




Urban Living Lab (ULL) as a Tool for Co-design Sustainable Transition in Critical Urban Contexts: Co-exploring The Site of National Interest of Bagnoli in the Metropolitan Area of Naples, Italy



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Abstract This paper explores the potential of the Urban Living Lab (ULL) methodology in multi-risk contaminated sites, focusing on the Bagnoli-Coroglio Site of National Interest (SIN) in Naples, South of Italy. ULLs are participatory environments for testing innovative urban solutions, yet their application in contaminated and multi-risk contexts remains underexplored. The research investigates how ULLs can facilitate knowledge sharing, stakeholder engagement, and co-design processes in such critical areas. The study is based on two co-exploration workshops held in February 2024, involving experts and students from local high schools. The workshops aimed to improve knowledge, assess risk perception, and identify key stakeholders. The results reveal a strong perception of social and structural risks, particularly linked to urban degradation and safety concerns, whereas climatic, environmental, and health-related risks appear less recognized by the group of students and experts. The findings suggest that ULLs can enhance awareness of multi-risk conditions and foster inclusive urban regeneration strategies integrating technical expertise with local knowledge to co-develop sustainable solutions. However, challenges remain, including the long time required for participatory processes and the opportunity to get meaningful engagement from diverse actors. By applying the ULL approach to a complex site like Bagnoli-Coroglio, this research contributes to the

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broader discourse on participatory urban planning in contaminated and multi-risk areas, offering insights for future applications in similar contexts.

Keywords Participatory governance · Urban Living Lab · Multi-risk context · Contaminated sites · Co-creation

1 Introduction

This paper presents a reflection on the possibility to apply the Urban Living Lab (ULL) approach to the project of sustainability transition in critical urban contexts such as the multi-risk contaminated sites. The concept of Living Lab (LL) has emerged in academic literature over the past decades. Some scholars date this approach to the year 2000 [1], referring to the moment when innovative research moved out of the “in vitro” laboratory into the “in vivo” urban space, actively involving potential users [2]. More recently, Urban Living Labs (ULLs) emerged as participatory, physical, and virtual environments designed to develop and test innovative urban experiments in real-life settings [3].

There is no single definition of an Urban Living Lab in scientific literature [4, 5]. Some studies defined ULL as a methodology, while others considered ULL as an environment, a system, or a governance approach [6]. Additionally, some scholars emphasize that the ULL approach is applied to projects of quite different scales and durations, with some evolving over time into participatory governance structures [7]. ULL methodology is based on the involvement of local stakeholders—both communities and experts—and can facilitate the sharing of knowledge.

As will be shown in paragraph two, even though the ULL methodology is extensively applied in research projects and practice, literature on ULL in multi-risk contaminated sites remains scarce.

In Italy, heavily contaminated areas designated for environmental remediation due to risks to human health and the environment, namely Sites of National Interest (SIN), are regulated by Legislative Decree 152/2006, the “Environmental Code”. They are critical but symbolic and valuable contexts that, from an ecological transition perspective, must become symbols of regeneration and sustainability. SINS are characterized by the presence of pollutants, such as heavy metals and hydrocarbons resulting from industrial activities or improper waste disposal. Given their spatial extent and the negative impact on exposed populations and natural resources, these areas require complex interventions. Currently, there are 42 SINS in Italy, covering approximately 149,000 hectares of land and over 77,000 hectares of marine areas [8].

This paper explores the possibility of applying the ULL methodology to SIN, with a focus on the case of Bagnoli-Coroglio in the Metropolitan Area of Naples, South of Italy. The SIN of Bagnoli-Coroglio was designated by the ministerial decree on 08/07/2014. It covers 249 hectares of land and 1,453 hectares of sea. The area is exposed

to multi-risk conditions, which is why it is considered a particularly relevant case study for testing the ULL approach in multi-risk contaminated sites.

Aiming at understanding which are the challenges and potentialities of applying ULL methodology in SIN as a tool for co-design, this paper especially focuses on the phase of co-exploration, presenting the results of two workshops organized in the frame of the project RETURN¹ (Multi-risk science for resilient communities under a changing climate), on the area of Bagnoli. The project RETURN is an extended partnership involving 26 partners, aiming to strengthen research networks on environmental, natural, and anthropogenic risks and to promote participation in European and global value chains. The activities are developed within the Spoke TS1–Urban and Metropolitan Settlements– WP4 task 5.4.4 and WP5 task 5.5.2². They aim to implement city scale exercise at the urban scale to define a participative ULL methodology for designing the transition in multi-risk critical context increasing knowledge on risk impact and perception in an initial phase; supporting, in later stages, the design process up to the implementation of project actions [9].

The paper is organized as follows. Section 2 will analyze the relationship between ULL and multi-risk contexts based on the relevant scientific literature, aiming to identify conceptual and operational approaches adopted in multi-risk urban contexts. Section 3 introduces the methodology adopted for the design of the co-exploration workshops Bagnoli-Coroglio. Section 4 presents the results of the co-exploration phase. The conclusions highlight the contribution of applying ULL methodology in multi-risk areas, such as in SIN contexts, emphasizing the potential and critical issues of this approach and outlining future research perspectives.

2 The Potentiality of ULL as Tool for Exploring the Sustainability Transition in Multi-Risk Contexts

Considered an innovative research method that enables the exploration, examination, testing, and evaluation of concepts, scenarios, and ideas directly in their context [10], ULLs have been widely used in different phases of the design process, particularly in transition studies and urban and landscape planning [11]. In this context, the ULL methodology fosters change processes and contributes to sustainable transitions [9, 12].

Several studies have conducted extensive bibliographic reviews on the use of ULLs [13], highlighting significant differences in geographical distribution and addressed themes. From a geographical perspective, this approach first gained attention in Northern European countries and the USA [14]. Today, it is widely used in Europe,

¹ <https://www.fondazione{return}.it/>

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as highlighted by the foundation of the European Network of Living Labs (ENoLL) in 2006. However, there are also examples of LLs in cities of the Global South [15].

Noble and Enseñado [16] emphasize the role of ULLs in proposing solutions to climate change. Indeed, ULLs are an effective tool for driving sustainable transition [17] toward innovative urban systems based on circular economy (CE), especially due to their capacity to create shared knowledge [18, 19] and raise awareness. The ULL methodology is particularly useful in promoting collaboration within circular systems (CE), including the application and testing of Nature-Based Solutions (NBS) [5]. Bradley and Mahmoud [7], referring to the CLEVER Cities project, underscore the importance of LLs for the co-creation and co-validation of NBS in contexts with limited social networks. In this regard, Amorim, Menezes, and Gonçalves Fernandes [15] stress the use of ULLs in developing resilience in critical urban infrastructure to combat climate change in cities of the Global South.

Although the use of ULLs is often associated with the co-creation and co-validation of NBS in the transition toward cities that are more resilient to climate risks, there are very few cases of their application in multi-risk contaminated sites to design more inclusive and sustainable regeneration strategies.

Nevertheless, it is within those contexts, often characterized by conflicts of interest between different stakeholders, that ULLs may represent an innovative approach that integrates knowledge from different disciplines and different social roles [20], creating unusual partnerships between different actors. Here, the use of the ULL approach may provide an inclusive, multidisciplinary participation model, helping institutional authorities to cooperative decision-making processes and shared governance, fostering citizen empowerment [21].

2.1 Applying ULL Methodology to SIN

In Italy, the regeneration of SINS is often hindered by overly expensive remediation actions, by the complexity of managing institutional process, by the long-time administrative approval schedule [22] and by political struggles that occur over time, all factors that cause extremely long remediation process, with the places inaccessible to communities. Additionally, it also represents a loss of opportunities for urban development. The Ministry of Environment and Energy Security (MASE) oversees the management of the process of remediation of SIN areas, with the technical support of the National Network System for Environmental Protection (SNPA). The ISPRA 2023 report on the state of remediation of contaminated sites in Italy states that out of a total of 35.022 remediation procedures at the national level, more than the 45% are still ongoing [23]. In the case of the SIN of Bagnoli-Coroglio, the remediation process lasted for almost 30 years. The remediation project was approved for approximately 234 ha, while the remaining 8 ha are still potentially contaminated areas [24].

The integration of ULLs in urban and environmental regeneration processes helps to shift the focus from the mere technical analysis of remediation to the construction

of relationships between the actors involved [19]. In SInS, where soil contamination has had prolonged impacts on local communities due to lack of accessibility to the area and on the regeneration process itself, a multi-stakeholder approach may facilitate dialogue between institutions, residents, and businesses, reducing conflicts and improving the quality of decisions [23]. Furthermore, the direct involvement of the local community increases transparency and strengthens trust in institutions, favoring the acceptance of the proposed solutions—as they are shared—and accelerating the remediation and regeneration process. As reported by several scholars [24, 25], the concrete experimentation of solutions in a real environment allows the testing of innovative remediation strategies, reducing the risk of failure and promoting more effective management of resources. ULLs are thus configured as key tools in environmental regeneration processes, making all stakeholders protagonists of the transformation of the territory and increasing the resilience of communities [26].

In a context of growing attention to sustainability and environmental justice, the participatory involvement made possible by ULLs proves essential for innovative approaches to sustainable development [27], ensuring the success and durability of remediation and urban redevelopment interventions.

An attempt to increase participation in the remediation process has been made by the European Union through the mission “A Soil Deal for Europe,” which aims to lead a transition towards healthy soils by 2030 through the establishment of Living Labs and Lighthouses. In October 2024, the working groups bioeconomy and smart cities of the European Regions Research and Innovation Network (ERRIN) has funded 13 projects through the call “Living Labs in urban areas for healthy soils,” aiming at improving soil health through a shared and multi-actor approach, and at developing solutions in a co-creative way. However, an analysis of this experience is not yet feasible, given the limited time elapsed and the lack of appreciable results.

Even though participatory processes may represent an opportunity for more inclusive and sustainable remediation processes, the specific technical nature of the remediation processes prevents both from inclusivity and representativeness of local community [20] and bring to a general underestimation of the perception of inhabitants in the regeneration strategy.

3 Methodology of Return Bagnoli-Coroglio ULL

3.1 The Three Phases Methodology

Within the research activities, to define the methodology for the ULL RETURN Bagnoli-Coroglio, a collection of examples and a synthetic-comparative analysis of results was carried out, the analysis of samples also helped to identify the most appropriate exercises at city scale [30]. Among these cases the most common type of innovation introduced concerns positive impacts on environmental, technical, and social areas.

The collection includes ULL developed in different urban contexts and at different urban scales; those most investigated include the urban-district scale, particularly the city center and the peri-urban areas. As also referred to in national and international Technical Policy documents, such as the Italian National Climate Adaptation Plan, the district scale is the most appropriate scale for the green transition and is therefore the one adopted for defining the methodology of the RETURN ULL Bagnoli-Coroglio.

Concerning the methodological approach introduced in the examples, the number of phases for ULLs may vary depending on specific conditions and expected outcomes; nevertheless, some common characteristics can be identified. Despite the differentiated temporal ranges, all the analyzed cases present an initial phase of urban knowledge followed by the definition of the main objectives and strategies, concluding with a phase of results analysis and discussion. Other common characteristics relate to voluntary participation [31] and to the possibility that participants are not necessarily the end users of the innovation process.

From the above-mentioned study, the methodology that has been defined for the development of the RETURN Urban Living Labs in multi-risk territory is structured in three phases: co-explore, co-design, co-test. The three phases are preceded by a scouting finalized to the identification of the stakeholders to be involved. Direct contact turned out to be the most effective method for the involvement of local communities followed by open calls and social media. This initial set of stakeholders is progressively expanded in later stages according to interactions with various community groups.

The first phase of co-exploration aims at improving the knowledge about risk perception both understanding the different risk perceived and the intensity of perception. The first phase also allows us to identify further stakeholders to be involved in later phases. The second phase is oriented towards the definition of inclusive and sustainable scenarios for the regeneration of multi-risk contaminated site; finally, the third phase focuses on the validation of the strategy elaborated in the second phase.

The Urban Living Lab methodology defined within the RETURN project is developed over a period of 3 years (according to the duration of the project).

In the first phase—co-exploration—the implementation of multi-stakeholder engagement processes [32] enables the definition of shared visions to orient planning and design strategies and solutions, in the later phases. In multi-risk urban contexts, gaining complementary, site specific and shared knowledge through community involvement, integrating the social dimension of the impacted contexts [33], is a key factor for risk reduction processes (Fig. 1).

3.2 The Study Area

The research focuses on the SIN of Bagnoli-Coroglio. Among the 42 Italian SIN this study considers the area of Bagnoli because of several factors. First of all, the site's unique environmental characteristics: a former agricultural plane in the west of the

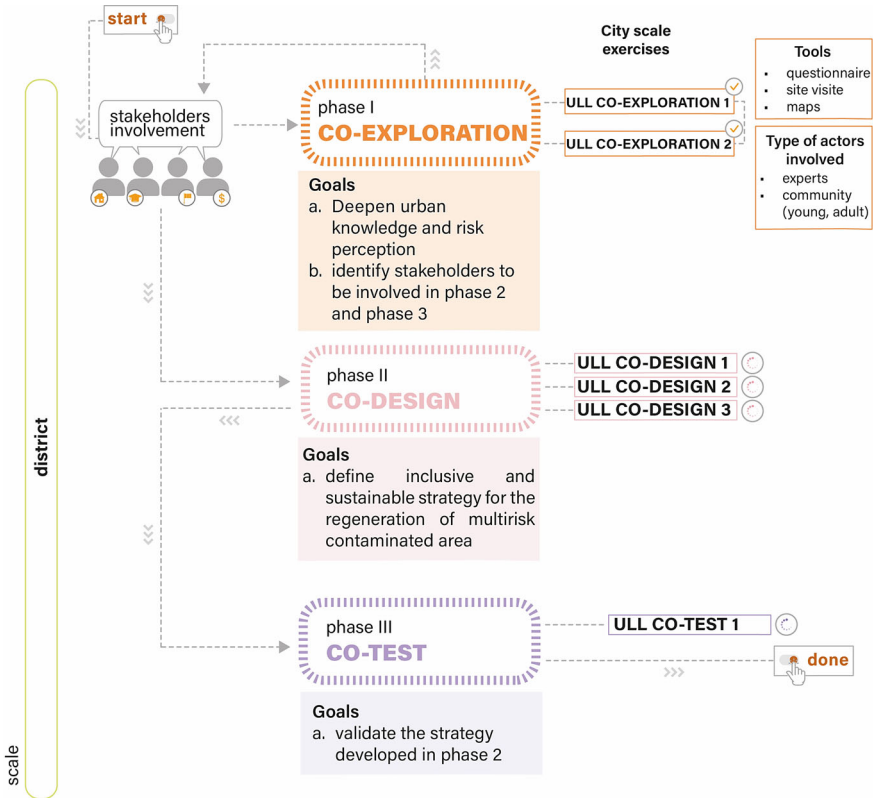


Fig. 1 Diagram showing the three phases of the process

city of Naples, at the border of the municipality of Pozzuoli, in the area of Campi Flegrei, lapped by the sea, downstream of the ridge of Posillipo and facing the small island of Nisida; then the quantity and severity of pollutants, and their impact on the environment, including ecological and health-related risks. Furthermore, the site is subject to significant anthropic pressure due to the extremely high residential density of the metropolitan area of Naples (2527,5 inhabitant/km²). As the area is part of Campi Flegrei it is also a red bradyseism zone, exposed to seismic risk. Additionally, consequently to the seismic risk, it has been included on an area subject to a general residential construction stop declared per legislative decree n. 91/2024, which is a further problematic for a regeneration site. About the remediation process it is worth to notice that, after a first participatory phase with important music festival and community activities in the last decade of the past century, the site become inaccessible representing not only a negative landmark but also a missed opportunity for local communities.

The area also faces disadvantaged socio-economic conditions, partly due to the closure of the ILVA plant in 1992 and is subject to hydrogeological and climatic



Fig. 2 Bird-eye view of the SIN Bagnoli-Coroglio from Posillipo

risks too. Given the complex multi-risk condition arising from the overlap (aggregate, compound, and cascade impacts) of anthropogenic, environmental, and natural risks, the Bagnoli area is considered a particularly relevant case study for this research (Fig. 2).

3.3 Co-exploring a Contaminated Site

The co-exploration phase was structured through two different urban exercises. The first exercise was held on February 23rd, 2024, in the SIN Bagnoli-Coroglio with the involvement of a group of about 20 experts with different skills and backgrounds—urban planners, architects, engineers and environmental science experts. The second experience took place on February 28th, 2024, at the Department of Architecture of Naples, with the participation of about 40 students aged between 17 and 19 years old—in the frame of the “Percorso per le Competenze Trasversali e l’ Orientamento—PTCO”³ from the high schools of the Bagnoli and Agnano area (Art college Umberto Boccioni and High School Francesco Saverio Nitti). The involvement of groups with different competencies and backgrounds made it possible to offer complementary perspectives: one more technical and expert, the other more linked to the daily experience of the inhabitants, thus providing a more complete vision of the perception of the risks of the area and the opportunities for regeneration.

³ The authors thank professor Emanuela Coppola from the Department of Architecture of the University of Naples Federico II for sharing her contacts with us and for enabling this meeting to take place.

The organization of the first co-exploration activities required complex coordination since the area of the SIN is completely closed and owned by the National Agency for Business Development INVITALIA s.p.a. consequently access is allowed only by permission. The site visit represented a fundamental moment to directly observe the conditions of the area, to understand the spatial criticalities and to interact with important key actors involved in the regeneration process. After the site visit, analysis and restitution of the activities have been done at Circolo Ilva, a place full of meaning and historical value for Bagnoli, representing one of the few tangibles and active presence of the former working-class community, that now has become a recreational and sports club.

To ensure an effective co-exploration process, participants were divided into groups of approximately three people, who were provided with two maps developed in a GIS environment—one at territorial scale and one at the district scale—illustrating the overlapping of risks present in the area, together with some contextual elements such as public housings, equipment and the perimeter of the SIN area. In addition to the two maps, participants were given two questionnaires in the form of cards to stimulate reflection. The first card contained five open questions to obtain information on actors to be involved in future ULLs, while the second card presented four questions aimed at investigating the risks perceived during the site visit and possible temporary uses to be imagined during the remediation process. Furthermore, the visual support of the maps made the issues addressed more concrete, facilitating the comparison between the different stakeholders and encouraging a more conscious reading of the area.

The second exercise saw the participation of high school students from local schools. The students were divided into groups of about ten people, each accompanied by an expert tutor. Each group was assigned a specific theme: culture/school, public space and green areas, sea and coast, and mobility. To support the activity, each group was provided with risk maps on a territorial and local scale and a sheet with five questions. The maps were the same as the first exercise, while the questions were adapted based on the participants involved. This made it possible to obtain an integrated vision of how the different actors perceived the risks present in the area. The answers were then located by the students on the map to identify the different spaces and their actual use, together with suggestions and perceptions. The last step required was to share and collectively discuss the perceptions that emerged in the groups through a moment of comparison, encouraging a broader reflection on the problems linked to risk and on the potentialities of the territory under investigation.

4 Results

The result of the first co-exploration exercise highlighted a high perception of the risks present in the area, linked to the conditions of degradation of the industrial archaeologies located within the site, more than the environmental risk. Concerning possible uses to be foreseen in the Bagnoli-Coroglio Site of National Interest, most

of the actors involved suggested adopting temporary uses of the SIN to grant back, at least in part, to the local community a space long denied, thus enabling a more inclusive and circular regeneration process.

The results of this co-exploration exercise have been synthesized on a matrix. The matrix helps to identify some questions to be further analyzed in co-design phase, as well as additional actors to be involved in next exercises. The matrix is conceived as an operational tool that collects in a structured and comparable way the contributions that emerged during the working tables. It summarises the outcomes of the discussions according to a number of key categories. For each participant group, the actors considered strategic to be involved in the subsequent phases were identified (subdivided according to their sphere of belonging: public bodies, private subjects, academia, citizenship, others), the tasks and work packages of the RETURN project for reference in the subsequent phases, the perceived risks and those that are difficult to represent, as well as suggestions on temporary uses that are compatible with the remediation process or already tried out in similar contexts. The objective of the matrix is twofold: on the one hand, to facilitate a transversal reading of the perceptions, criticalities and proposals that emerged in the co-exploration phase; on the other, to offer a solid and shared cognitive basis for the start of the subsequent co-design and co-test phases. In particular, it allows for the emergence of key themes on which to focus design attention—such as safety, place memory, accessibility and latent conflicts—and for the identification of new actors to be involved in future participatory moments. Finally, the matrix is a useful tool to compare the different visions expressed by the participants and to highlight convergences and divergences with respect to perceptions, priorities and regeneration ideas of the Bagnoli-Coroglio SIN.

The analysis of the results of the second exercise showed that students' perception of risks is mostly linked to social risk, particularly to the lack of safety, especially at night. Another risk perceived by students is the seismic risk linked to the phenomenon of bradyseism, which, in the present circumstances is particularly relevant, is strongly felt by those who live in the area. Although they had no connection with the industrial past of the area, due to their age, they know what lies behind the wall of the SIN. However, very few of them perceive the environmental health risks linked to pollution of both the soil and the sea.

The second exercise led to the definition of a map of the perceived risks that highlights both dangerous places as well as the potentialities of the area. The results of this map will provide complementary information to be integrated into the maps of risk elaborated for the project RETURN through the desk analysis and will also be at the base of the co-design phase (Fig. 3).

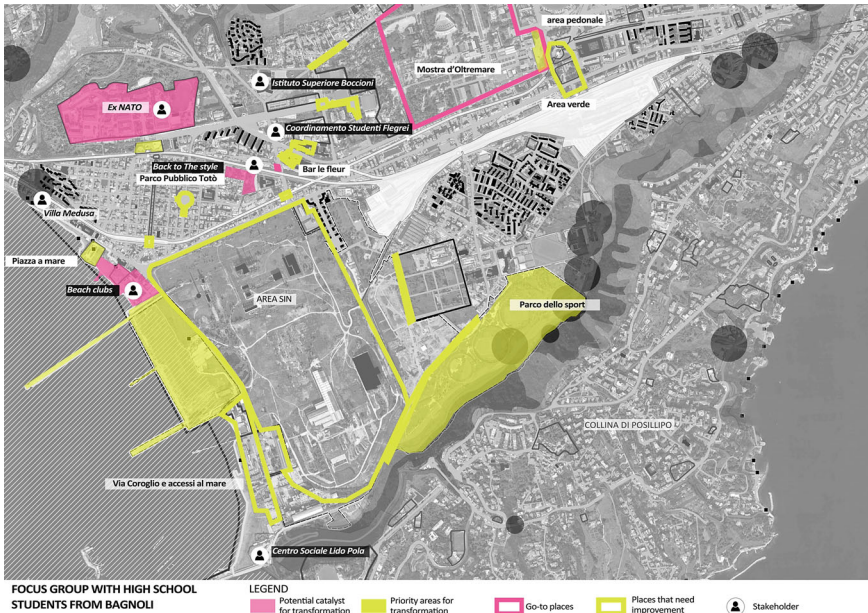


Fig. 3 Map of perceived risks. Elaboration P. Galasso and F. Vingelli

5 Discussion and Conclusion

The paper presents the results of two city-scale exercises of co-exploration for the SIN of Bagnoli-Coroglio, in Naples, South of Italy. The results highlight a high perception of social risk among the young community, and the perception of risks related to the abandonment of the area and the degraded state of industrial heritage for the experts but a general low perception of environmental and health related risk from both groups involved in the urban exercises. This confirms that the technical nature of these risks and the specialized remediation processes tends to hinder the engagement and representativeness of the local community [20]. The use of ULL approach may help to make environmental risks more visible, favoring knowledge exchange and increasing the resilience of communities [26] through open and inclusive participation being a useful tool to elaborate more sustainable urban transformation [34].

However, the implementation of the ULL approach is not free of critical issues. First, it entails considerable time investment for the organization of workshop activities, and for the interpretation of the results, which are not always tangible. Furthermore, although as stated in the introduction of this work, the ULL approach can be applied across projects of varying scales and durations, achieving a meaningful and effective participatory process generally requires extended timeframes. Therefore, despite the inherent complexities and technical nature of the subject matter, the ULL methodology proves particularly suited to long-term and intricate regeneration processes, such as those involving Sites of National Interest (SINs).

The use of Urban Living Labs (ULLs) in urban and environmental regeneration processes can not only support the application of nature-based remediation solutions (NBS) for contaminated sites but also foster the gradual reappropriation—both physical and symbolic—, of abandoned and underuse urban spaces. ULL experimentation enables the exploration of regeneration processes that diverge from conventional models for transforming polluted areas allowing instead for the imagining of alternative and innovative scenarios, including through temporary uses, as demonstrated in the first participatory exercise.

Definitely, applying the ULL approach to land reclamation process may help to transform remediation process into collective and flexible learning paths, involving all actors in an active and constructive way.

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