Sustainable Development Goals (SDGs) [1].

In its first definition, according to the American model, a nature conservation area was understood as a different, exceptional site of uncontaminated nature, where human intervention was almost absent. The local community is excluded from land use because it is considered a threat to the preservation of natural ecosystems.

However, the success of these areas requires better collaboration with indigenous peoples, community groups and private initiatives, which are crucial.

However, these governance models must be participatory, because any conservation and promotion measures are more likely to fail without the education and direct involvement of different social actors.

The term Living Lab was introduced in the early 2000s to describe a user-centred research methodology to detect, validate and refine complex solutions in multiple and evolving real-life contexts. They were recognised as a dynamic multi-stakeholder network, that aims to stimulate and manage user-driven innovation in real-world contexts and to promote the interaction between technological and socio-economic forces.

This scenario allows the following research question to be formulated: "Can Living Labs represent a sustainable participatory model for sharing environmental, social and economic values in a natural area?".

In order to answer this question, a brief outline of the definition of Living Labs and the different approaches used will initially be provided. The methodology to be applied to natural areas for solving the management problems related to the complex heritage that characterise today's natural areas in general will then be illustrated.

Keywords: living labs · protected area · ecosystem services · innovation governance model · resilient rural area

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1 Introduction

The Protected areas are clearly defined geographical spaces, recognised as such and dedicated to the long-term conservation of nature, with associated ecosystem services and cultural values [2]. They provide environmental, social and economic benefits to society [3], which can be enjoyed at local, regional and international levels [4] and support the Sustainable Development Goals (SDGs) [1]. In its first definition, according to the American model, a nature conservation area was understood as a different, exceptional site of uncontaminated nature, where human intervention was almost absent. The local community is excluded from land use because it is considered a threat to the preservation of natural ecosystems [5–7].

However, the success of these areas requires better collaboration with indigenous peoples, community groups and private initiatives, which are crucial [8]. Over the years in Italy, the legislative orientation has changed from a vision of protection to one of protection and sustainable use, with the aim of conserving the natural environment (a path that began with National Law No 394/1991). In recent years, the majority of Italian parks have recorded a strong increase in tourist-recreational use, in accordance with the general expansion in demand for environmental tourism [9]. The increase in visitation (residents, national and international tourists) has induced a deepening crisis within these unique ecosystems, associated with population growth, increased consumption, climate change, increasing dependence on visitor revenue and growing demand for rural outdoor recreation [10].

All this has encouraged the development of a complex decision-making framework, characterised by a marked anthropocentrism and a continuous search for new management solutions and knowledge sharing. Therefore, there are conflicts in the use of a park's environmental resources that must be resolved to achieve environmentally compatible economic development [11]. Through good governance and effective management, the use and conservation of these areas can be ensured to meet the needs of current generations without compromising the possibilities of future generations [12]. However, these governance models must be participatory, because any conservation and promotion measures are more likely to fail without the education and direct involvement of different social actors [13].

Studies on Living Labs have been conducted by researchers for more than a decade [14, 15]. The existing literature addresses Living Labs not only as a topic that offers a wide range of research opportunities for creative scientists, but also as an innovative tool, methodology and design for stakeholders to address multiple challenges and needs in today's world [16]. The Living Lab concept first appeared in the 1990s. The term Living Lab was introduced by Prof. William Mitchell of the Massachusetts Institute of Technology in the early 2000s to describe a user-centred research methodology to detect, validate and refine complex solutions in multiple and evolving real-life contexts [17].

It was only in the 2000s that Living Labs were recognised as a dynamic multi-stakeholder network: a network that aims to stimulate and manage user-driven innovation in real-world contexts [18] and to promote the interaction between technological and socio-economic forces [19] . In Europe, Living Labs became established only in 2006 with the birth of the pan-European network ENoLL (European Network of Living Labs), consisting of 19 European Core Laboratories. ENoLL pursued the goal of addressing Europe's declining economic competitiveness and social challenges [20, 21].

In the following years, several state-level networks were also established e.g. in Belgium, the Netherlands, Spain, Portugal, Slovenia, the UK and also in Italy. Since 2010, ENoLL has opened its borders to non-European Living Labs, effectively becoming an intercontinental network and confirming itself as the largest association of LLs globally. Since their establishment, the Living Labs phenomenon has grown exponentially; in 2007 there were 19 such activities in Europe, while in 2022 the number exceeded 680.

This scenario allows the following research question to be formulated: "Can Living Labs represent a sustainable participatory model for sharing environmental, social and economic values in a natural area?"

Therefore, the main objective of this research is to present a possible approach to place Living Labs in the context of natural areas and to evaluate their possible contribution to their sustainable development. Indeed, the innovative Living Lab environment could be a key element of community and social change, as other experiences have shown, however in different (mainly urban) settings.

In order to answer this question, a brief outline of the definition of Living Labs and the different approaches used will initially be provided. The methodology to be applied to natural areas for solving the management problems related to the complex heritage that characterise today's natural areas in general will then be illustrated.

2 Development of the Living Lab Concept and Main Characteristics

As already mentioned, the Living Lab concept was born in 2000 [22, 23] , with the initial aim of testing new technologies in real-life context, initially familiar contexts.

In the course of their design, the Living Lab contest evolved [24] into an environment [25, 26], as well as a methodology [27–29] and thus, as a system [30].

Living Labs are, therefore, part of the broader category of real-world labs [31], in which other types of experimental approaches such as urban living labs, design labs, city labs, smart city initiatives, innovation hubs, community-based initiatives, social innovation labs and other specific experimental approaches can be found.

It is possible to find, around the concept of the Linving Lab, numerous practical applications as well as different research perspectives. For this reason, there is actually no single definition of Living Lab and several can be listed in the literature. It was deemed important to list some of them (Table 1), which are considered significant to highlight the evolution of the concept.

According to Molinari [37] a Living Lab can be considered as a multi-stakeholder platform "comprising different stakeholders, who perceive the same problem, realize their own respective interdependencies, and come together to agree on the best action strategies for solving it" [38].

Table 1. Main Living Lab definitions in literature (revised by [24]).

	Definition	Source
1.	*Living Lab represents a user-centric research **methodology** for sensing, prototyping, validating and refining complex solutions in multiple and evolving **real-life contexts***	first definition by Mitchell, W., J. Larson, K., and Pentland, A. at the Massachusetts Institute of Technology [23,32]
2.	*A user-driven **open innovation ecosystem** based on a business–citizens– government partnership which enables users to take an active part in the research, development and innovation process*	[33]
3.	*An organized set of **methods** and stakeholders, which focus on user involvement, user-centric research methodology for sensing, prototyping and validating solutions in evolving **real life contexts***	Vinnova (http://www.vinnova.se/sv/EU-internationell-samverkan/Nordiska-program-och-samarbeten/NORIA-net-Living-Labs---Nordiskt-baltiskt-samarbete-inom-IT/)
4.	*Consciously **constructed social environments** in which the uncontrollable dynamics of every day life are accepted as part of the innovation environment which enables designers and users to co-produce new products and services*	[34]
5.	*A user-centric research **methodology** for sensing, prototyping, validating and refining complex solutions in multiple and evolving **real life contexts***	[27]
6.	*Experimentation **environment** in which technology is given shape in **real-life contexts** and in which (end) users are considered co-producers*	[25]
7.	*Functional regions where stakeholders have formed a Public-Private-Partnership (PPP) of firms, public agencies, universities, institutes and people all collaborating for creation, prototyping, validating and testing of new services, products and **systems** in **real-life contexts**. Such contexts are cities, villages, rural areas and industrial plants*	[30]
8.	***Systemic innovation approach** in which all stakeholders in a product, service or application participate directly in the development process*	[35]
9.	***Home-like environment** by ambient intelligence and ubiquitous computing technologies such as wireless and sensor technologies to sense, prototype and validate **complex ICT solutions***	[36]
10.	*A user-centric **innovation milieu** built on every-day practice and research, with **an approach** that facilitates user influence in open and distributed innovation processes engaging all relevant partners in **real-life contexts**, aiming to **create sustainable values***	[24]
11.	*A design **research methodology** aimed at co-creating innovation through the involvement of aware users in **real-life setting***	[29]
12.	*Living Labs are open innovation ecosystems in **real-life environments** using **iterative feedback processes** throughout a **lifecycle approach** of an innovation to create **sustainable impact**. They focus on **co-creation, rapid prototyping & testing** and **scaling-up** innovations & businesses, providing (different types of) **joint-value** to the involved stakeholders. In this context, living labs operate as **intermediaries/orchestrators** among citizens, research organisations, companies and government agencies/levels.*	(https://enoll.org/about-us/what-are-living-labs/)(2023)

The main components of the Living Lab are shown in Fig. 1, which highlights aspects related to the multi-method approach, in which different users and stakeholders co-participate, to co-create ideas, projects, innovative strategies, by the help of Information and Communication Technologies (ICTs).



Fig. 1. Main components of Living Lab (author's elaboration)

The main characteristics recognised for Living Labs are as follows [30]:

- *Continuity:* allows for good collaboration, based on trust, which takes time to develop, but is important for strengthening creativity and innovation.
- *Openness*: is a fundamental principle in the innovation process, as it allows many points of view to be gathered, resulting in rapid progress. The open process allows the user-driven innovation process to be supported, wherever they are.
- *Realism*: it is necessary to create situations of use and behaviour of the specific context as close to reality as possible. The focus on real situations is relevant as it is what distinguishes Living Labs from other types of open co-creation environments (Second Life).
- *User empowerment*: it is important to motivate and empower users to engage in innovation processes, always based on the needs of the users. The efficiency of Living Labs is, in fact, based on the creative power of the user communities and their commitment in pursuing the objectives is crucial.

– *Spontaneity*: the collection of users' spontaneous reactions and ideas over time, as well as their processing and organisation, is very important for innovations to be successful [24].

From a conceptual perspective, today, there are four "types" of Living Labs:

- *Urban & Rural Living Labs*: city or rural area is a site for experimentation co-creation, active user engagement, real-life settings experimentation, multi-stakeholders, multi-method.
- *Research driven Living lab***:** they are research focused; this type of Living Labs are dealing with co-creating models for solving problems.
- *Living testbed:* this type of Living Lab focuses on the development of new technologies. (e.g. House/Farm of the future, Industry 4.0 labs).
- *Living Labs as a service:* this type of Living Labs offers, for SME's and start- ups, tools and methodologies to help them accelerate their innovation funnels.

Most Living Labs present today are, in effect, a combination of the four types described, with one of them becoming predominant.

In the specific context of natural areas, Living Labs could be considered as a tool that integrates local resource utilisation processes and could enhance the strengths for the future development of the areas considered. Thus, Living Labs in natural areas could be considered as an evolution of those created for rural areas, themselves developed by Smart Villages, which represent a model of sustainable villages. Through this model, bottom-up governance approaches can be used and ICTs solutions can be integrated into different services (such as e-health, e-mobility, e-government, e-education, e-commerce, agriculture 4.0, etc.) [39–42], enhancing the area's circular economy and ecosystem services of the natural area.

It is possible to find several examples of Living Labs on the web, in specific platforms (among all, the NEoLL) and also the literature offers a vast review of research carried out on Living Labs. In fact, most of the early initiatives on Living Lab approaches were mainly focused on urban areas. Over time, the Living Lab model adopted in urban areas evolved and was modified to be applicable to rural areas. Living Labs, on the other hand, are of little relevance in territorial areas characterised by natural areas, in any case partly man-made by local communities, where economic activities take place, some based on the use of natural resources and related ecosystem services.

A possible evolution could still enhance this model to be adapted to the realities prevailing in natural area. In particular, a Living Lab model area could contribute to the development of smarter, more inclusive and resilient and sustainable communities present in natural area, through the implementation of nature-based solutions, of projects for the valorisation of ecosystem services and the resources, co-created with and for local communities and stakeholders.

Based on experiences gained in Living Labs, in rural and also urban contexts, where the objective was the co-creation and sharing of sustainable and resilient innovations (CIHEAM Bari Mediterranean Innovation Rural Living Lab, Lunigiana Amica, ARCA LL, UNALAB, just to name a few on Living Labs - European Network of Living Labs [43], it is possible to hypothesise the main components that could characterise a Living

Lab model in natural area. In particular, they could be as follows: Governance, Natural context, Financing and business model, Nature and sustainable solutions, Users, Approach and method; ICTs support (Fig. 2).

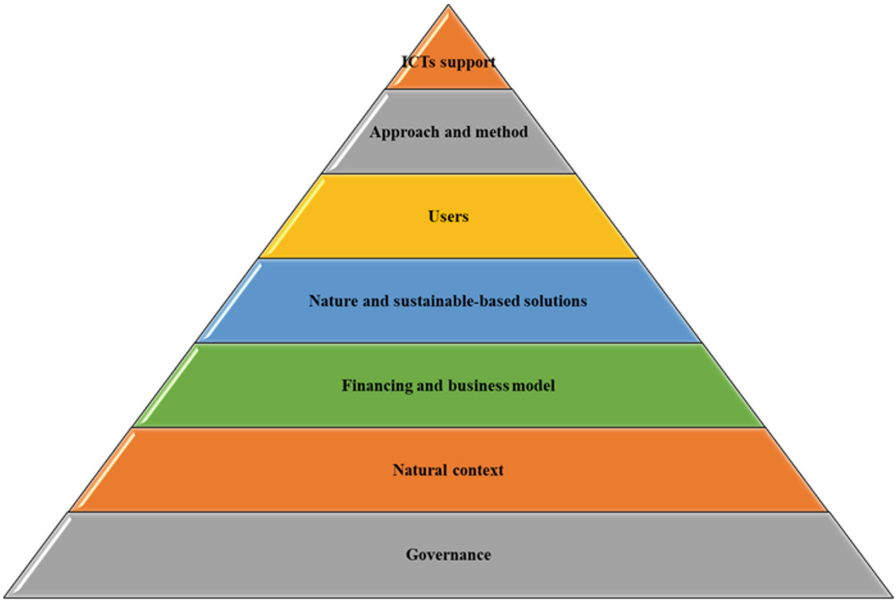

Fig. 2. Main components of Natural Living Lab (author's elaboration on [43]).

In natural areas, the Living Lab should enable the creation of a complex ecosystem, consisting of different actors, who act together to collaborate and co-create solutions to protect natural resources and related ecosystem services, on the one hand, and to develop the economic, social and environmental well-being of local and regional communities, on the other [38, 44].

3 A Possible Living Labs Model for Natural Areas

Globally, it is becoming increasingly important to ensure favorable living conditions and to adopt a sustainable approach in the development of natural areas. However, there are significant challenges to deal with, such as depopulation, lack of access to services and lack of innovation. For this reason, Living Labs are gaining importance as ecosystems built around local and regional needs, new technologies and participatory processes. To pursue the sustainable development goals established in the SDGs, it is important to use multidisciplinary knowledge and consider local contexts in the development process [45]. In this context, Living Labs for natural areas represent a concept that aims to create a holistic ecosystem in which various actors, such as inhabitants, entrepreneurs, policymakers, educators, farmers, and young leaders, work together based on sustainability values. The main purpose of Living Labs in natural areas is not only to maintain and

protect the environment but also to improve the economic, social, and environmental well-being of local and regional communities [44].

The innovation made by Living Labs in the context of natural areas, compared to other participatory approaches, is to focus explicitly on collaboration and involvement of the territory and its actors from the very beginning. In this way, the Living Lab turns out to be a real and virtual research environment, a context in which all actors can actively participate in the innovation process and in which all scenarios generated in the natural area can contribute to build smarter environments. The co-creation approach is essential for the design and implementation of successful products and services, especially when based on ICTs. Furthermore, if users are involved from the very beginning of the innovation process, the chances of developing services that truly meet their needs increase, as they can directly contribute with their opinions, ideas, behavior, and preferences [46].

If the objective of facilitation is to continuously involve all actors, a systematic mapping of those directly and indirectly involved helps to understand the different interests at the different stages and makes it possible to develop strategies to keep them motivated at all stages [47, 48]. It is important to systematically recruit stakeholders, and all interested parties to involve them in the collaborative planning of natural areas. Mapping all stakeholders helps to identify the necessary actors for the different stages around a central group, considering the variable involvement during the process [49].

The establishment of a Living Lab in a natural area could be articulated in several action plans to be implemented within the area, where culture, research and knowledge find a common place with the aim of promoting a sustainable tourism and development model. Within these action plans, it would be desirable to structure activities in environmental, social, economic, climate and landscape terms. In the context of these activities, the actors involved (resident citizens, tourist visitors both local and foreign, stakeholders in general, etc.) become an active part of a knowledge project, together with research organizations and institutions to implement a citizen science-oriented policy. Regarding the environment and landscape, it is planned to open the natural area to all interested parties as a place of culture on topics such as the protection and quality of landscapes, as well as the realization of environmental education programs in a natural setting, on topics such as air and water quality or anthropisation. In social terms, promoting the usability of natural areas is an important issue for the promotion of a healthy and sustainable lifestyle. Therefore, efforts should be directed towards making natural areas accessible in a safe and sustainable manner for all visitors. This can be achieved through the construction of infrastructure such as paths, cycle tracks and parking areas, the installation of information signs and the promotion of cultural and educational activities. Furthermore, it is important to make visitors aware of the need to respect the environment and adopt sustainable behaviour during their visit, such as respecting safety regulations, collecting waste and protecting the local flora and fauna.

The accessibility of natural areas not only promotes a healthy lifestyle, but also contributes to the preservation of biodiversity and ecosystem services and to supporting the economic activities of local communities. From an economic perspective, the tourism development of natural areas through a Living Lab can offer a unique opportunity to combine environmental and social sustainability with economic growth. The involvement of various actors, including residents, tour operators, government agencies,

environmental experts and others, can develop new solutions to promote tourism and enhance the area's natural resources. This can include the implementation of innovative technologies, the creation of ecological tourist routes, the promotion of local products and the organization of cultural and entertainment activities.

The Living Lab model is based on the concept of *Open Innovation*, in which the involvement of the users' community is fundamental, not only as observed subjects, but above all as sources of creation, true "drivers of change". In fact, information is collected directly from users in order to learn, immerse themselves in reality and propose sustainable development models for the natural area.

The Living Lab model proposed for a natural area is articulated in the following phases:

1) co-creation
2) research/exploration
3) experimentation
4) evaluation/monitoring

The Living Lab becomes a real and virtual research environment and, at the same time, an intelligent community in which all actors can actively participate in the innovation process and in which all scenarios of everyday life can be consulted and aimed at the development of innovative, shared services that meet users' needs.

The methodology proposed to implement Living Labs in the context of natural areas provides a barycentric action by the managing authority (park, province, etc.), which acts as a catalyst for the system of information from universities, territorial research centers (CNR, INGV, ISPRA, ecc.), environmental associations, and territorial institutions (municipalities, GAL, etc.). The information system as represented in Fig. 3 provides for the circularity of data and content between the actors involved to foster participation and the creation of sustainable development paths that includes the interaction of actors with different matrixes.

The active involvement of cultural associations in a Living Lab for natural areas is crucial to promote sustainability and conservation of local ecosystems. Collaboration between municipal authorities, local communities, businesses, and industry experts makes it possible to develop innovative solutions to manage natural resources more efficiently and sustainably, preserving the environment for future generations. The active participation of citizens allows for the acquisition of useful feedback to improve natural resource management policies and practices, as well as to promote environmental awareness and education. In this way, the Living Lab becomes a collaborative and inclusive space where the community can share knowledge, experience, and expertise to create shared solutions beneficial for all. The involvement of tour operators in a Living Lab for natural areas is crucial to promote sustainable and responsible tourism. Tour operators can offer their customers unique and authentic travel experiences, which contribute to the conservation of natural areas and the enhancement of the cultural heritage of local communities. The involvement of the Healthcare system in a Living Lab for natural areas is important to ensure the health and safety of visitors and local communities, promoting the physical and mental well-being of people and preserving the beauty and biodiversity of natural areas for future generations. Involvement of pension associations and schools in a Living Lab for natural areas is important to promote environmental education and

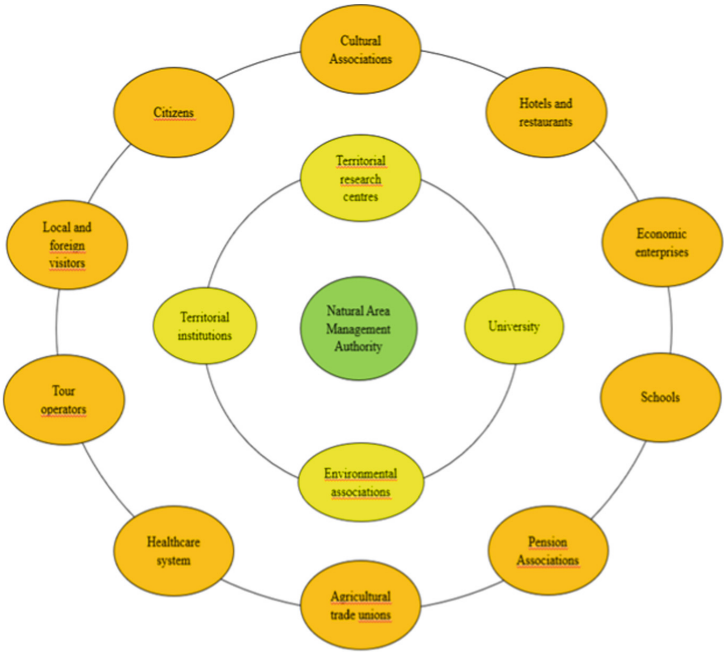

Fig. 3. Living Lab Operational Model Structure for Natural Areas (author's elaboration)

sustainability awareness among different segments of the population. This contributes to the formation of a culture of sustainability and the creation of a more environmentally aware and responsible society. Through the involvement of economic enterprises in a Living Lab for natural areas, it is promoted the development of a sustainable and inclusive local economy that creates job opportunities and value for local communities and preserves natural areas for future generations. The involvement of hotels and restaurants in a Living Lab for natural areas is important to enhance local culture and traditions. In this way, hotels and restaurants can offer their guests authentic and sustainable travel experiences, which contribute to the conservation of natural areas and the enhancement of local traditions.

Furthermore, an important element to consider should be the continuous monitoring and evaluation of the process itself, as Living Labs can fail due to user unsatisfaction or failure to implement innovations. The reasons for these failures often lie in the lack of monitoring and evaluation of the work and readjustment in the early stages [50].

4 Conclusion

Living Labs represent an important opportunity for the sustainable development of natural areas and the communities that inhabit them. Through their collaborative nature, Living Labs can involve all relevant actors and create synergies between them to develop innovative and sustainable solutions to specific problems in these areas. In particular, the focus on active participation of the local community and participatory planning are key

elements in ensuring the success of Living Labs. Indeed, systematic stakeholder mapping helps to understand the different interests in the various phases and enables the development of strategies to keep actors motivated and involved in all phases. Furthermore, the use of multidisciplinary knowledge and the promotion of sustainable development are further elements contributing to the success of Living Labs in wilderness areas.

A Living Lab in natural areas can include a wide range of sustainable solutions, such as the responsible management of natural resources, the promotion of sustainable tourism, the production of renewable energy, the collection and recycling of waste, the creation of sustainable agriculture and the promotion of local products. The testing of these sustainable solutions takes place through the involvement of actors at all stages of the process, from design to experimentation and the evaluation and dissemination of the solutions developed.

Living Labs have proven to be an important avenue to achieve the sustainable development goals set by the SDGs, as they enable knowledge networking between different actors and promote the circular economy and green growth. However, to optimize the benefits of Living Labs in natural areas, it is necessary to maintain a constant commitment to the active participation of the local community and to ensure the involvement of all actors concerned, including those less represented. This is the only way to ensure a sustainable future for natural areas and the communities that inhabit them.

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