Co-Designing nature-based solutions for Energy Efficiency and Climate Adaptation in the NatUR-W Urban Regeneration Project

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Extended abstract

Introduction

Cities across Europe face mounting challenges related to climate change, biodiversity loss, and urban expansion. Nature-based solutions (NbS) offer a promising framework for addressing urban environmental challenges while enhancing social and economic resilience (Hurst et al., 2025). Due to their multifaceted benefits – ranging from climate adaptation and energy efficiency to social well-being - NbS are increasingly gaining traction in European cities (O'Sullivan et al., 2020). The NbS concept distinguishes itself from ES by emphasising innovative solutions to urban sustainability challenges (Nesshöver et al., 2017). While its distinction from GBI remains ambiguous, NbS is seen as a more immediate planning approach, centering "nature" in development debates and balancing ecological and socio-economic benefits (Mell and Clement, 2020). Implementing NbS requires careful consideration of the nature and persistence of problems, the communities affected, and the framing of "nature" itself. The degree of human intervention, trade-offs between ecosystem services, and the balance between benefits and risks (e.g., health impacts) further complicate NbS design. Additionally, NbS must navigate systemic complexities, integrating technical, intellectual, and social innovations while ensuring democratic stakeholder engagement, social equity, and the reconciliation of conflicting interests (Nesshöver et al., 2017).

The NatUR-W project, implemented in Lorca, Spain, exemplifies how NbS can navigate these complexities by transforming urban landscapes through participatory planning and technological innovation, balancing ecological integrity, stakeholder engagement, and sustainable solutions.

Lorca, located in the Region of Murcia, experiences a semi-arid Mediterranean climate characterised by high summer temperatures exceeding 30°C and irregular precipitation patterns. These climatic conditions and socio-economic vulnerabilities exacerbate energy poverty and urban heat stress. The NatUR-W project aims to transform Barrios Altos, a district in Lorca marked by exclusion and fragmentation. Home to predominantly

low-income families and migrants, the area struggles with limited public spaces and poor housing conditions, with over 60% of buildings in poor state and widespread energy poverty. It is worth mentioning that a recent survey by the city's Social Services revealed that 50% of households struggle to maintain adequate winter temperatures, and more than 70% face similar challenges in the summer. Thus, addressing these issues requires a systemic approach that integrates NbS with energy-efficient solutions and sustainable water management.

The NatUR-W Approach: Integrating NbS with Urban Renaturalisation and Green Wall Technologies

The NatUR-W project proposes a holistic strategy that combines urban renaturalisation, participatory governance, and innovative energy solutions. A key innovation in this project is the GreenThermoWall (GTW), a self-sustaining green wall system designed to enhance building insulation, mitigate heat stress, and contribute to urban resilience. While green walls are widely recognised as effective NbS for mitigating high indoor temperatures and thus improving the living conditions of dwellings (e.g. Evola et al., 2021; Dkedjig et al., 2017), the suggested innovation takes a step forward by incorporating bio-polyurethane - an insulating substrate made from recycled materials. This innovation significantly reduces energy demand while lowering carbon emissions. Specifically, by reducing heat loss in winter and mitigating heat stress in summer, GTW aims to cut energy consumption and utility costs, benefiting vulnerable social housing and public buildings, such as the repurposed citizen university in Lorca's former prison. Furthermore, the GTW system will improve upon conventional green walls by using native plants that require no maintenance and are adapted to local conditions, with irrigation only needed in summer.

Adopting a circular economy in cities offers ecological, health, community, and economic benefits, yet urban water circularity remains a critical challenge. NbS can play a key role in addressing this by facilitating infiltration, retention, and contaminant treatment. Advancing circular systems for water reuse and resource recovery requires identifying suitable NbS, understanding their functions and co-benefits, and exploring their integration and scalability in urban areas. In line with this, implementing NbS within NatUR-W focuses on enhancing water management by integrating natural water cycle principles into its interventions. Specifically, it repurposes existing water reservoirs to support the irrigation of GTWs and surrounding green spaces, ensuring self-sufficiency and reducing maintenance costs associated with urban green infrastructure.

Additionally, the NatUR-W project expands its circularity and urban resilience efforts by creating an urban forest (i.e. a new public green area of 3,500m^2) on an underutilised plot (which includes the rehabilitation of the old water reservoirs of Lorca). This new green space will function as a climate shelter, reducing heat stress, enhancing biodiversity, and contributing to urban cooling. Beyond environmental benefits, the urban forest will provide recreational and cultural opportunities, promoting social cohesion and strengthening community well-being. Together, these interventions demonstrate how NbS can effectively support circular urban systems while delivering multiple co-benefits, as commonly highlighted in NBS research (e.g. Debele et al., 2023; Raymond et al., 2017).

Co-Design and Stakeholder Engagement

The success of NbS interventions depends on local engagement and governance. The NatUR-W project emphasises a participatory co-design approach, ensuring that implemented solutions align with residents' needs and expectations and promote engagement activities to ensure long-term sustainability. The project has already conducted several co-design workshops, mapped and analysed key stakeholders, and established a Stakeholder Board that meets quarterly to foster citizen involvement in local governance.

Figure1. First Co-design workshop with the neighbourhood association in Lorca (26th June 2024)

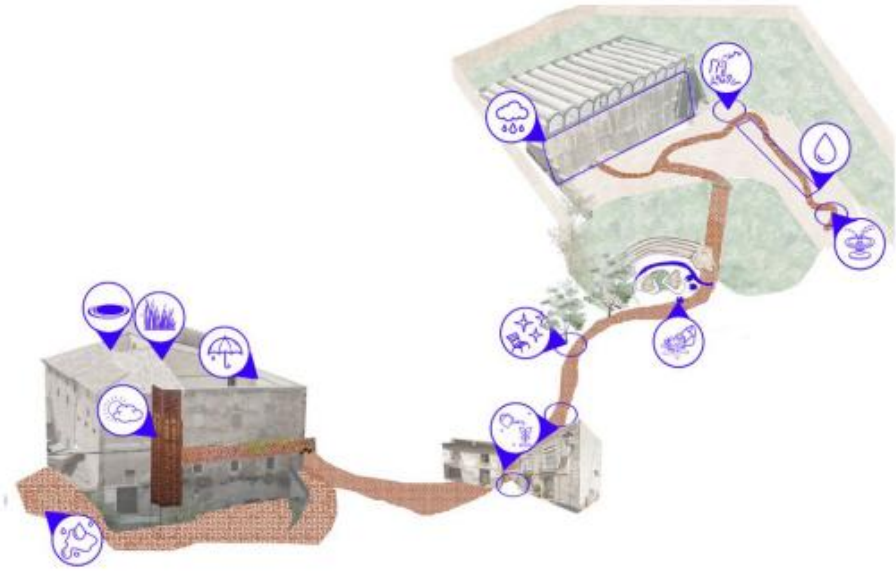

Figure 2. Draft presentation of the project's proposed solutions during the co-design workshops

This co-design approach fosters better community acceptance and enhances long-term sustainability and resilience by incorporating diverse perspectives into the planning and implementation process (of the Nature-based Solutions). One of the project's key objectives is to engage at least 100 stakeholders in co-design activities, ensuring a broad representation of local voices throughout the project.

Monitoring, Digital Innovation, and Sustainability

The integration of digital technologies enhances the effectiveness and replicability of NatUR-W solutions. IoT sensors will be deployed to monitor energy savings and climate benefits, while an open-access digital platform is expected to ensure data transparency and facilitate knowledge sharing. These technologies will enable real-time assessment of NbS impacts, allowing adjustments to optimise performance and inform future urban interventions.

As mentioned, the NatUR-W project will also align with broader green transition objectives by promoting the circular economy. Using recycled biopolyurethane in GTWs and adaptively reusing existing urban infrastructure will reduce the project's carbon footprint. Furthermore, by integrating NbS with self-sustaining water management systems, NatUR-W will enhance urban resilience while reducing dependency on external resources.

Additionally, the project will indirectly boost the local economy by attracting more visitors to the Historic District through enhanced urban aesthetics and cultural events. Local businesses, such as shops and restaurants, will likely benefit from increased foot traffic generated by students and visitors. Furthermore, creating green jobs to maintain NbS, such as maintaining green walls and urban gardens, will provide additional employment opportunities for the local population.

Conclusion

The NatUR-W project is a scalable and replicable model (NatUR-W Plans) for sustainable urban regeneration. It illustrates how NbS can tackle energy poverty, climate adaptation, and social cohesion simultaneously. The project fosters long-term sustainability and community ownership by prioritising participatory planning, utilising digital tools and technologies, and integrating innovative energy and water management solutions. As cities worldwide seek solutions to pressing urban and environmental challenges, the NatUR-W model aims to offer valuable insights for advancing climate-resilient, circular, and socially inclusive urban development.

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