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EDITED BY
Feni Agostinho,
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Mc Forelle,
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Leticia Ozawa-Meida,
De Montfort University, United Kingdom

*CORRESPONDENCE
Carolina Innella
carolina.innella@enea.it

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Experimenting urban living lab methodology on circular economy co-design activities in some Italian urban territories

Carolina Innella[1]*, Grazia Barberio[2], Claudia Brunori[3], Francesca Cappellaro[4], Anna Rita Ceddia[3], Rocco Civita[1], Salvatore Dimatteo[5], Marco Ferraris[6], Rocco Pentassuglia[7] and Luigi Sciubba[6]

[1]Support for Coordination of Activities on Circular Economy Section, Department for Sustainability, ENEA-Italian National Agency for New Technologies, Energy and Sustainable Economic Development, Trisaia Research Centre, Rotondella (MT), Italy, [2]Support for Coordination of Activities on Circular Economy Section, Department for Sustainability, ENEA-Italian National Agency for New Technologies, Energy and Sustainable Economic Development, Casaccia Research Centre, Rome, Italy, [3]Department for Sustainability, ENEA-Italian National Agency for New Technologies, Energy and Sustainable Economic Development, Casaccia Research Centre, Rome, Italy, [4]Support for Coordination of Activities on Circular Economy Section, Department for Sustainability, ENEA-Italian National Agency for New Technologies, Energy and Sustainable Economic Development, Bologna Research Centre, Bologna, Italy, [5]Laboratory BioProducts and BioProcesses, ENEA-Italian National Agency for New Technologies, Energy and Sustainable Economic Development, Trisaia Research Centre, Rotondella (MT), Italy, [6]Laboratory Technologies for the Efficient Use and Management of Water and Wastewater, Department for Sustainability, ENEA-Italian National Agency for New Technologies, Energy and Sustainable Economic Development, Bologna Research Centre, Bologna, Italy, [7]Support for Coordination of Activities on Circular Economy Section, Department for Sustainability, ENEA-Italian National Agency for New Technologies, Energy and Sustainable Economic Development, Brindisi Research Centre, Brindisi, Italy

The Urban Living Lab (ULL) is both a methodology and a place where different actors of a territory can collaborate with the aim of urban transformation and sustainable development. This paper briefly introduces a methodological framework, that combines stakeholder engagement and co-design process on Circular Economy (CE) ideas and projects. The structure of the methodological framework foresees four main phases: scouting and analysis of the territorial context, listening and exploration, participation and execution. The main objective of this paper focuses on the application and experimentation of the same ULL methodology framework in four different Italian urban territories (Anguillara Sabazia in the metropolitan area of Rome, Bologna, Taranto and Venosa, a small town in southern Italy), to highlight how the ULL is an effective approach for stakeholder engagement and co-design processes aiming to the transition toward CE. The discussion section of the four ULL cases highlights the main results of the co-design process: the ideation of project proposals of CE activities suitable for implementation in the reference urban territories. The four ULL cases have shown how the same methodological steps can be applied in urban areas with different geographical, territorial and socio-economic characteristics, with comparable results in terms of activating processes of engagement and co-design within the communities living there. In conclusion, experimenting the proposed methodological framework in each of the four urban areas, despite their differing characteristics, it has stimulated the growth of cultural capital and community ties. This was achieved through the exchange of different skills and the collaborative contributions of multidisciplinary teams, resulting in increased collective awareness.

KEYWORDS

urban living lab, circular economy, sharing economy, urban community, co-creation, co-design

1 Introduction

The economist Henry Chesbrough introduced the concept of open innovation in 2003. This strategic and cultural approach enables companies to create more value and compete more effectively in the marketplace by not relying solely on internal ideas and resources, but also on external ideas, solutions, tools, and technological expertise (Chesbrough, 2003). This involves taking innovation beyond the boundaries of research and development labs and exposing it to various influences from businesses, civil society, institutions, and academia (Chesbrough et al., 2006).

The Living Lab (LL) is an operational tool commonly used to create these contaminations. Its concept was first introduced by William J. Mitchell in 2003. Living spaces, such as cities or buildings, can serve as laboratories for generating and testing solutions to problems (Dutilleul et al., 2010). The LL approach was soon adopted in the United States and Europe not only to produce technical innovation but also to promote civic involvement and co-creation (Brask, 2015). In order to enhance the economic competitiveness of Europe, the European Commission established the European Network of Living Labs (ENoLL)[1] in 2006. A comprehensive overview of these activities, their achievements, and Living Lab methodology in general are presented in a dedicated booklet (European Commission 2009). Since its formation in 2006, ENoLL has labeled 440+ Living Labs. Within the LL environment, different stakeholders are involved in the implementation of innovative services, solutions and business models (Schuurman et al., 2011; Leminen et al., 2012; Ballon and Schuurman, 2015; Cappellaro et al., 2018).

The Urban Living Lab (ULL) is similar to the LL, but with a key difference: it requires a physical location in the target area and it is specifically focused on urban sustainability (Steen and Van Bueren, 2017; Menny et al., 2018). ULLs in fact are widely used as experimental forms of governance by which urban actors develop solutions to address various challenges such as sustainability, climate change, energy and transportation systems, social innovation, quality of life, and environmental quality (Bulkeley et al., 2016). The ULL approach is mainly based on multistakeholder involvement, with stakeholders from academia, business community, public sector, and civil society (Delosrios-White et al., 2020). ULLs are often seen not only as "safe spaces" for experimenting with new ideas and projects, but also as a way of enabling collaboration and attracting public support (Marvin et al., 2018). Citizen engagement is a key element of ULL, as they play an important role in the functioning of the lab by providing feedback and being active partners throughout the innovation process, interacting and negotiating with key stakeholders (Nevens et al., 2013).

According to the European Commission's New Circular Economy Action Plan (EU-COM 98 Final, 2020), the transition road toward Circular Economy (CE) is based on a "co-creation" systemic approach, through the cooperation of different actors: public institutions, research, economic actors, citizens and civil organizations. Within this perspective, stakeholders' engagement is the driver of the circular transition (Farmer, 2020). Therefore, the community engagement process is of paramount importance in territorial areas (Suárez-Eiroa et al., 2021).

ULL represents at the same time a methodology and a place in which different actors of a territory can cooperate aiming to the urban transformation (Massari, 2019), addressing sustainable development (Veeckman and Temmermann, 2021; Cuomo, 2022). The implementation of ULL may lead to the formation or consolidation of social ties among citizens and other participants, particularly if an inclusive approach is adopted (Cuomo et al., 2020).

The objective of this paper is to describe the application of the same ULL methodology framework (Innella et al., 2024) highlighting the effectiveness of the ULL both to engage stakeholders and co-design CE project proposals. This is shown through four cases implemented in four different Italian urban territories: Anguillara Sabazia (metropolitan city of Rome), Bologna, Taranto and Venosa (a small town of the Basilicata region, in Southern Italy).

The first three cases above mentioned were carried out in the framework of the RECiProCo project, where the main activities were focused on: (i) mapping of good practices already carried out by consumer associations, (ii) developing labels for products and services with a reduced environmental impact, and (iii) promoting the participatory co-design processes of CE solutions. Participatory activities aimed at involving consumer associations, citizens' associations, and the other target stakeholders, from three pilot Italian cities with different geographical, economic and territorial characteristics: Anguillara Sabazia (metropolitan area of Rome), Bologna and Taranto.

The last case is part of the BHSL project. This project was based on the involvement of about 20 pilot cultural sites, where Heritage Smart Labs (HSLs) were set up. A HSL is a multidisciplinary group of researchers, entrepreneurs, young talents, active citizens, experts and innovators involved to co-create different interventions applied to the conservation, enhancement and use of the tangible and intangible cultural heritage. The HSL named "Basilicata Living Lab" was implemented in the town of Venosa (Basilicata Region, in Southern Italy), with the cooperation of the city government, many local cultural and environmental associations, citizens and some cluster enterprises, aiming to co-design CE activities.

In the following paragraphs, the methodological framework is briefly presented, and each case is described highlighting the implementation of the methodology phases. In the results and discussion section, the analysis and comparison of the four ULL cases is presented.

2 Materials and methods

This section provides the overview on the materials and method included in this paper. The materials considered are both scientific

1 https://enoll.org/

articles and documents related to ULLs, as well as informative material available on dedicated websites. Other materials considered in the work are those related and elaborated for the following research projects:

- RECiProCo project[2] (implementation of circular economy tools and initiatives for consumers) was funded by the former Italian Ministry of Economic Development, now the Ministry of Enterprises and Made in Italy, during the years 2021–2022.
- Basilicata Heritage Smart Lab project[3] (BHSL) was promoted by the Cluster of Cultural and Creative Industries of Basilicata region (southern Italy), funded by the Basilicata Region as part of the Smart Specialization Strategy, Axis I of the PO FESR 2014–2020 – Research, Innovation and Technical Development, during the years (2021–2024).

Project materials include: surveys at a territorial level, interviews (online, in-person or telephone interviews), as well as notes, feedback and observations taken during the implementation phase of the ULLs.

The method used for the paper includes both quantitative and qualitative aspects, as descriptive statistics for surveys, thematic analysis in particular for interviews. Beside the methodological aspects, it was included also an analytical framework for the stakeholder analysis. The implemented ULLs welcomed several participants with diverse experiences and characteristics. In order to present the participants to the ULLs in accordance with the scope of this paper, the classification adopted follows the pentahelix multi-stakeholder framework (Carayannis and Campbell, 2010; Ostrom, 2010; Calzada, 2017). In particular, the framework includes the following classification:

- Academia and research: institutions performing research specialized in producing and disseminating scientific knowledge (research centers, universities, research associations).
- Public: local governments of the pilot areas.
- Private: companies in charge managing collection, recover, recycling and disposal of waste in the pilot areas, companies in charge of managing water and wastewater, companies of cultural and creative industries.
- Civil society: local representatives of national consumer associations, local NGOs advocated for consumer rights, for environmental and/or cultural issues.
- Citizens: activists, social entrepreneurs, innovators of the four pilot cities community.

For the comparative analysis presented in the dedicated section, the considered and compared items regarding the ULL results are the following: (a) Critical issue(s) detected in the context analysis; (b) Solution(s) identified by participants; (c) Cooperation needs for the implementation. These three aspects support the detection of the link from the phases of the ULL in term of needs mapped and identified at local level, the solution elaborated and the channel of cooperation for a possible further development of participant proposals.

For what concern the ULL methodology, since there is not in the literature a universal ULL methodology devoted to stakeholder engagement aiming to a co-design process on Circular Economy (CE) ideas and projects, the authors developed an *ad hoc* ULL methodological approach, described in detail and step by step (Innella et al., 2024) to carry out the stakeholder engagement and the co-design activities. In addition to the RECiProCo and BHSL projects mentioned above, the methodology also refers to another research project carried out by ENEA researchers, the Biocircularcities[4] project.

The above ULL methodology framework is structured into the following four main phases, and briefly synthesized as follows:

1 Scouting phase and analysis of the territorial context: studying of the territorial area, based on bibliographic and web sites sources, in order to have a comprehensive picture of its geographic, economic and social aspects, and mapping of the potential target stakeholders.
2 Listening and exploration phase: the target stakeholders are then invited to participate in the launch event (in presence, hybrid or online) of the ULL, during which the ULL's path, objectives and timetable are presented. More specifically, the launch event was organized online in the case of Anguillara Sabazia, Bologna and Taranto, and it was organized in presence in the case of Venosa. Since it is necessary to get the stakeholders' point of view about the needs of the investigated territory and the CE pathways to be implemented, an *ad hoc* survey is also presented during the launch event. Target stakeholders are invited to fill it in during the event itself, or at a later stage online (by using the link or the QR-code). The survey is distributed to both the target stakeholders and online through social channels to reach other participants in the specific urban area. The survey includes a declaration of commitment to follow the subsequent ULL four meetings, forming a group of about 20 to 30 people. Based on the survey results, a detailed program for the next two phases can be prepared.
3 Participation phase: this step involves two meetings focused on capacity building and cross-fertilization of the participants. During these meetings, focused on the themes that emerged from the survey, the participants discuss the needs and engage in a co-ideation process to develop possible CE ideas suitable for implementation in the investigated territory. The brainstorming process results in a list of possible ideas, albeit at an embryonic level. The co-design process in the subsequent phase of the ULL involves developing ideas that may become project proposals. This process takes place during the next two meetings, which represent the execution phase.
4 Execution phase: this step involves two meetings where participants co-design a CE project or projects for the reference urban area. The aim is to bring up the most significant ideas generated in the previous meetings and use the world café facilitation methodology (Gurteen, 2008) to co-design the output. A final event could be held to share the results of the ULL with the community. Participants would present the

2 https://www.reciproco.enea.it/

3 https://www.heritagesmartlab.it/smartlab/home

4 https://biocircularcities.eu/

pathway taken and the project ideas that emerged from it to authorities, citizens, companies and other stakeholders of the territory.

In the following section, the presentation of the four Italian cases is provided, and includes the elements provided above.

3 Urban living labs on circular economy

As part of the activities of the research projects RECiProCo and Basilicata Heritage Smart Lab, four ULLs on CE co-design were implemented by the authors in four different Italian urban territories: Anguillara Sabazia (in the metropolitan city of Rome), Bologna, Taranto and Venosa, a small town in the Basilicata region of Italy.

Following the pentahelix stakeholder framework, in Table 1 is reported, in an aggregate form, the number of mapped stakeholders, the number of responses to the survey and the number of participants for each ULL case, coordinated and implemented by the ENEA researchers (about six for each ULL), Obviously, the ENEA researchers have not been included in the number of stakeholders listed in the following table.

3.1 Urban living lab Anguillara Sabazia

1 Scouting phase and analysis of the territorial context: Anguillara Sabazia is a municipality of 19,145 inhabitants (ISTAT, 2023a) in the metropolitan area of Rome. It is a territory enriched by protected area, Parks and two lakes, Lake Bracciano and Lake Martignano. Presence of human settlements dates to the Neolithic period and through the centuries local cultural heritage was developed and still present nowadays. Currently, diverse economic activities take place in area, as food production, animal breeding, handcraft and, tourism, which is the driving one of local economy, due to highly attractive force of Bracciano Lake.

2 Listening and exploration phase: after the mapping phase, when the research team detected 31 stakeholders according to the quintuple helix approach (Table 1), an online survey was launched. Thanks to the 188 responses to the survey held in the exploration phase, it emerged how residents were aware of alternative paradigms importance, while also showing the need on specific CE topics, as shown in the Figure 1.

3 Participation phase: in the Anguillara Sabazia area, the ULL four meetings were attended by 29 participants (Table 1). They were both citizens, members of local associations, contact person for consumers association and members (or former members) of local public administration, local public services as well as employed in the private sector. The main themes explored during the participation phase by the ENEA researchers and the ULL participants were:

- Introduction to circular economy
- Sustainable tourism
- Sustainable agriculture, European policies and the role of innovation in the agri-food sector
- Agribusiness, healthy, safe and sustainable food products
- Sharing economy, Green in the city
- Sustainable consumption

The lively interest and growing participation, as well as the deep rootedness in the territory and the desire for innovation, led to the drafting of four project proposals.

4 Execution phase: the ULL has led to the co-design of four project proposal, described below.

- Nothing is thrown away!

After considering the increase of waste in the area (both from the data of the National Waste Registry[5] and from direct observation from the participants during voluntary activities, that noticed the increase in waste in the areas), the lack of information on waste treatment (the type of waste considered is primarily urban waste), and the absence of services promoting reuse, repair, and regeneration of electronics and electric objects, a group of participants proposed setting up a repair laboratory in a spare building in Anguillara Sabazia. The proposal aims to encourage waste reduction and take advantage of the competences and interests of the residents in repair activities. The proposal's social value was important to the group, as repairing activities that involve socialization are seen as a positive dynamic among locals. This recalls familiar ways of passing experiences from one generation to the next.

- L.A.G.O. Project (places, agriculture, green economy, hospitality)

During the co-creation process, participants identified the need to preserve the distinctive features of local traditions as a necessary step toward reinterpreting them in the light of inclusive and sustainable development. There was particular interest in wool waste from sheep farmers and other waste from agricultural activities in the area. Participants noted that both had negative visual and environmental impacts, and waste treatment actions (in particular materials and waste deriving from agricultural and breeding, above all wood for this latter) were targeted as a behavior to be changed. Developing a network of local entrepreneurs who adopt sustainable business practices can integrate and enrich the synergies of local entrepreneurs in the Lazio region. This can also foster economic advantages by connecting with other regional networks and districts.

- GiroLago - the slow tour of lake Bracciano

As tourism is crucial for the local economy, participants suggested actions to promote alternative ways for visitors and tourists to experience the area surrounding the Lakes. The complex nature of challenges ahead, as the lack of a common service and sharing offers, the definition of a safety plan, difficulties in obtaining authorisations and the organization of the road network and parking areas, and the fragmented visions, prevented the elaboration of an inclusive and coordinated solution between different institutional entities, local economic and social actors. The proposal includes several activities to address the need for a formal agreement to develop a framework for tourist services in inter-municipal areas. It also addresses the need for

5 https://www.catasto-rifiuti.isprambiente.it/index.php?pg=mDetComune&aa=2022&regidb=12&nomereg=Lazio&providb=058&nomeprov=Roma&regid=12058005&nomecom=Anguillara%20Sabazia&cerca=cerca&&p=1

TABLE 1 Participants of the four ULLs.

Stakeholders classification	Number of mapped stakeholders	Number of responses to the survey*	Number of stakeholders -number of persons participated in the ULL
ULL Anguillara Sabazia			
Academia and Research	1	3	1–1
Public	12	50	2–3
Private	4	59	1–1
Civil society	14	61	8–9
Citizens	0	15	15
Total	31	188**	29 persons
ULL Bologna			
Academia and Research	1	2	1–2
Public	1	2	1–1
Private	1	1	1–1
Civil society	20	13	3–3
Citizens	0	90	15
Total	23	108**	22 persons
ULL Taranto			
Academia and Research	2	2	1–2
Public	2	3	2–2
Private	7	3	3–3
Civil society	18	54	8–15
Citizens	0	8	3
Total	29	70**	25 persons
ULL Venosa			
Academia and Research	2	2	1–2
Public	1	2	1–1
Private	3	5	2–2
Civil society	9	11	5–10
Citizens	0	5	4
Total	15	25	19 persons

*The number of survey responses may be higher than the number of mapped target stakeholders and the number of participants in the ULL, because the survey was openly shared, hence more people could respond for each stakeholder typology.
(**) This value (in the case of Anguillara Sabazia, Bologna and Taranto) reflects the fact that several respondents (about 10% of the total respondents) qualified themselves as part of more than one type of stakeholder, as they belonged to both professional fields and social organizations at the time of the survey. For this reason, the total number of responses is higher than the actual number of respondents, because the survey allowed respondents to qualify themselves by selecting more than one option. In the case of Venosa instead the survey allowed respondents to qualify themselves by selecting only one option.

training local actors on circular and sustainable tourism. Participants identified as a result of their proposal a single organizational approach that would allow to make available and public the different and existing connections for the achievement of improving the local trails and itineraries around the Lake.

- Anguillara in social - sustainable tour

The aim of this project proposal is to develop communication activities that promote sustainable and circular approaches adopted by associations, restaurants, and hotel services. The participants identified the recovery of a display located near the Tourist Information Point and the dissemination of circularity practices in the Anguillara Sabazia area, including on digital platforms, as necessary steps. The proposal includes a feedback mechanism for tourists and residents to share comments and suggestions on local services, with the aim of improving them.

3.2 Urban living lab Bologna

1 Scouting phase and analysis of the territorial context: Bologna is an Italian city with 389,850 inhabitants (ISTAT, 2023b). The decision to implement an ULL in Bologna, focused on water conservation and its circular approach, was based on the city's strong historical and cultural connection to water, as well as its geographical location. In this case, in fact, among the topics regarding CE, the issue of water management was established

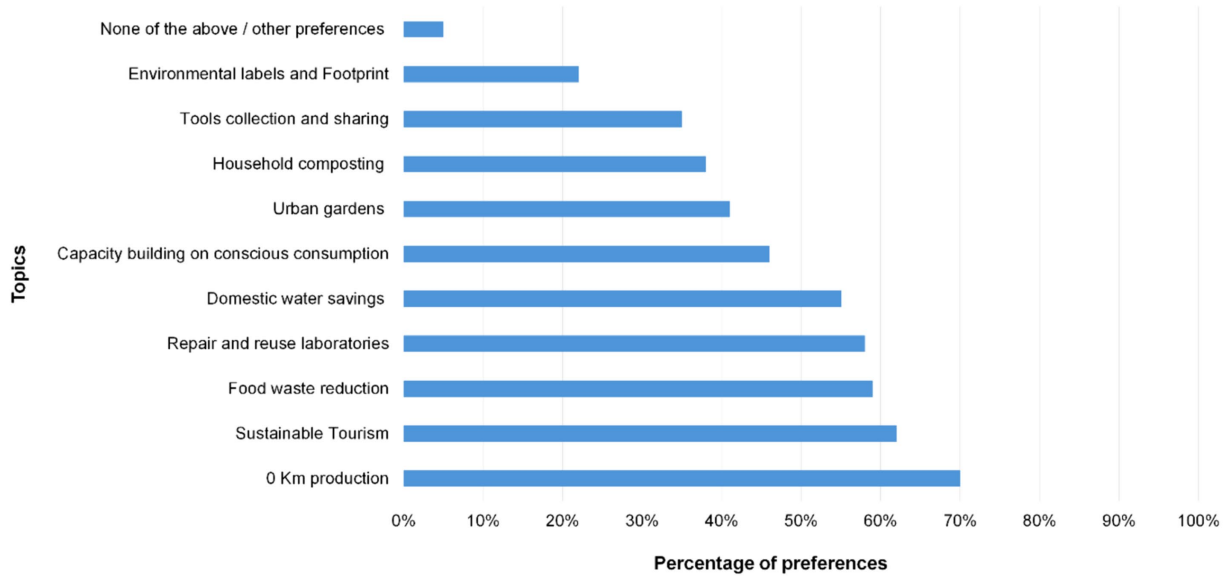

FIGURE 1
Preferences on circularity needs in Anguillara Sabazia.

before the beginning of the ULL path, to try a preliminary addressing of the possible topics related to the peculiarity of the Bologna territory and valorising the skills and previous findings of the ENEA Bologna researchers, directly involved in the project. Although one of the main issues regarding water circularity is constituted by water leakage in public infrastructures, the approach of water saving by citizens should be really interesting as it is a form of consumption that could be directly managed by the same citizens; moreover, the utilization of a lower water amount could reduce the hydraulic stress of piping and consequently improve its efficiency thus lowering the leakage percentage. Bologna has a network of artificial canals, constructed in the 12th century for production, energy, and transportation purposes, which were instrumental in the city's growth and development. This ancient cultural foundation is now complemented by a vast network of associations focused on environmental and socio-cultural sustainability. To prepare for engagement, a thorough analysis of the territory and stakeholder mapping was conducted. 23 target local stakeholders were mapped (Table 1).

2 Listening and exploration phase: the listening/exploration phase consisted in a survey on water issue, aiming to analyse the needs of the citizens and the other stakeholders on the issues of water saving, valorisation and recycling of water in order to: (i) obtain information regarding the consumer habits in relation to the topic of domestic management of water resources and (ii) identify further topics for the planning of expert interventions during the other ULL phases. A total of 108 answers was collected, whose results are in Figure 2.

3 Participation phase: the ULL in Bologna was attended by about 22 participants, mostly citizens in non-associated form. The ULL meetings favored the dissemination and sharing of information, ideas and reflections on a very important and topical issue such as the sustainable management of water resources. The meetings made it possible to involve people who approach the water issue from different points of view, such as citizens, authorities (i.e., authorities of the water sector, as the local multiutility company responsible of water, light and gas providing, the regional agency for water and waste services and the Bologna municipality), researchers, testifying to the transversality of the issue.

The main themes explored during the participation phase by the ENEA researchers and the ULL participants were:

- The issue of water scarcity
- Sustainable water management in our houses
- Circular management of wastewater
- Approach to circular economy
- Approach to responsible consumption
- Circular management of rainwater and greywater

4 Execution phase: the co-design process of the ULL path led to the elaboration of three proposals, belonging to the two different topics of "requests to the water in-charge authorities" and "education and awareness about water."

- The water transparency

This proposal project addressed the issue of water losses in supply networks. In Italy, this amount is estimated at about 40% of the total volume (ISTAT, 2023b, statistics of water), often due to the obsolescence and inadequacy of the network. The consequences of this low distribution efficiency have been discussed in the ULL meetings, which deal with important economic and environmental issues, together with an increase in water tariffs for citizens. The proposal that emerged from this discussion was the idea of bringing this issue to the attention of the local authorities responsible

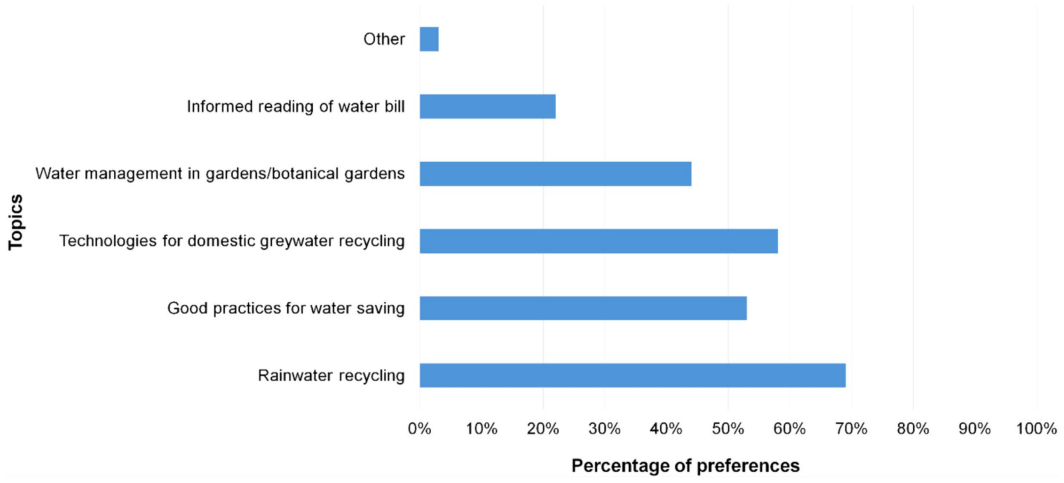

FIGURE 2
Preferences on circularity needs in Bologna.

(municipalities and institutions managing integrated water services), with the aim of requesting greater clarity in the information provided to citizens and greater awareness for the benefit of consumers. In particular, the authorities were asked to improve the monitoring of losses in the water supply network and to quantify and include them in water tariffs. Greater clarity of information on water losses could encourage consumers to save water, thus preserving the conditions of the water supply network and obtaining lower charges as a result. Finally, a virtuous water cycle could be encouraged, contributing to the environmental sustainability of cities. This proposal was the subject of a follow-up meeting with the Municipality of Bologna, where members of the city administration and water authorities discussed these issues with the researchers and representatives of consumer associations.

- Water houses on Wikipedia

It was linked to the theme of "water education and awareness." The idea arose from an analysis of the small number of Wikipedia pages dedicated to these public water points compared to other articles on water issues. Therefore, a special focus group of participants was created within the ULL with the aim of updating and completing this Wikipedia page, adding data on the distribution, number and type of water houses (i.e., public stations for water distribution for citizens, available in many Italian and European cities) in the Italian territory, also in relation to other European countries. In the new page, further information has been added to underline the benefits of these public water distribution points for people. For example, a greater use of water houses could lead to a reduction in the use of plastic bottles and the associated transport problems, with consequent environmental benefits. The updated item is available at the following URL: https://it.wikipedia.org/wiki/Casa_dell%27acqua.

- Water: a limited and precious resource

The theme was "Education and awareness on water." In particular, the idea was based on the fact that the topic of sustainable water management is not sufficiently known among young people and is not fully explored in compulsory education in Italy. Increasing the dissemination of water saving and recycling among students could increase the knowledge and awareness of young people and their families, contributing to their education as responsible citizens. Therefore, this proposal aimed to identify contents for lessons, meetings and seminars dedicated to students of different ages and classes on water topics. Examples of topics identified were water management, the indirect water footprint linked to the production of food and clothing, the CE in general, and consumer lifestyles to be adopted for more responsible behavior. The focus group also suggested that such lessons could be given by researchers or teachers (there were teachers and members of two technical secondary schools of Bologna among the citizens participants of the ULL), using also the hours dedicated to the subject of civic education, which in Italian schools for some years has also been dedicated to environmental issues, adapting the topics to the specificities of the different territories, thus supporting networking and collaboration between researchers, schools and municipalities. Finally, CE education applied to water resources could itself be part of the CE strategy for Bologna and other cities.

3.3 Urban living lab Taranto

1 Scouting phase and analysis of the territorial context: Taranto is an Italian city with a population of 198,283 inhabitants (ISTAT, 2023a), located in the Apulia region. The strategic geographical position and the specific morphological conformation have made the port of Taranto an important commercial and industrial reality, as well as home to an arsenal of the Italian Navy. Taranto is also known for its great industrial importance, especially for the steel industry, as it is home to ILVA, the largest steel mill in Europe. 29 Target stakeholders have been here mapped.
2 Listening and exploration phase: in the listening/exploration phase, in order to identify the circularity needs of the city of

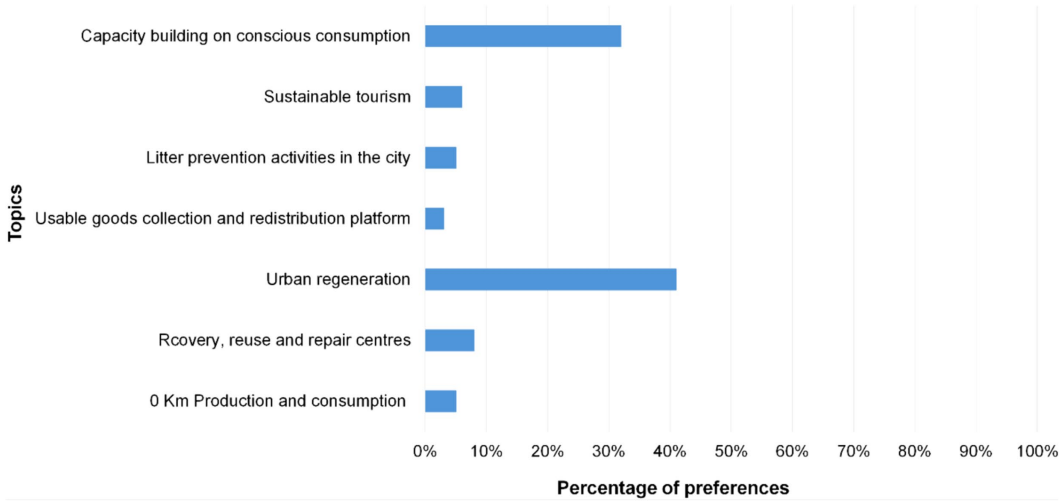

FIGURE 3
Preferences on circularity needs in Taranto.

Taranto, a survey was distributed among the target stakeholders and the urban community. The results emerged from the 70 answers to the survey are presented in Figure 3.

3 Participation phase: following the scouting and listening/exploration phase, four ULL meetings were held. In the Taranto area, about 25 participants, mostly representatives of environmental and socio-cultural associations took part in the ULL meetings, as the sensitivity and tendency toward associations is particularly strong in this town.

The main themes explored during the participation phase by the ENEA researchers and the ULL participants:

- Transition from linear to circular economy
- Good practice in the circular economy of urban communities
- Shared gardens: entrusting urban spaces to citizens' associations
- Collaboration pacts between public administrations and private entities for the care of common goods
- Presentation of "The circular consumption chart"[6] elaborated by the National Italian Consumer Associations

4 Execution phase: the co-design process led to the development of three project proposals listed below.

- We are at the fruit

The "We are at the Fruit" project proposal involves the collection of fresh fruit left in the fields because it is not economically viable for the producers, which would otherwise go to waste, and its distribution to families in difficulty or to canteens for the less well-off, with the involvement of volunteers and citizens. To implement the project, the first step is to establish direct relations with local producers and sign agreements with them. Then, awareness-raising initiatives will be launched to activate a nucleus of associations, citizens and students who can support the logistical and organizational activities.

- A garden in the history

The aim of this project proposal is to restore a section of the Greek Walls Park in the city. The archeological site is located within a large urban green space that is currently not maintained, guarded or enhanced. The aim is to enhance the value of the site by increasing its usability through the maintenance of the green space. This will promote socialization between residents and local associations, as well as improving the cultural accessibility of the site for audience development. In the first phase of the intervention project, a cooperation pact will be activated with the town council, in accordance with the "Regulation on cooperation between citizens and the administration for the maintenance and regeneration of urban spaces." This will define a group of active citizens who will commit themselves to the implementation of the intervention. The pact will define the specific modalities for the regeneration of the green spaces and their joint management with the city administration, as well as the financial resources available for the reimbursement of the costs incurred. This project is aimed at the CE, as it is an activity of urban regeneration, because the shared gardens increase the green surface and the absorption of CO2, while the cultivated urban areas increase the production of zero km, contributing to the process of resources efficiency.

- Re-help café

This project aims to provide not only a Repair Café but also a space where social interaction is maximized through the sharing of tools and skills. The project requires ample space for several services, including: (i) sharing of recyclable goods; (ii) sharing of durable goods; (iii) a repair space equipped with specific tools and equipment for simple work that can be done on site and does not require special attention to safety; and (iv) recreational space.

6 https://www.confconsumatori.it/wp-content/uploads/2021/06/Carta-del-consumo-circolare_8_1_2021.pdf

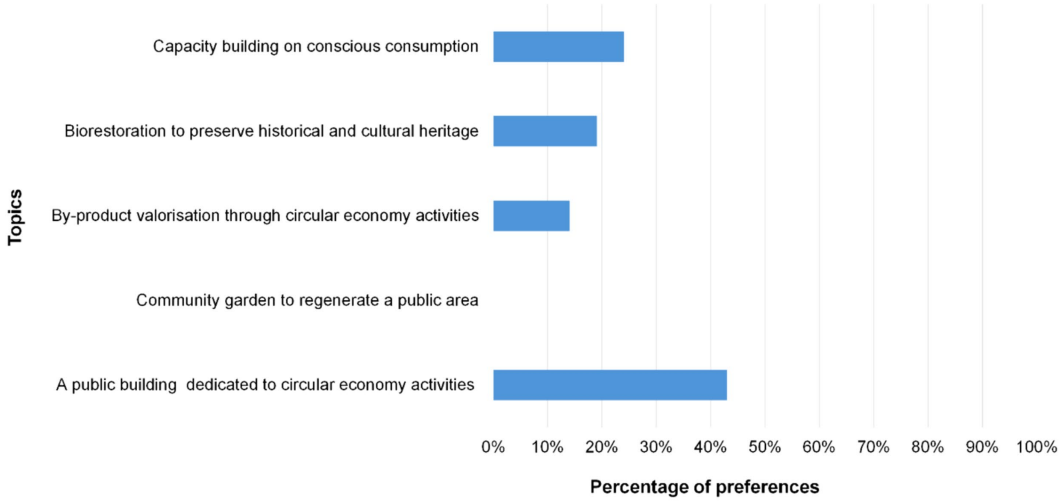

FIGURE 4
Preferences on circularity needs in Venosa.

3.4 Urban living lab Venosa

1 Scouting phase and analysis of the territorial context: Venosa is a town in the Basilicata region of southern Italy with a population of 10,807 according to ISTAT (2023a). Venosa is known for its rich historical, cultural and culinary heritage. Venosa is also known as the "Horatian city" due to its association with the birthplace of the Latin poet Quintus Horatius Flaccus. It is also one of the municipalities included in the list of "Italy's most beautiful villages"[7]. This case was carried out in the context of cultural and creative industries, so the target stakeholders were mainly cultural and environmental associations and companies. The ULL path in Venosa was set up in close cooperation with the municipality, facilitating connections between the researchers and the local stakeholders, particularly cultural and environmental associations. The target mapped stakeholders were 15 (Table 1).

2 Listening and exploration phase: the survey revealed 25 respondents and emphasized the need for a public building to be dedicated for CE activities, as illustrated in Figure 4.

3 Participation phase: the ULL was attended by 17 participants. The ULL assumed that the city council would have a public space dedicated to the co-creation of new forms of culture, awareness and sociability, through the implementation of various CE activities related to educational processes, awareness and cultural growth, as well as inclusivity and new forms of sociability and sharing.

The main themes explored during the participation phase by the ENEA researchers and the ULL participants:

- Transition from linear to circular economy
- Many examples and good practice from the Circular Cities Declaration Report 2022[8]
- Efficient use of food resources
- Examples from all over the world linking circular economy to art and creativity
- Efficient use of water resources
- Biorestoration for cultural heritage

The ULL participation phase started with the following question: "In the hypothesis of having at your disposal a public building for CE activities aimed at raising awareness and knowledge in the community of Venosa, what would be your/your association/company proposals?"

4 Execution phase: at the beginning of the co-design process, two proposals were considered and then merged into a single proposal called:

- Forge in circle - ideas and activities on circular economy.

The proposed ideas and activities are (i) organizing seminars on CE and sustainability for the local community; (ii) implementing knowledge-based activities for the participants to run creative recycling courses for different age groups and for disabled or disadvantaged sections of the community; (iii) valorising the intangible cultural heritage of the area (e.g., old recipe using local ingredients); (iv) organizing information and training sessions to create an energy community; (v) setting up a platform to facilitate the exchange of second-hand goods; (vi) creating a time bank available to the community; (vii) creating a book-crossing house to be installed in an iconic place in the city; (viii) organizing photo and art exhibitions focusing on the CE. The next step is to identify, in cooperation with the municipality, the public space suitable for the project and to draw up a cooperation agreement for

7 https://borghipiubelliditalia.it/en/borgo/venosa/

8 https://circularcitiesdeclaration.eu/fileadmin/user_upload/CCD-Report-2022.pdf

public-private joint management of the space. They will also look for public and crowdfunding funding opportunities to support the project.

4 Comparative analysis and discussion of the four ULL cases

The activities described in the four above ULL cases have shown how the same methodological steps can be applied in urban areas with different geographical, territorial and socio-economic characteristics, with comparable results in terms of activating processes of engagement and co-design within the communities living there. A summary of the four cases and their 11 CE-related project proposals is given in Table 2, in which the solutions identified and co-designed by the ULLs participants are also accompanied by the information on the cooperation of the actors needed for the implementation.

These results showed that each methodological phase contributed to improving the engagement and the co-design processes, as described below, and in each case.

1 The scouting phase and the analysis of the territorial context resulted in a comprehensive picture of the urban area from a territorial point of view and in a map of the target stakeholders.
2 The listening and exploration phase was based on a survey distributed and diffused among the target stakeholders and the urban community, resulting in the identification of the circularity needs within the local community.
3 The participation phase led to the integration, with all the stakeholders participating in the ULL, of citizens' opinions perceptions, habits and ideas into the knowledge and project framework considered fundamental for the benefit of the communities.
4 The execution phase resulted in the co-design of several project proposals in line with the characteristics of the territory. The proposals focused on sustainable development activities and CE models, such as sustainable tourism (GIRO LAGO, L.A.G.O, Anguillara in Social Tour), sharing economy models (Nothing is thrown away!, Re-Help Cafè), urban regeneration (We are at the fruit, A garden in history), efficient management of water networks (The water transparency), education and awareness raising (Water houses in Wikipedia, Water: a limited and precious resource) and cultural growth processes (Forge in Circle-Ideas and activities on CE).

In addition to the contributions mentioned in the previous paragraph, other considerations emerged from the evidences of the four ULL cases. The considerations are presented in detail below.

4.1 Factor of attractiveness toward ULLs

4.1.1 Tailored activities and learning experience components

ULLs result to be attractive for participants due tailored activities developed after an active listening phase and due to the "learning experience" component included by design. What emerged from direct observations and informal colloquium with participants in the ULLs is that regardless from the typology of participants they are classified with, their participation was moved *inter alia* by the desire of understanding the innovative aspects emerging from circular paradigm. This element is evident in general for all actors of the quintuple helix.

4.1.2 Connection with structural dynamics

As in other fields, (Johnson et al., 2020) it is acknowledged that the transition to alternative paradigm does not automatically lead toward fairer or just changes. Hence, ULLs as a practice to promote circular solutions in order to solve also structural issues needs to be further explored in this direction. Nevertheless, it has been noted how the ULLs represented a starting point for participants to become familiar with the notion of practices of alternative paradigm as circularity, especially in small-scale urban context or urban context experience characterized by both infrastructural divide and environmental issues.

4.2 Citizens' presence and demographic characteristics of the participants

The presence of non-associated citizens in the ULLs allow to raise some considerations, in the first place due to the fact that presence registered of citizens overcome the detection undertaken during the mapping phase. On the one hand, it suggests to furtherly explore dynamics occurring during the mapping and the exploration phase. On the others, it suggests that citizens who were willing to participate found in the ULL an open window to undertake interactions and take part in social exchange in different settings, with respect to those already experienced by the participants, e.g., associations meeting or other local social events.

Furthermore, age and gender of the participants characterize the experience of the implementation phase. Adults and women took part in the meetings and participated in the formulation of proposals, especially in the ULL of Taranto and Venosa.

4.3 Self-perception and social characterisations of participants

During the meetings, it has been observed how participants generally have been adopting the connotation – or role -of "citizen" to characterize themself and their presence in the ULLs, even in case in which they have confirmed their role as members of academia, local administrations, associations or private sector. This aspect is interesting both on its own as when interpreted in conjunction with the other two elements mentioned above. It suggests posing the attention to the alternance of roles in intrapersonal and interpersonal situations of learning processing, while there is opportunity to explore how ULLs address broader questions on the connotation, intertwining and differences that exist between the role of users, consumers and citizens (Aberbach and Christensen, 2005; Verhees and Verbong, 2015) at the local level.

Feedback was asked after each meeting and in each ULL to every participant, through an online form to collect them.

Moreover, individual interviews were undertaken in person or online with participants that agreed on sharing more on their experience in the ULL. The results allowed to find out that without the

TABLE 2 Summary of the results of the four ULL cases.

ULL	Name of the proposal	Critical issue(s) detected in the context analysis	Solution(s) identified by participants	Cooperation needs for the implementation
Anguillara Sabazia	Nothing is thrown away!	Presence of waste; locked potential of repair skills and willingness to learn; lack of repair services.	Repair laboratory in a spare space in Anguillara Sabazia.	Local municipalities (as Environment related Departments; Welfare – social support Services); Research organization (ENEA); Trade organization; Higher Technical Education institutes; Entrepreneurs, non-governmental organization; citizens.
	L.A.G.O. Project (Places, Agriculture, Green economy, Hospitality)	Lack of care in waste management by local entrepreneurs.	Branding sustainable business practices to unlock local economic potentials and promote CE behaviors. Intercept waste to be recycled or by-product.	Networks of citizens; institutions; enterprises; research centers; universities; trade associations; local groups for solidarity purchase; economic actors and entities for tourism promotion; park authorities.
	GiroLago -the slow tour of Lake Bracciano	Tourism impact on environment, lack of a common service and sharing offers, bureaucracy and the fragmented visions among local actors.	Develop and formalize local agreement for touristic services (e.g., sharing) in inter-municipal areas; training local actors on circular and sustainable tourism	Lake navigation Consortium; park authorities; institutions of the lakeshore municipalities (Anguillara, Bracciano, Trevignano, Rome); Citizens' associations; Experts from various sectors and Research Center experts.
	Anguillara in Social -Sustainable Tour	Difficulties in gathering information about sustainable and circular practices to foster alternatives to high multi-dimensional impact tourism.	Recover existing information totems, develop a digital platform to communicate and disseminate circular and sustainable services and products	Local public authorities; Research Centers; Park Authority; Local Association; European Institutions.
Bologna	The water transparency	Water losses in supply networks. Lack of information toward citizens in water bills	Request to the authorities to have more information about water management and losses	Local municipalities; water supply multiutilities; public authorities.
	Water houses on Wikipedia	Scarcity of information about water houses in the online encyclopedia	Upgrade of the Wikipedia page on water houses, by studying of reports and documents	Local authorities in providing data and information about water houses.
	Water: a limited and precious resource	Low level of information about water management in education paths	Proposal of lessons and seminars, by researchers and experts, in schools, about water management	Local municipalities; consumer associations; primary and secondary schools.
Taranto	We are at the Fruit	Fighting food waste and poverty.	The Solidarity Emporium expanded to collect, store and distribute fresh products.	Chamber of Commerce; agricultural producer associations; local farms; other voluntary associations.
	A garden in the history	Recovery of the city's historical and archeological heritage.	Co-operation agreement with the local council for urban regeneration and the creation of a community garden.	Social promotion associations; Municipality of Taranto; voluntary associations; universities, primary and secondary schools.
	Re-Help Café	Reducing the waste of usable goods and social cohesion in response to intangible needs.	Repair Café to share tools and/or equipment that can be used to repair various objects and to share skills.	Municipality of Taranto; network *Repair Café*; other voluntary associations; sponsoring companies.
Venosa	Forge in Circle-Ideas and activities on circular economy	Lack of public buildings dedicated to CE activities in the cultural and creative supply chain in order to generate new forms of sociality and territorial development.	To have a public space where CE activities can take place, of different nature but all linked to educational and cultural growth processes	Municipality of Venosa; voluntary associations; universities, research bodies (ENEA); creative recycling experts; primary and secondary schools; experts of local customs and traditions; sponsoring companies.

10.3389/frsc.2024.1406834

ULL, participants would not have had the opportunity to participate in alternative paradigm initiatives. However, it was found that participants tended to consolidate relationships within the ULLs rather than both inside and outside the initiative, suggesting that more attention has to be dedicated to unlock relational resources to increase and consolidate alliances and cooperation.

5 Conclusion

This paper aimed to apply an *ad hoc* ULL methodological framework, dedicated to the implementation of stakeholder engagement and co-design of CE ideas and project proposals at the urban level. The methodological phases, implemented in the four Italian urban territories, allowed the co-design of a set of CE project proposals suitable for implementation in each local context, highlighting the effectiveness of the ULL methodology.

The ULL methodological framework tested in four urban areas with many different characteristics also demonstrates its great flexibility and adaptability to any urban context. The implementation of the proposed methodological approach in each of the four urban areas, albeit in territories with different characteristics, has helped to stimulate the growth of cultural capital and community ties through the contamination of different skills and the choral nature of multidisciplinary contributions.

It can be seen how the implementation of ULLs has led to an increase in individual and collective awareness, which is a key prerequisite for a paradigm shift toward the implementation of innovative CE projects through collaborative teamwork in a win-win logic. As ULLs practices can lead to different trajectories and outcomes, research is needed to analyse and discuss the factors and social dynamics that influence the implementation of ULLs and their impact on the CE transition.

However, research on ULLs would benefit from a broader discussion on contextual and operational aspects that influence the living lab experience, such as those identified by Hossain et al. (2019), *viz.*: "*Temporality, governance, unanticipated outcomes, efficiency, recruitment of user group(s), and sustainability and scalability of their innovation activities*." (Hossain et al., 2019, p. 983).

Furthermore, in line with other research (Cuomo et al., 2020; Cuomo, 2022), the present paper suggests that the future perspective of the study should also be oriented toward studying the links between ULLs, outcomes and impacts on both individual and social levels, and comparing them with other initiatives or methods. Regarding the promotion of civic participation and engagement in CE transition processes, it would be relevant to study how ULLs influence them, in order to avoid the situation where they are only a "*mere functional for temporary experiments*" (Cuomo, 2022). To this end, this paper has made a first contribution to the systematization of a replicable methodological approach to overcome the barriers that prevent the emergence or consolidation of alliances between different stakeholders for the transition to circular socio-economic systems. In this paper, the barriers and opportunities related to legislative, economic, technical and governance issues, were not investigated, opening the root toward new research.

However, the authors recognize that the main difficulty, and at the same time the weakness, of the methodology is to put into practice the co-designed project proposals in any pilot case. In order to prevent that the ULL proposals will remain a purely intellectual exercise, a possibility is to have funding available to implement the proposed CE activities. For this reason, the role of research is important because its capability to access project funding that could enable the activities to be implemented. Among the pilot cases presented in this paper, the Bologna ULL has reached the follow up opportunity through the subsequent Interreg Central Europe NiCE[9] research project, where ENEA is one of the 9 project partners for the implementation of CE activities at urban level. In this framework, the city of Bologna has been considered as pilot site to keep on the activities on the theme of circular water resources consumption.

Future development to complement and complete the work described in this paper is represented by broadening and deepening the focus on other aspects of ULLs as implementation (García Robles et al., 2015; McCormick and Hartmann, 2017), which, consists of the experimentation and evaluation phases and provide additional phases to the exploration and design phase described, tested and presented in this paper, Proceeding with the research in the prospected direction would thus allow to assess the actual impact on the transition to a CE and the actual contribution to the EU CE Action Plan.

Moreover, in the light of the considerations made in the previous sections, it is considered useful to indicate how the reported ULLs experience suggests further investigation also on gender aspects and, more generally, on participation and intersectionality in societal transition process. The authors suggest dedicating future research to the relationship between ULL practices and their role in tackling compound issues in complex systems.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Author contributions

CI: Writing – review & editing, Writing – original draft. GB: Writing – review & editing, Writing – original draft. CB: Writing – review & editing, Writing – original draft. FC: Writing – review & editing, Writing – original draft. AC: Writing – review & editing, Writing – original draft. RC: Writing – review & editing, Writing – original draft. SD: Writing – review & editing, Writing – original draft. MF: Writing – review & editing, Writing – original draft. RP: Writing – review & editing, Writing – original draft. LS: Writing – review & editing, Writing – original draft.

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9 https://www.interreg-central.eu/projects/nice/

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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