

VISIONARY NATURE-BASED ACTIONS FOR HEALTH, WELL-BEING & RESILIENCE IN CITIES



Policy Brief

Digital Twins for Greener, Healthier Cities

Through its activities, VARCITIES has explored a number of key topics linked with the **improvement of health & well-being in urban areas**, identifying existing **shortcomings, knowledge gaps** and the **opportunities** available for **policy stakeholders** to address them. In our series of policy and technical briefs, we present recommendations that we think most critical. This policy brief on **digital twins for greener, healthier cities** prepared by VARCITIES' project partners, **IES** and **ISOCARP Institute**, gives policy stakeholders interested in the question key recommendations on the topic.

This policy brief explores the potential of digital twins for municipalities to advance sustainable urban development, based on VARCITIES experience with its own digital twin tool, the Health & Well-Being Platform.

This policy brief highlights existing and potential benefits and provides concrete measures to help cities implement digital twin technologies for greener, healthier cities.



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Urban digital twins

What is a digital twin?

Since its introduction in 2022, the concept of Digital Twins, a virtual replica of a physical asset, has gained traction across diverse sectors as these virtual models allow for real-time monitoring, analysis, and optimization based on continuous data updates from their physical counterparts¹. Initially conceived for product lifecycle management, their applications have expanded through advancements in data analytics, machine learning, and the Internet of Things (IoT) to now provide accurate simulations, predict outcomes, and optimize performance across various industries².

The application of digital twins to urban planning and development is currently being discussed and researched at length. Such ‘urban digital twins’ have gained prominence for their potential to transform how cities work, as they have been deployed in use cases to manage physical built environment assets such as buildings and infrastructure, focusing primarily on monitoring and optimizing energy consumption, where they offer direct return on investment through energy efficiency and cost savings.

1 Gupta. 2024. The Role of Digital Twins in Sustainable Urban Planning.

2 Gupta. 2024. The Role of Digital Twins in Sustainable Urban Planning.

What can they offer to urban development?

By combining different forms of urban data from sources such as sensors and satellites, urban digital twins are now able to offer a comprehensive replica of the urban environment, reflecting the properties, conditions and behaviour of complex urban systems (mobility, waste and water management, economic flux, ecosystems services, heating and cooling networks, irrigation systems, etc.). They have the potential to provide municipalities with a new lens to explore and envision future scenarios, facilitating responsive urban initiatives and informing decision-making processes through³:

- Simulative/predictive analyses from real feed of thermo-physical data.
- Increased awareness of various spatiotemporal situations in urban areas.
- Accurate predictions of future scenarios.
- Better integration of city domains and stakeholders.

VARCITIES’ Health & Well-Being Platform is a notable example, with the digital twins of seven pilot sites offering real-time data on a number of health and well-being parameters.

3 Wolters, B. M. (2023). Exploring the potential of urban digital twins in climate adaptive development.

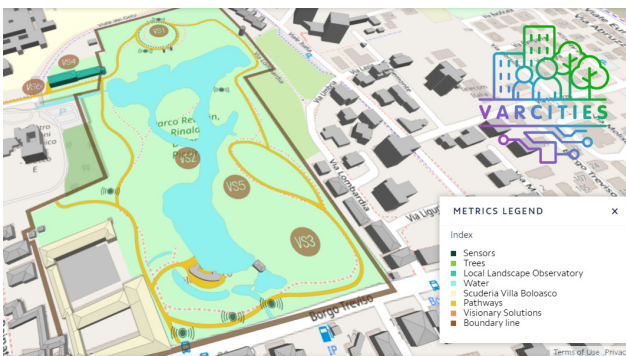


VARCITIES' Health & Well-Being Platform

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Contributing to the sustainable city

As demonstrated by VARCITIES through the Health & Well-Being Platform, broader applications of digital twin technology can support cities in developing initiatives that go beyond enhancing energy performances, and offer broader benefits related to sustainability and quality of life. Although this broader scope may offer less direct economic value, it allows for a more holistic view of urban operations, facilitating smart city development and optimizing various aspects of city development and provide important long-term benefits⁴.



Digital twin of VARCITIES pilot site in Castelfranco Veneto.



Digital twin of VARCITIES pilot site in Chania.

Promising technological outlooks

From a technical perspective, digital twin technology is expected to further develop to offer several news benefits:

- Integration of IoT and AI: expands the scope of the data collected and the analysis.
- Enhanced simulations better support data-driven decision-making: improved outdoor thermal comfort simulations to understand and adequately tackle urban heat-island effect.
- Improved operational efficiency to provide real-time insights leading to better resource allocation.

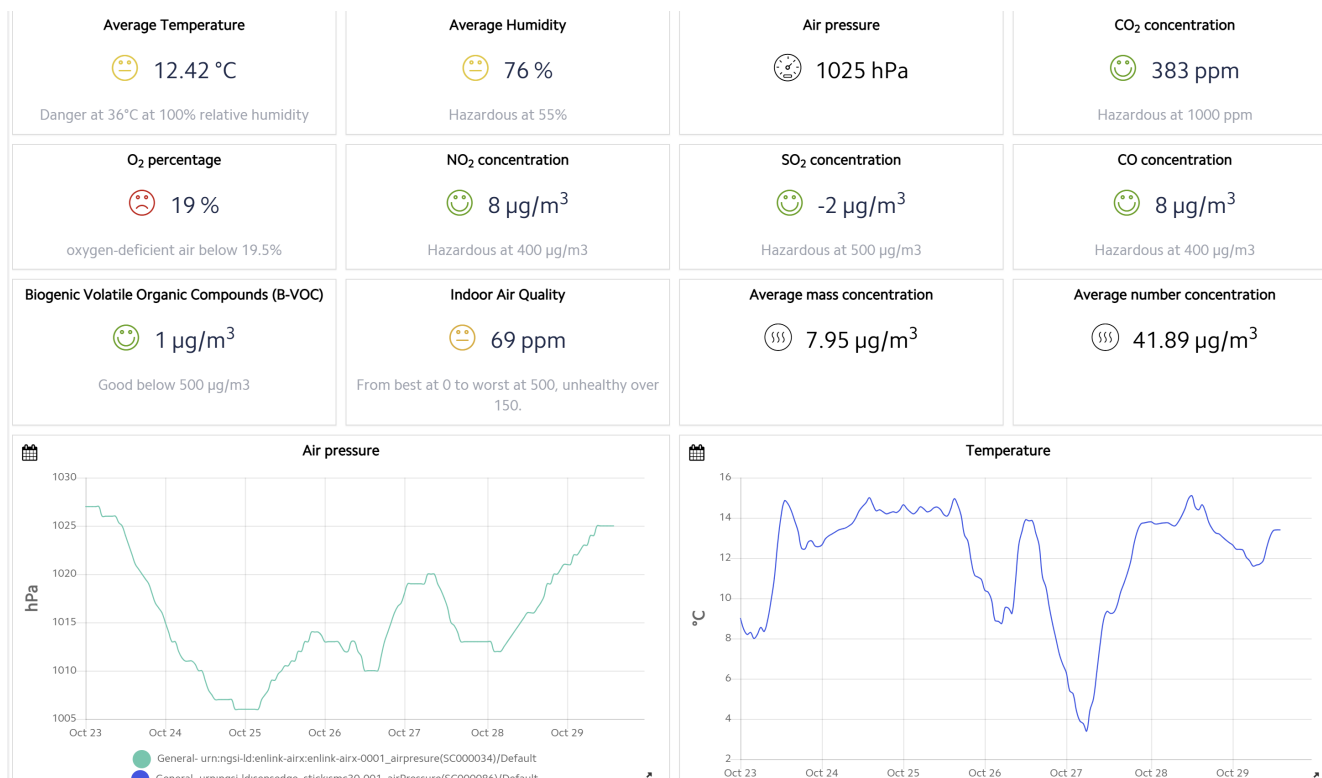
4 Nikolić, D., & Ewart, I. (2023). Going beyond energy consumption: digital twins for achieving socio-ecological sustainability in the built environment.

However, despite the rapid development of digital twins in the urban context, and the scientific evidence for their effectiveness in different systems, their implementation by municipalities is still limited. This is especially due to several challenges⁵:

- Lack of technical expertise and knowledge to develop and adopt digital twins, and of understanding of the benefits that the technologies can offer.
- Complexity of ensuring interoperability between different systems and integrating various data sources.
- Financial barriers for investment required for the implementation and maintenance of digital twin systems.
- Privacy and cybersecurity concerns regarding data collected and used by digital twins.

These challenges highlight a significant gap in long-term measures and planning strategies to support their deployment and integration into municipal agendas.

5 Wolters, B. M. (2023). Exploring The Potential Of Urban Digital Twins In Climate Adaptive Development



Policy recommendations

The following are strategic recommendations for the local and EU levels to effectively design and promote the successful adoption of digital twin technologies.

EU actions to support digital twins

To support their mainstreaming and ensure municipalities across the EU can benefit from their application, the following actions are recommended at the EU level.

Research and Innovation (R&I) Policy

- Prioritize funding for scalable digital twin solutions that can be easily adapted and replicated across diverse urban contexts within the EU.
- Encourage collaborative R&I projects that involve multiple cities, enabling the development of best practices and ensuring solutions are applicable to a wide range of urban environments.

Financing through the European Structural and Investment Funds (ESIF)

- Support projects that leverage digital twin technologies to drive sustainable urban development, with a focus on delivering clear environmental benefits.
- Ensure that ESIF-funded projects incorporate strong community engagement components, using digital twin technologies to involve citizens in urban planning and decision-making processes.
- Facilitate access to ESIF resources for municipalities looking to implement digital twin solutions, particularly in regions with lower digital adoption rates.

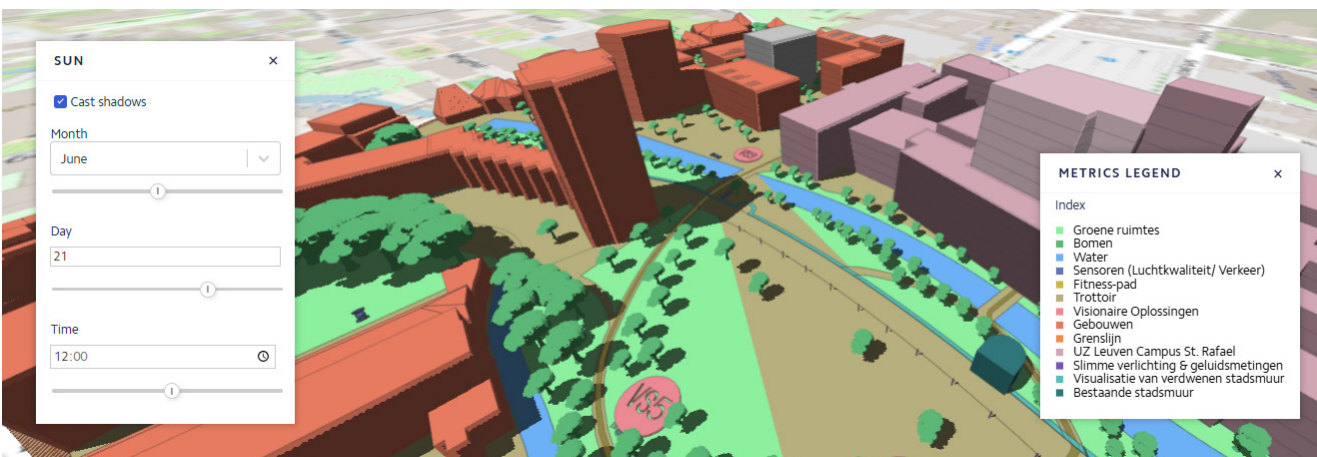
Policy and Regulatory Framework

- Develop EU-wide guidelines and standards for the deployment of digital twin technologies, ensuring consistency and interoperability across member states.

- Create incentives for municipalities to adopt digital twin technologies by linking EU funding opportunities to the implementation of digital strategies and smart city initiative.
- Promote the integration of digital twin technologies into EU-wide urban policy frameworks, making them a core component of sustainable and resilient urban planning.

Capacity Building and Knowledge Sharing

- Establish EU-level platforms for knowledge exchange, enabling cities to share experiences, challenges, and successes in implementing digital twin technologies.
- Support training and capacity-building programs at the EU level to equip municipal staff with the necessary skills to effectively use and manage digital twin technologies.
- Encourage the creation of networks and partnerships between municipalities, academia, and the private sector to foster innovation and the spread of digital twin solutions.



Digital twin of VARCITIES pilot site in Dundalk (above) and in Leuven (below).



Promoting digital twins in local policies

Financing

- Explore and secure diverse funding mechanisms, including public-private partnerships (PPPs), to support digital twin implementation and scaling.
- Invest in joint initiatives that promote the adoption and scaling of digital twin technologies across cities, utilizing synergies between EU, national, and local funds, for instance through a European Digital Infrastructure Consortium (EDIC).

Technical

- Prioritize platforms that support advanced analytics, 3D modeling, and effective data management.
- Implement unified data management strategies across department.
- Incorporate tools like augmented and virtual reality (AR/VR), visualization technologies, and natural language processing to enhance digital twins' capabilities.

Education and Capacity Building

- Establish comprehensive training programs for municipal staff, including urban planners, engineers, and IT specialists.
- Ensure continuous learning and development to keep pace with technological advancements and effectively leverage digital twin technologies.
- Encourage knowledge sharing and the scaling of successful digital twin projects through digital innovation hubs and other collaborative platforms.

Collaboration

- Foster partnerships and break down silos within municipal departments and with external stakeholders, including technology providers, academic institutions, and other cities.
- Promote collaboration to drive innovation, share best practices, and facilitate the development and implementation of digital twin technologies.

Taking it further: A business case for digital twins for greener, healthier cities

With the rising demand and interest for urban nature planning, particularly with the recent adoption of the EU Nature Restoration Law, digital twin technologies can play a key role in advancing green initiatives and targeting urban nature plans requirements.

Following the adoption of the European Green Deal in 2019 by the European Commission and the subsequent revision and adoption of a new Biodiversity Strategy, clear goals for nature restoration by 2030 have been set. City-led policy initiatives aiming to translate these high-level goals into actionable solutions are now running, particularly with the Green City Accord, the Greening Cities Partnership of the EU Urban Agenda and the recent Berlin Urban Nature Pact. All of these initiatives call for the development and implementation of Urban Nature Plans, reflecting a growing interest from

cities in frameworks for integrating nature into urban planning, which has led to several research initiatives on the topic.

The EU Nature Restoration Law adopted last June 2024 further formalized the nature restoration goals of the EU with binding targets for the restoration of degraded ecosystems for Member States. The regulation mandates the implementation of specific measures aimed at restoring nature within urban ecosystems (Art. 14(4)), further highlighting the need for urban nature planning.

In this context, Digital Twin technologies hold significant potential to support the development of these city level plans, and their execution, providing data-driven insights that align with the requirements established by the EU law.



Image: VARCITIES Pilot in Chania, Greece.



Digital twins directly supporting the development of Urban Nature Plans

Following the toolkit and guidance provided by the EC on the development of Urban Nature Plans, digital twins can play an important role supporting cities in crucial aspects of this approach.

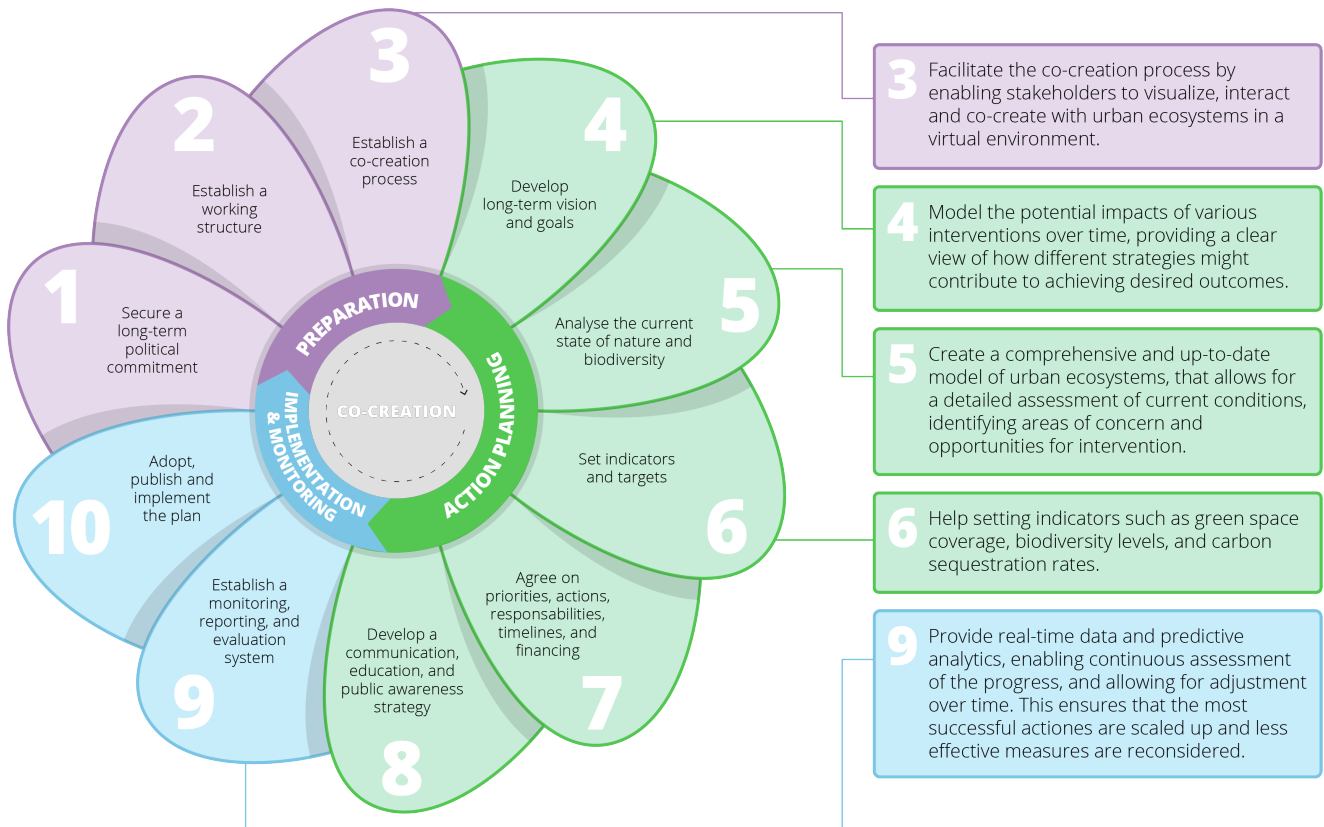


Figure adapted from: EC. (2023). Urban Nature Plan Guidance and Toolkit. European Commission - Urban Nature Platform https://environment.ec.europa.eu/topics/urban-environment/urban-nature-platform_en.

With the right policy support, digital twin technologies can become a strategic tool for creating greener, healthier cities, not only for enhancing urban efficiency and achieving financial savings, but also as a strategic investment that can bring significant social and environmental returns.

Article 29.5 Disclaimer

This document contains information that reflects only the authors' views and the European Commission/ INEA is not responsible for any use that may be made of the information it contains.

Stay tuned for the next updates from the project! <https://www.varcities.eu/>

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