SESSION DESCRIPTION

ID: T5b

Digital twin–ai integration for ecosystem services: bridge to a nature-positive future or threat to integrity?

Hosts:

	Name	Organisation	E-mail
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Abstract:
Nature-based solutions (NbS) are increasingly recognized as essential pathways toward a nature-positive future, offering integrated responses to climate change, biodiversity loss, and sustainable development. Their promise is widely acknowledged in international frameworks and global policy strategies. Yet persistent challenges remain: long-term performance data are scarce, monitoring practices are fragmented, and current evaluation approaches often fail to capture the complex socio-ecological interactions that determine NbS effectiveness. The difficulty of quantifying diverse ecological, social, and economic benefits—ranging from flood protection and urban heat mitigation to cultural and recreational values—continues to hinder mainstreaming, scaling, and investment.

Digital Twin technology, understood as virtual replicas of real-world systems continuously updated with real-time data, offers transformative opportunities to address these challenges. When combined with artificial intelligence (AI), Digital Twins can dynamically integrate field observations, remote sensing, and socio-economic datasets, enabling adaptive monitoring frameworks that quantify uncertainties, enhance transparency, and improve ecosystem service performance assessment. This AI-driven approach also provides novel opportunities to embed intrinsic, relational, and instrumental values of nature's contributions to people into NbS evaluation. By synthesizing ecological metrics, economic indicators, and community narratives, these tools can reflect the multiple ways societies benefit from and connect with ecosystems.

This interactive session will highlight advances in interdisciplinary and transdisciplinary research at the intersection of ecosystem service science, digital technologies, and policy. Discussions will focus on how AI-enhanced Digital Twins can improve the assessment of NbS by capturing the full spectrum of ecosystem service values, the role they can play in strengthening policy evaluation, resilience planning, and investment frameworks, and the ethical, social, and governance safeguards required to ensure their transparent, equitable, and accountable use. The session aims to advance dialogue on how digital innovations can accelerate the mainstreaming of NbS, bridge the gap between science and practice, and ultimately contribute to a people- and nature-positive future, while carefully addressing the potential ethical trade-offs involved.

Goals and objectives of the session:
This session aims to critically examine the potential benefits, trade-offs, and challenges of integrating AI-driven tools to advance transdisciplinary ecosystem services and values research in support of sustainable decision-making. In particular, the session will explore how AI-enhanced Digital Twins can serve as dynamic tools for ecosystem service monitoring and assessment, while showcasing innovative applications that integrate ecological, environmental, and socio-economic data. A central focus will be on how these technologies can embed intrinsic, relational, and instrumental values into decision-making frameworks, address ethical and governance implications of data-driven approaches, and foster collaboration to develop knowledge tools that strengthen sustainable decision-making and resilience planning.

Planned output / Deliverables:

Synthesis Brief / Summary Note

- A concise (2–3 page) written summary capturing the key insights, opportunities, and challenges identified during the session.
- The note will be shared with session participants, uploaded to the ESP conference website, and circulated through relevant working groups to extend reach and impact.
- Collaborative Network / Interest Group
- Formation of a small network or mailing list connecting participants interested in advancing AI-enhanced Digital Twins for ecosystem services and NbS.
- This network could serve as the foundation for future collaborations, joint proposals, or the establishment of a dedicated ESP working group.
- Blog Post
- Development of a short, accessible blog post summarizing the discussion highlights and emerging priorities.
- All session participants will be invited to contribute as co-authors, ensuring diverse perspectives and co-ownership of the output.

Session format:

To foster an engaging and participatory exchange, this 90-minute session will adopt a World Café format. It will begin with a short framing presentations (approximately 5 minutes) highlighting methodological advances, applied case studies, and innovative applications that demonstrate how Digital Twins and AI are being used—or could be used—to monitor, model, and evaluate ecosystem services, as well as to inform restoration projects and resilience planning.

Following this introduction, participants will rotate through a series of small-group discussions at themed tables. Each table will be guided by a central question, such as: What opportunities and barriers exist for integrating AI-enhanced Digital Twins into ecosystem service assessments? How can diverse values—intrinsic, relational, and instrumental—be incorporated into these tools to inform sustainable decision-making? What ethical, governance, and social considerations must be addressed to ensure transparency, accountability, and equity?

The session will conclude with a plenary “harvesting” exchange, synthesizing insights from all groups, identifying areas for collaboration, and charting pathways for scaling up AI-enhanced tools in practice. The expected outcome is a shared understanding of both the opportunities and trade-offs of these technologies: whether they represent a bridge toward a people- and nature-positive future or risk undermining ecological integrity and governance accountability. By generating actionable insights and fostering interdisciplinary collaboration, the session will contribute to the development of replicable, evidence-based tools that strengthen NbS design, monitoring, and policy relevance across scales.

Voluntary contributions accepted:

Yes, I allow any abstract to be submitted to my session for review

Related to ESP Working Group:

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