

How and why to build participatory digital twins of nature-based solutions?

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Abstract Recent efforts to develop digital twins (DTs) for nature-based solutions (NbS) have primarily focused on capturing technical complexity, often overlooking the social and participatory dimensions essential to their real-world legitimacy and adoption. In the context of just urban transitions, this oversight risks reinforcing top-down decision-making and limiting the responsiveness of digital tools to diverse community needs.

This study explores how DTs of NbS can better reflect stakeholder perspectives by focusing on input legitimacy – the degree to which the knowledge embedded in DTs is co-produced through participatory processes. Drawing on four co-design case studies across Europe, we test four participatory methods from psychology and service design – namely, role construct repertory tests, the 20 statements test, impact journey mapping, and motivations canvassing, with 112 participants engaged in NbS implementation

Our findings show that these methods produce stakeholder insights that can be directly translated into performance indicators and design principles for DTs. Psychology-based approaches elicit mental constructs and framing preferences, while service design tools reveal experiential values and potential use-cases. Together, these approaches allow DTs to be shaped not only about NbS performance, but also for the people they are meant to serve.

The main contribution of the study is demonstrating how knowledge brokerage can enhance the democratic legitimacy of DTs of NbS, offering practical methods for NbS project managers to ensure that their interventions reflect and respond to the needs of the wider public.