



Insights from the TerraDT Urban Impact Workshop: User perspectives for urban climate change adaptation

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IMPACT WORKSHOP

Workshop Speakers



Isra Mohamed Hussein (CSC)



Devaraju Narayanappa (CSC)



Liisa Kulmala (Finnish Meteorological Institute)



Leif Backman (Finnish Meteorological Institute)



Inês Girão (+ATLANTIC)



Jan Mateu Armengol (BSC - UrbanAIR)



Tero Aalto (CSC)



Anu Riikonen (Sitowise)



Jaana Bäck (University of Helsinki)



Dragana Bojović (BSC - Impetus 4 Change)



Pablo Martinez (trecientosmil)



Antonia Frangeskou (BSC)



Diana Urquiza (BSC)

Overview: Horizon Europe projects for urban impact modelling

The workshop “Urban Impact Models for Climate Adaptation” aimed at creating the foundations to build a constructive dialogue between Earth system scientists and those who can make the most of science-based insights on the rapid changes in our urban climates: **local policy makers and urban planners**. The event presented how the TerraDT project is not only extending Destination Earth's climate capabilities with high-resolution digital twin components, but also creating new **impact models** to support cities to adapt to a changing climate.

Introductory talks outlined TerraDT's goals: to build modular digital twin components for cryosphere (land/sea ice), land surface, and aerosols, and to couple them with core climate models on EuroHPC systems. This enables kilometer- to sub-kilometer-scale simulations that better capture land heterogeneity, which is essential for realistic urban climate and impact assessments. The urban impact workstream then showed how high-resolution, data-driven approaches downscale climate and weather information to neighborhood scale, combining reanalyses, sensors, and static predictors to map heat exposure, and how ecosystem models and emulators are used to estimate carbon fluxes from urban green spaces in cities like Helsinki, Barcelona, Lisbon, Munich, Paris, and Zurich.

Complementing TerraDT, the Urban Air sister project was presented as a digital twin of the urban environment, linking air quality, heat, wind, and human behavior for decision support in cities such as Barcelona, Antwerp, Paris, Rotterdam, and Bristol. Use-case demonstrations covered operational high-resolution temperature mapping, heat-wave and heat-island indicators, and emulator-based carbon flux maps at ~50 m resolution, all designed to feed into user-friendly tools for urban planners.

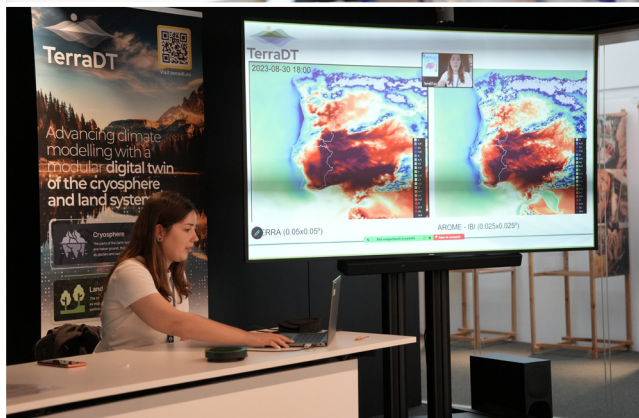


Horizon Europe projects for urban impact modelling

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Expert panel: user perspectives

The panel, moderated by Tero Aalto (CSC), explored what users need from digital twins for climate adaptation, particularly in urban environments, and how TerraDT can ensure real-world adoption of its outputs. The moderator opened by stressing that digital twins have no value without users, and that the project is still early enough to adjust development based on feedback. The panel brought together four experts: **Dragana Bojović** (BSC), **Pablo Martínez** (300 000 km/s), **Jaana Bäck** (University of Helsinki) and **Anu Riikonen** (Sitowise), combining scientific, technical, planning, and user-advisory perspectives.

1. What users need from digital twins

When thinking of end-users of impact models, one should keep in mind that **“users” is not a homogeneous category**. Spanning from local policy makers to architects and urban planners, our expert panel stressed that different user subgroups might each have different needs and different skills and an emphasis should be placed on **accessibility and alignment** with users’ existing practices. In other words, before discussing functionality, developers must understand **who the users are, how they make decisions and what constraints they face**. In fact, many public-sector users have never seen high-resolution urban climate projections before and often don’t know how to act on them thus creating a large **gap between new data and actual decisions**. This means that **providing data is not enough**: developers must **co-imagine** applications together with users.

Insights from the discussion also highlighted the need for impact models and their user interfaces to provide **high-resolution, actionable data**, especially to support nature-based solutions, stormwater management, biodiversity, and scenario testing. They also emphasized the increasing role of **citizens** as participants and end users of environmental information.

2. The most crucial characteristics of a successful digital twin

Although several factors matter, the panel identified a few high-priority essential features of usable and actionable digital twins:

- 🌐 **Trustworthiness and transparency**: users need to understand how data is produced, how uncertainties are handled, and what assumptions underlie the models.
- 🌐 **Usability and non-overwhelming interfaces**: the platform should spark curiosity without being too technical or *science-heavy*.
- 🌐 **Clarity about model quality**: digital twins risk oversimplifying scientific complexity behind a polished interface. Users must be able to distinguish between high- and low-quality models.
- 🌐 **Commitment to long-term availability**: for adoption, users need confidence that data and services will remain accessible and stably maintained after the project ends.

Collectively, these elements build trust, which the panel saw as the single most important ingredient for adoption.



3. Challenges in digital twin usability and adoption: from scientific foundations and ecosystem representation to implementation of nature-based solutions in cities.

There are, however, scientific challenges of representing ecosystems in digital twins:

- 🌐 **Temporal and spatial scale mismatches** between climate processes and ecosystem change.
- 🌐 Extreme **heterogeneity in urban environments**, where conditions vary drastically across short distances.
- 🌐 Critical **feedback loops** between vegetation and climate, which are essential for assessing risks such as urban flooding or heat stress.

For research infrastructures to trust TerraDT, it was stressed that the digital twin should provide proper validation with independent data, transparent uncertainty quantification, clear documentation of data provenance and, finally, training for bottom-up data collectors, who may be experts in measurement but not in data architecture.

From the perspective of urban planners, the challenges faced include:

- 🌐 **Lack of space** and high land costs
- 🌐 Uncertainty about future climate conditions and how much to invest
- 🌐 **Risk-averse, conservative decision-making cultures**
- 🌐 Difficulty in piloting untested solutions because public-sector decisions are closely scrutinized and tied to legal responsibility

Our guest experts noted that capturing micro-scale ecological variability in urban digital twins is extremely difficult and requires better theoretical understanding.

4. Lessons from user engagement and climate services (Impetus4Change project)

Impetus4Change (I4C) is a Horizon Europe project that brings together climate scientists, social scientists and urban stakeholders to improve the quality and usability of near-term climate information for cities. Its goal is to support better local adaptation decisions by translating climate data into practical, tailored services that address risks such as heatwaves and flooding. Insights and best practices from the project highlight its extensive co-production process:

- 🌐 Early and continuous stakeholder mapping
- 🌐 Creative multi-day *Adaptalab* sessions where practitioners and scientists co-design services
- 🌐 Intercity learning across Barcelona, Prague, Bergen, and Paris
- 🌐 Flexible definitions of *service* (not just tools but also communities of practice)

On impact evaluation, the project adopts a **co-evaluation** approach that assesses not only results but also the process and user experience. Learning flows both ways: users increase their climate literacy, and scientists learn about real-world contexts and constraints.

The key lesson: **Partnership, trust, and continuity must begin on day one, because building durable relationships takes longer than project timelines allow.**

5. Barriers to integrating climate data into public policy

300000 Km/s (Trecientosmil) is an urban design and data visualisation studio that operates at the intersection of architecture, urbanism and digital technologies. Their work focuses on translating complex urban data into accessible, visual tools that support decision-making, planning and public engagement. Through a combination of spatial analysis, storytelling and interactive design, they help cities and organisations better understand urban dynamics and communicate them effectively to diverse stakeholders. Findings from Trecientosmil's work with public bodies shows some key difficulties to take into consideration:

- 🕒 Many officials believe climate data is *not their department's responsibility* even when it's relevant.
- 🕒 A fatalistic attitude: *If the projections look bad, there's nothing we can do.*
- 🕒 Political cycles discourage investments with long-term benefits.
- 🕒 New data has little value if it's not integrated into existing administrative workflows.
- 🕒 A general **lack of imagination** about what actionable steps new climate data enables.

To address such hurdles, Trecientosmil outlined a multi-layered strategy for influencing public policy: from soft measures (articles, exhibitions, collaboration with architecture associations) to more direct engagement with lobbying groups, city networks, and even national housing regulators.

6. Main takeaways

Finally, the panelists each named one priority feature that would guarantee adoption of TerraDT's urban impact model:

- 🕒 **Long-term availability and clear licensing** of data.
- 🕒 **Robustness and transparency about what decisions the data can and can't support.**
- 🕒 **Guidance for users on how to actually use the data for decisions**, not just providing the data itself.

The panel converged on a central message:

For TerraDT to succeed, it must build trust, clarity, usability, and long-term continuity, while engaging users as partners, not audiences.

This requires transparent science, sustained engagement, co-development of use cases, integration into existing workflows, and support for decision-makers who face structural constraints. The discussion underscored that adoption is not a technical challenge alone, but a social, institutional, and communicative one.



Interactive session: answering users' burning questions

The interactive session generated a rich discussion on the practical use of urban impact models for climate adaptation and decision-making. Participants consistently emphasized the need for tools that support concrete urban choices, such as:

- 📍 Where to prioritize green and blue infrastructure
- 📍 How to reduce heat exposure in vulnerable neighbourhoods
- 📍 How to manage flooding and stormwater more effectively
- 📍 How to assess the resilience of critical infrastructure under future scenarios.

Across different sectors, from urban planning and public health to emergency management and private sectors, there was strong interest in **combining high-resolution environmental data with social vulnerability and exposure information to identify at-risk populations and assets**. Discussions also highlighted the value of scenario-based comparisons to evaluate trade-offs, costs, and long-term implications of interventions like cool roofs, low-emission zones, or nature-based solutions.

Finally, the session emphasised the importance of interoperable, decision-oriented outputs that can be integrated into existing workflows, alongside clear risk communication strategies that are tailored to diverse audiences and decision contexts.





Conclusions

The TerraDT Urban Impact Workshop confirmed that the value of high-resolution climate modelling ultimately depends on its translation into decisions that can support and shape cities. The models produced by the project have a strong potential to bridge this gap, offering detailed, science-based insights that respond to real urban challenges, from heat exposure to carbon management. However, **their success will rely less on technical sophistication alone and more on how effectively they are embedded into the everyday practices of planners, policymakers, and other stakeholders.**

Across discussions, a consistent message emerged: **adoption requires trust, usability, and continuity.** This means ensuring transparency in how models are built, providing clear guidance on how outputs can inform decisions, and maintaining long-term access to data and services. Equally important is the need to design tools that align with existing workflows and constraints, recognising the institutional, political, and cultural realities in which urban decisions are made.

The workshop also highlighted the importance of co-development. Engaging users early and continuously, as demonstrated by initiatives like Impetus4Change, allows solutions to evolve in response to real needs rather than assumed ones. This approach fosters shared ownership, improves climate literacy, and ensures that digital twins become practical instruments rather than abstract innovations.

Looking ahead, TerraDT is well positioned to contribute to the next generation of urban climate services within the Destination Earth ecosystem. By combining robust science with user-centred design and sustained engagement, it can help cities move from understanding climate risks to actively managing them, supporting more resilient, informed, and adaptive urban futures.

