FinEst Centre
for Smart Cities

SMART CITY CHALLENGE 2025
Solution idea for the city challenges

send to smartcity@taltech.ee by Nov 30, 2025

Solution Idea Title: Adaptive Nature Based Solution Planner

Planned pilot project duration – 24 months

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1. Which urban challenge or problem are you planning to provide a solution to?

Rainwater harvesting in the city - https://finestcentre.eu/challenge-proposal/rainwater-harvesting-in-the-city/

2. The solution you are proposing

The solution we are proposing is an adaptive geospatial planning and operations toolkit that links stormwater hydraulics, soil characteristics, and micro-topography with plant functional traits and 3D rainfall simulations. Its purpose is to optimize the spatial placement, type, and sizing of nature-based solutions (NBS), such as rain gardens, bioswales, tree pits, green streets, and retention areas, in pilot sites of partner cities. The toolkit would recommend locally adapted species mixes for each micro-site, drawing on an integrated knowledge base of plant traits and ecological indicators. It also provides a method to integrate realized NBS assets into existing 3D city models or digital twins, enabling simulation-based stress-testing and long-term monitoring.

Designed for interoperability with city digital twins, the platform ensures that cities maintain control over their models and data while gaining domain-specific intelligence for stormwater and biodiversity management. Antscape's contribution includes a plant library of around 900 species suited to the Baltic Sea region, each described by Ellenberg indicator values related to moisture, nutrients, light, and pH. This database allows precise matching between plant traits and local environmental conditions, supporting resilient, diverse, and high-functioning NBS.

By integrating hydrological, topographic, and ecological data, the toolkit helps cities design spatial green infrastructure that performs reliably under changing rainfall patterns. It guides the selection of plant species that improve infiltration, filtration, and durability while supporting biodiversity in urban microenvironments. Continuous monitoring through digital twins enables adaptive management, proactive maintenance, and reduced lifecycle costs.

For urban planners, the solution delivers site-specific recommendations for NBS design and implementation, integrates biodiversity considerations, and enhances decision-making with spatially explicit data. This approach strengthens the ecological effectiveness, management efficiency, and long-term credibility of NBS as core components of sustainable urban water and landscape infrastructure.

How we imagine that the solution works

1. **Collect and integrate city data:** The proposed solution connects to existing city datasets and digital twins (terrain, buildings, land use, soils, drainage networks, existing green–blue infrastructure and climate data etc.) to build a shared spatial baseline for planning.

2. **Link site conditions with plant traits and NBS types:** For each micro-site, local conditions (e.g. moisture regime, soil, shading, salinity, existing vegetation) are matched with plant functional traits from the Antscape library and with suitable NBS types (rain gardens, bioswales, tree pits, retention areas, etc.).

3. **Analyse hydrology and micro-topography:** Using this baseline, the system analyses micro-topography, flow paths and storage areas, and runs rainfall–runoff simulations to show where water currently in the real city or in a proposed new district flows, ponds and overloads grey infrastructure under heavy rain.

4. **Design and compare NBS scenarios in 2D/3D:** Users, e.g. planners and designers can then use the toolkit's interface to draw, adapt and configure alternative NBS layouts and species mixes directly on the map/3D model, then simulate different rainfall events (e.g. average, HQ30, HQ50, HQ100) to compare how well each scenario reduces runoff, flooding and, if applicable, captures water for reuse.

5. **Select preferred design and embed it in the city model:** The preferred NBS configuration is selected based on performance, feasibility, biodiversity and co-benefits, and is then written back into the 3D city model / digital twin as a structured layer of planned assets.

6. **Implement NBS on the ground and register assets:** Once construction takes place (This is not a part of the service we would provide, but something the city would need to do themselves), the realised NBS elements (geometry, type, plant palette, soil/media, design capacity) are registered as operational assets linked to the digital twin, so they are visible to planners, engineers and maintenance teams.

7. **Monitor, maintain and adapt over time:** As monitoring and maintenance data accumulate (inspections, sensor readings, observed issues), the proposed solution updates performance assumptions, flags underperforming sites, and supports adaptive maintenance and future redesign, turning NBS into continuously optimised, long-lived stormwater and biodiversity infrastructure.

3. Innovation and piloting of your pilot solution.

Current tools for stormwater and NBS planning fall into three main groups, each with important gaps. 1. Stormwater and green-infrastructure models (e.g. SWMM-based tools, InVEST Urban Flood Mitigation, static NBS catalogues) mainly represent hydrology and land cover, treating vegetation as generic parameters such as roughness or interception rather than explicit, site-specific plant communities with functional traits. This makes it difficult to design locally adapted plant–soil systems or optimise species mixes for specific micro-sites. 2. Urban digital twins and 3D city models increasingly represent buildings, transport networks, grey infrastructure and sometimes green surfaces, but they rarely include operational intelligence for NBS. They do not indicate where NBS should be located, which plant assemblages are suitable, how they will perform under extreme rainfall, or how they should be managed over their lifecycle, and thus act mainly as geometric and attribute containers, not as decision-support tools. 3. Plant selection tools and planting guidelines offer useful species lists, but they sit outside hydrological models, GIS workflows and city-scale datasets, and are not spatially linked to runoff, soil moisture or micro-topography, nor interoperable with city-model environments.

Overall, existing tools tend to treat NBS as engineered hydraulic devices rather than living plant–soil systems with biodiversity, resilience and long-term ecological dynamics. They lack integrated 3D scenario testing across departments, making it difficult to jointly explore, compare and communicate options. Moreover, they offer little support for feeding built NBS assets back into digital twins, which fragments long-term management and learning.

It is often ignored that NBS is a broad concept, covering not only engineered stormwater systems but also planting schemes, habitat creation, soil regeneration, and other landscape-based ecological approaches, which many existing solutions do not provide. Our aim is to integrate wider scope of potentially used NBS's for a biodiverse and resilient solutions. Many solutions also lack a practical pathway for cities to integrate to their existing 3D city models or digital twins, and therefore to environments where multiple urban planners can co-operate and compare alternative urban designs from multiple points of view.

What cities need for piloting

- Access to relevant datasets (DEM/DTM, building footprints and heights, sewer system where possible, land use, soil/substrate data, existing green infrastructure, climate and design storm information).
- A clear test area and designated piloting partners in planning, water/utilities and green-space management.
- If technically and organisationally possible, access or interfaces to existing 3D city models and digital twins, so the platform can be tested as an integrated component and not only as a standalone prototype.

Team Capabilities

- **Urban hydrology and NBS modelling:** researchers with experience in stormwater, naturebased solutions and greenblue infrastructure performance assessment.
- **Digital twins and geospatial technology:** TalTech digitaltwin and GIS experts in 3D geospatial databases, and simulationlinked digital twins.
- **Landscape and plant ecology expertise provided by Antscape:** Practical experience in designing resilient, biodiverse planting schemes in northern coastal climates.
- **Software engineering and UX:** Developers experienced in web-based geospatial platforms, data integration, and user-centric design for city planners and engineers.

4. Expected impact of your pilot solution

The pilot applies this wider NBS scope in practice. It supports NBS that fit local conditions and reduce flooding. By selecting suitable plant species and linking them to the right NBS type, the solution improves performance, lowers maintenance costs, and reduces failures such as plant loss or soil clogging. By providing a practical pathway for integrating NBS-based scenario simulations to cities' existing 3D models and urban digital twins, the solution becomes accessible to large number of cities in their effort to mitigate increasing rainfall events in warming climates. For the urban environment, the solution supports stronger biodiversity and more usable green spaces. For residents, this means cleaner and greener neighbourhoods.

The approach also supports sustainability goals by embedding biodiversity considerations into planning and management. We will consider the principles of ISO 17298:2025. The standard guides organisations in integrating biodiversity into strategy and operations. It helps assess impacts and dependencies, manage risks, and identify opportunities for green growth and nature-positive finance.

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<u>Disclaimer</u>: by submitting this form you will give the FinEst Centre for Smart Cities the right to share this idea with cities and other researchers, companies through FinEst Centre homepage. If this idea is selected, the FinEst Centre for Smart Cities has the right to implement this idea with offering you an active role in conducting the pilot. If this pilot is selected then the financing is an investment by the FinEst Centre for Smart Cities.

CHECKLIST AND FAQ

Are you a researcher from TalTech? - Yes – you are warmly welcome to propose one or more solutions ideas.

Are you a researcher from another university? - Yes – you are warmly welcome to propose a solution but form a team with TalTech researchers. Need help with contacts, please ask.

Are you from a company? - Yes - you are warmly welcome to propose a solution but form a team with TalTech researchers. Need help with contacts, please ask. NB! But keep in mind that we cannot finance the costs of companies as partner. The companies are welcome to propose ideas in case they would need researchers to develop their solutions considerably further and they would like to become the commercialisation partners of these solutions. The companies need to be mature enough to cover their own expenses for participation.

Are you a city, municipality or a campus / private real estate developer? - Yes – do not propose solution ideas but wait the researchers and companies to propose the solutions and read their proposals from our homepage from Dec 2.

Which urban challenge can the solution idea address? - Please choose one from the list of the urban challenges chosen for the Smart City Challenge 2025, i.e. Round 5. The challenge needs to have minimum 1 city from Estonia and one from another country interested, the more the better.

How will the proposed solution ideas be evaluated? – We will not evaluate the proposed initial solution ideas but cities/municipalities/campuses/private real estate developers will say to you if they are ready to join your proposal and pilot the solution proposed by you or not. You will need minimum one Estonian city/county and one city/county from another country to make the pilot project proposal already together with them by Febr 28, 2026.

Can we have private real estate developers or campuses instead of cities as partners? – No, you need minimum one Estonian city/county and one city/county from another country but you are welcome to have private real estate developers and campuses as additional partners. In several cases they are more likely future customers for your solution. And there can be other possible customer segments who are worth to involve in one or other way as well. We can cover the costs of any private partner.

Do we need to send a confirmation letter from the cities with the challenges we address? – No, you do not. But you are very welcome to discuss and develop your idea with these cities already in this phase. That would raise the probability to be successful in the next phases considerably. The city contacts are available at FinEst Centre homepage under the Smart City Challenge 2025 challenge list.

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