Soil Mission Pathways for Policy Makers, Volume I:

Preventing and Reversing Soil Sealing

Why this theme matters to policy makers

Ongoing urbanization coincides with substantial environmental impacts, among which soil sealing is considered one of the most severe threats to urban ecosystems [1]. Soil sealing refers to the permanent or long-term covering or alteration of the soil surface that prevents or strongly reduces the natural exchange of water, gases and organisms between soil and the atmosphere, typically through the application of impermeable or compacted materials (e.g., asphalt, concrete, metal, glass or plastic) [2; 3]. Soil sealing increases the fragmentation of urban green infrastructures, contributing to overall biodiversity loss, flood risks, intensification of the urban heat island effects and air pollution [4; 5]. In this context, soil sealing represents a critical challenge for policymakers, as it constrains the long-term sustainability and resilience of urban environments, thereby highlighting the need for integrated spatial planning and effective regulatory action.

Soil sealing is widely acknowledged as one of the major soil degradation threats, and the EU Soil Mission (MS) has identified the objective of achieving "no net sealing and increasing reuse of urban soils" among its key priorities [6], which directly contributes to the broader objective of achieving no net land take by 2050. Moreover, reducing and progressively stopping soil sealing would strongly contribute to the success of other EU missions, such as Oceans, Seas and waters (through improved flood mitigation) and Climate Neutral and Smart Cities (by enhancing urban soil health and local climate regulation). Across the EU, the proportion of land affected by soil sealing-induced soil degradation ranges from 1 to 2.4%, although this share can be considerably higher at local scales [7; 8].

To reach this objective, the Soil Mission foresees the following key activities:

- development of practices, tools, technologies, and approaches to map and assess soil sealing;
- identification of the main drivers and enabling factors of soil sealing;
- co-development and co-creation of pathways with stakeholders in urban and rural areas, including the formulation of a roadmap toward no net soil sealing strategies;
- scaling up and coordinating cooperation with international partners.

Image: Dreamstime / Sebastian Czapnik

Current state-of-the-art

The conversion of natural and agricultural land into urbanized areas dominated by sealed surfaces remains a major challenge for ecosystem functioning and resilience in the EU. Despite the ambitious target of achieving zero net land take by 2050, the observed annual net land take rose from 409 km^2 during the period 2012-2018 to 540 km^2 in 2018-2021 (Fig. 1), with arable land being the most affected land-use category [8]. Soil sealing leads to the loss and degradation of key soil functions, including water infiltration and purification capacity [9], microbial diversity and activity [10; 11], and soil buffer capacity as a geochemical barrier against pollutants [12; 13].

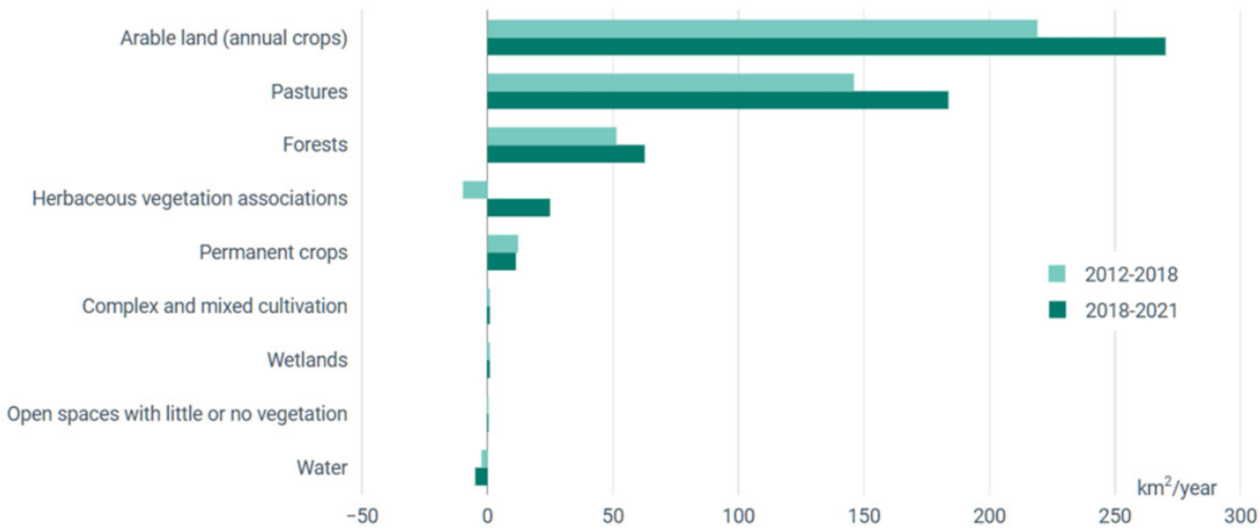
Depending on the type and intensity of land-use intervention, sealing may result either in the complete removal of the soil layer (e.g., for housing or industrial infrastructures) or in substantial alteration of surface soil horizons (e.g., for roads and pedestrian pathways), leading to pronounced declines in overall soil functionality. Such sealed soils are classified as Ekranic Technosols [14]. These soils are characterized by limited biological activity, disrupted hydrological processes, and a near-total loss of ecosystem service provision.

The EU Soil Mission and adopted Soil Monitoring Law (SML) recognize soil sealing as one of the major land degradation threats and aim to mitigate its impact on soil health through the following measures:

1. Monitoring, assessment, and control of soil sealing at the EU and national levels within the established soil monitoring framework

For the systematic monitoring of soil sealing, the use of EU-level tools made available through the Copernicus component of the Union Space Programme is recommended. Among these, the Urban Atlas is recognized as the most detailed and harmonized pan-European product for urban areas. The Urban Atlas uses Functional Urban Areas as the reporting unit and incorporates soil sealing information through, such as continuous urban fabric (>80% sealed) or discontinuous dense urban fabric (50-80% sealed). Land-cover information is regularly updated at intervals of 3-6 years, and net land take values for each period are provided as vector layers. The most recent fully validated dataset covers the period 2012-2018, while the validation of 2018-2021 dataset is expected to be completed and published in 2026.

Fig. 1 Yearly net land take in cities and commuting zones by land cover class, 2012-2018 and 2018-2021, EU-27 Member States (in km^2/year) [8]



The basic soil sealing indicators recommended by SML include the absolute (km^2) and relative (%) extent of sealed soils, as well as their temporal dynamics. Member States are required to ensure that soil sealing and soil removal indicators are updated at least every three years, based on available information. Additional indicators - such as land fragmentation or land recycling rate - can be derived using metrics estimated through remote-sensing datasets combined with machine-learning approaches.

Over recent decades, substantial progress has been made in soil sealing mapping, driven by significant improvements in satellite image quality. As a result, several global land-cover and impervious-surface products are now available based on Sentinel-1 and Sentinel-2 data archives and complementary spatial data sources, including ESA Worldcover [15], ESRI Land Cover at 10 m resolution [16], Hi-GISA [17] and GISA-10m [18]. The integration of remote-sensing data with geospatial modeling and scenario analysis (e.g., what-if modelling) has enabled the development of decision-support systems that facilitate the incorporation of soil sealing monitoring into urban planning and sustainable development. For example, the [LandSupport tool] [19] provides up-to-date information on more than ten metrics related to soil sealing, including marginal land take, urban sprawl, and edge density. These indicators are available at national and city scales and are specifically designed to support land-use planning decisions, while also offering valuable input for harmonizing sampling strategies for urban soil health monitoring.

Within this framework, the EU Horizon Europe BENCHMARKS project developed standardized protocols for urban soil monitoring that use land fragmentation as an integrative indicator of soil disturbance [20]. This approach is fully aligned with the SML principles, which emphasize that soil sealing and removal should be monitored alongside their impacts on soil's capacity to provide ecosystem services.

2. Better planning to reduce soil sealing

Monitoring soil sealing and its impact on soil ecosystem services aims to limit soil sealing according to the principle 'less and better' – that is, less sealing and better planning [21]. This principle emphasizes minimizing soil sealing wherever possible, in particular by encouraging the reuse and repurposing of already sealed soils, such as existing built-up areas. Where sealing cannot be avoided, it promotes preserving the 'best' soils by explicitly considering soil functions and soil health in urban planning.

For example, the recently developed DESTISOL tool supports decision-making on urban land use and land cover (e.g., lawns, urban gardens, or pavements) by scoring soil ecosystem services [22]. Such approaches help safeguard the healthiest urban soils (e.g., soil in urban forest and parks) and to avoid complete sealing of large areas by integrating green patches with open soil surfaces. In addition, the development of green infrastructures and nature-based solutions – such as permeable surfaces, green roofs, or rain gardens - can partially mitigate negative effects of soil sealing, including pluvial flooding and urban heat island [23].

3. Mitigation and compensation measures

To mitigate the impact of soil sealing, desealing typically involves partial restoration of the soil profile by removing sealed layers, loosening underlying materials, and adding organic and mineral substrates (e.g., compost, peat-sand mixtures, or excavated topsoil) to reconstruct topsoil and re-establish connections with natural subsoil.

A review of 85 research articles on soil sealing and desealing [2] shows that desealing almost always results in ecosystem service gain. However, the effectiveness of such projects strongly depends on appropriate spatial planning and applied technologies. For example, in many cases sealed surfaces were removed but compacted subsoils were left intact, which severely constrained soil multifunctionality and prolonged soil recovery. The specific technologies used for soil reconstruction (e.g., depth and properties of reconstructed soil layers) should be tailored to the intended land-use and target function, as habitat restoration, agriculture or recreation require different approaches. To evaluate the success of desealing projects, soil properties and functions (e.g., bulk density, aggregate stability, infiltration capacity, and microbial diversity and activity) should be monitored and compared with target land-use sites or appropriate natural reference soils.

Image: Dreamstime / Lookzone

Areas for action

The threats posed by soil sealing should be addressed through policy interventions focused on the following priority areas:

- establishing monitoring frameworks to control and minimize new sealing;
- promoting mitigation and compensation measures through desealing projects supported by clear guidelines and regulations;
- engaging citizens in soil desealing and revitalization initiatives by raising awareness, improving soil literacy, and supporting co-creation processes.

Monitoring and control new soil sealing

Net soil sealing – the balance between sealing and desealing - should be monitored on a regular basis. Regional and national authorities should develop soil sealing and desealing roadmaps, and spatial planning decisions should be aligned with these roadmaps. In particular, the allocation of the new sealed surfaces shall take into account soil health monitoring and assessment, with priority given to preserving the healthiest soils. Complete sealing of large areas (>1 ha) should be avoided by incorporating green patches with open soils and nature-based solution (NBS), which can partially compensate for the loss of soil ecosystem services.

Image: Dreamstime / Martin Mates

Desealing (where and how)

To mitigate the impacts of soil sealing, desealing projects should be implemented as close as possible to the locations where the ecosystem services have been lost due to soil sealing. Priority areas for desealing projects include brownfields (e.g., former industrial, commercial, or military sites), abandoned transport infrastructures (roads, railways, parking slots), and compensation sites associated with new infrastructure projects (e.g., redevelopment of previously built-up areas). The allocation of soil desealing and revitalization projects should take into account soil health indicators as well as topographic and landscape metrics. For example, local depressions or gaps in blue-green infrastructure networks can be identified as priority areas for intervention.

Some municipalities already apply such approaches. For instance, the municipality of Amsterdam has developed solution maps to guide the implementation of new blue-green infrastructure at the neighborhood scale, based on soil sealing assessment and hydrological modeling [24]. To achieve a net zero soil sealing target, the total area of desealed areas should be comparable to the area of newly sealed surfaces.

Typical technical steps of the desealing projects include:

1. removal of impervious surfaces including asphalt, concrete, and gravel foundation;
2. decompaction of the underlying subsoil layer;
3. testing of subsoil for contamination, and where contamination is detected, implementation of remediation measures or substitution with clean subsoil or sediments with similar physical properties (e.g., texture and filtration capacity);
4. partial or full reconstruction of topsoil by adding suitable substrates and creating constructed Technosols;
5. habitat creation or agricultural restoration, potentially combined with hydrological reshaping and NBS (creating rain gardens, ditches, or wetlands).

A wide range of substrates can be used for soil restoration, including both natural materials (e.g., excavated topsoil, bichar, sand, compost) and artificial or secondary materials (e.g., dredged sediments, bricks, zeolite, soil amendments, wood chips, or geomembranes) [25; 26; 27]. The selection of specific materials should be guided by the intended land use, costs of production and logistics, and environmental impact, with the priority given to locally available resources. More detailed assessments of costs and benefits for designing Technosols with specific properties can be conducted using a life cycle assessment approach [28] or process-based modeling [29]. Examples of best practices in the application of NBS for desealing projects can be found in global NBS platforms such as ClimateScan.

Enabling conditions

Given the high costs of desealing projects, their implementation largely depends on public awareness, incentives, or regulatory support. Soil desealing and revitalization projects can be integrated into policy instruments such as circular-economy targets, soil-sealing compensation schemes or green infrastructure funding [28]. SML recommends integrating desealing projects into investments programmed by Member States under the Recovery and Resilience Facility plans, particularly in areas related to soil decontamination, reduction of soil sealing, the reuse of organic waste and carbon farming.

In this context, the feasibility of financial instruments - potentially including the creation of a dedicated fund within the sustainable infrastructures policy window of InvestEU -can be explored to support desealing activities. At the EU level, initiatives, such as European Green Capital and Green Leaf Awards encourage municipal master plans that incorporate desealing among the proposed measures. At the national level, a Dutch 'Stonebreaker' program provides an example of an initiative aiming at mitigating soil sealing. At the city level, the Clean Soil Bank program in New York illustrates how the circulation of excavated soils and urban compost streams can be reorganized into a non-profit publicly coordinated system that supports soil construction in greening and desealing projects.

Key soil de-sealing principles for policy makers

- **Set targets and monitor net soil sealing**, integrating sealing and de-sealing into spatial planning and soil health monitoring frameworks.
- **Prioritise high-impact locations**, such as brownfields, abandoned infrastructures, and gaps in blue-green networks, where ecosystem services can be effectively restored.
- **Base decisions on soil and landscape data**, using soil health indicators, hydrology, and topography while adapting solutions to local contexts.
- **Limit extensive new sealing**, avoiding large continuous impervious surfaces and integrating green patches and nature-based solutions.
- **Ensure spatial proximity between sealing and de-sealing**, maximising local environmental and social benefits.
- **Provide enabling regulatory and financial conditions**, embedding de-sealing in compensation schemes, green infrastructure funding, and recovery investments.
- **Support stakeholder and citizen engagement**, strengthening soil literacy and co-creation at local level.

Case study:
De-sealing school playgrounds in Nantes (France)

In Nantes, measurements show that school playgrounds are on average hotter than the surrounding built-up urban areas. As heat waves increasingly occur during school terms, playgrounds have become critical spaces for climate adaptation. The City has therefore identified schoolyards as priority areas for action, favouring nature-based solutions wherever possible and resorting to artificial solutions only when necessary. While these interventions primarily benefit children and school staff, they also contribute to cooling and improving the surrounding neighbourhood.

The goal: The City of Nantes aims to transform 30% of its school playgrounds by 2026. Beyond reducing heat stress, the project seeks to redesign playgrounds around children's needs through participatory processes involving pupils, teachers, activity leaders, municipal services and families. Five guiding ambitions structure this approach: climate adaptation, inclusiveness and equality, integration into the neighbourhood, eco-management, and the creation of lively, playful and educational spaces. Translating these ambitions into concrete projects requires careful consideration of design choices and long-term management.

The how: A central challenge is to move away from the systematic use of black asphalt, which contributes both to soil sealing and to heat accumulation. Playground redesign therefore focuses on introducing a diversity of surfaces that respond to children's uses while improving permeability, thermal comfort and environmental performance. This work is carried out in close cooperation with municipal departments responsible for green spaces, ecological transition and water management.

Surfaces are organised into three main categories. Impermeable and load-bearing surfaces are limited to what is strictly necessary, such as sports courts, rolling areas, accessible paths, entrances and vehicle access. Semi-permeable surfaces are used for secondary paths or where significant technical constraints exist. Permeable surfaces are prioritised for play areas, quiet zones and vegetation. Each type of surface presents advantages and limitations depending on the playground configuration, which means there is no one-size-fits-all solution.

Fig 2. École des Châtaigniers school playground renovation and de-sealing project

Images: Valerie Joncheray

Permeable areas such as lawns and planted zones play an important role in cooling and biodiversity, but their effectiveness depends on appropriate management. Access sometimes needs to be restricted, particularly during wet periods or when vegetation is newly established. Wood chips are widely used because they are permeable, cushion falls and are relatively easy to manage. Leaves can be left on site to decompose, provided volumes remain moderate. However, loose materials require anticipation, as they can spread beyond their intended areas, clog drainage systems if these are not adapted, and need to be replenished regularly.

Key messages: Finally, the Nantes experience highlights the importance of a sober approach to design and management. Priority is given to making the most of existing elements such as trees, open ground and reusable materials, and to avoiding the replacement of impermeable surfaces with new sealed materials unless strictly necessary. The number and types of surfaces are limited to simplify maintenance and allow for standardisation across schools. Particular attention is paid to layout, ensuring accessibility for people with reduced mobility and directing rainwater towards permeable areas. Through the progressive reduction of soil sealing in school playgrounds, Nantes demonstrates how everyday public spaces can become effective levers for climate adaptation, biodiversity and improved quality of life.

Case study:
Restoring ecosystem services in Ancona (Italy)

In Ancona, many urban soils have been sealed for decades by impermeable materials such as asphalt, leaving them underused and functionally degraded. These sealed surfaces limit essential ecosystem services, including water infiltration, carbon cycling and support for local biodiversity. The REUSES project (Restore Urban Sealed Soil for Alternative Ecosystem Services), funded by the European Union through Next Generation EU, addresses this challenge by transforming sealed public spaces into productive and socially inclusive community gardens.

The goal: The main objective of REUSES is to recover long-sealed soils in selected public areas of the Municipality of Ancona and to reactivate their ecological and productive functions. The project focuses on uncovering and characterising soils to assess their physical, chemical, and biological conditions, including potential contamination. This diagnostic phase provides the basis for targeted restoration strategies that respond to site-specific constraints and opportunities.

The how: Once exposed, soils are prepared for productive use by reducing compaction and applying carefully selected green compost amendments to restore fertility and biological activity. Seasonally appropriate vegetable crops are then planted, integrating food production into the city while supporting biodiversity and creating new green spaces accessible to residents. Soil and plant properties are monitored before and after interventions to assess restoration effectiveness and to ensure food safety, allowing for adaptive management over time.

A key dimension of the project is citizen engagement. Local residents are involved through surveys and participatory activities that explore perceptions of urban gardens on these de-sealed surfaces and promote shared responsibility for soil stewardship. This social component strengthens community cohesion and helps embed restored spaces into everyday urban life, increasing long-term acceptance and care.

Key messages: The REUSES project demonstrates that de-sealing is not only a technical operation but a process of ecological and social regeneration. By treating soil as a living resource rather than a passive substrate, the project shows how targeted de-sealing and greening can recover soil functions lost through long-term sealing. It highlights the importance of integrating soil characterisation and monitoring into urban regeneration projects from the outset, both to improve restoration outcomes and to protect human and environmental health. More broadly, the experience in Ancona illustrates how medium-sized cities can develop replicable practices for urban de-sealing and soil restoration, contributing not only to climate resilience, biodiversity enhancement, and European policy objectives such as the goal of no net land take by 2050, but also to active citizen engagement, fostering shared stewardship of urban soils and more inclusive, participatory urban regeneration processes.

Fig 3. Urban gardens growing on de-sealed surfaces in Ancona (Torrette and Vallemiano areas). Formerly sealed areas have been transformed into productive community spaces, showing how soil restoration can support urban resilience, local food production, and citizen involvement.

Conclusions for policy makers

Soil sealing is a structural challenge for urban sustainability that requires clear policy direction and long-term commitment. The evidence and case studies presented in this booklet show that reducing soil sealing and restoring sealed soils is both technically feasible and socially beneficial, provided that enabling policy frameworks are in place.

For policymakers, several key takeaways emerge:

Prevention must remain the first priority: limiting new soil sealing through integrated spatial planning, reuse of already built-up areas, and protection of the healthiest soils is the most effective and cost-efficient strategy. Soil sealing indicators and targets should be systematically embedded in planning, permitting and monitoring processes at local, regional and national levels.

Where soil sealing already exists, **de-sealing and soil restoration should be recognised as strategic urban regeneration measures**, not as secondary or compensatory actions. Clear technical guidance, minimum quality standards and monitoring requirements are essential to ensure that de-sealing projects effectively restore soil functions and ecosystem services. Linking de-sealing objectives to climate adaptation, flood risk management, biodiversity and public health policies can further strengthen their relevance and uptake.

The case studies also underline the importance of **early integration of soil knowledge into decision-making**. Soil characterisation and monitoring should be conducted at the outset of urban projects to guide design choices, manage risks related to contamination or compaction, and maximise long-term benefits. Cross-sectoral coordination between planning, environment, water and green infrastructure departments is a critical enabling factor.

Finally, **citizen involvement and local stewardship** play a key role in the durability of de-sealing initiatives. Participatory approaches increase acceptance, reduce maintenance pressures and help embed restored soils into everyday urban use. Supporting such approaches through funding schemes, awareness-raising and capacity building can accelerate the transition toward more permeable, resilient cities.

Image: Dreamstime / Photographerlondon

References

1. Kabisch, N. & Haase, D. 2013. Green spaces of European cities revisited for 1990-2006. Landscape and Urban Planning, 110.

2. Tobias, S., Conen, F., Duss, A., Wenzel, L.M., Buser, C. & Alewell, C. 2018. Soil sealing and unsealing: State of the art and examples. Land Degradation and Development, 29.

3. European Commission (EC). 2021. EU Soil Strategy for 2030. Reaping the benefits of healthy soils for people, food, nature and climate. COM(2021) 699 final. Communication from the Commission to the European Parliament, the council, the European economic and social committee and the committee of the regions.

4. Vasenev, V., Varentsov, M., Konstantinov, P., Romzaykina, O., Kanareykina, I., Dvornikov, Y. & Manukyan, V. 2021. Projecting urban heat island effect on the spatial-temporal variation of microbial respiration in urban soils of Moscow megalopolis. Science of the Total Environment, 786.

5. Calfapietra, C., Di Lonardo, S., Peruzzi, E., Doni, S. & Masciandaro, G. 2025. Perspectives From Nature-Based Solutions to Restore Soil and Ecosystems. European Journal of Soil Science, 76.

6. Panagos, P., Jones, A., Lugato, E. & Ballabio, C. 2025. A Soil Monitoring Law for Europe. Global Challenges, 9.

7. Arias-Navarro, C., Panagos, P., Jones, A., Amaral, M.J., Schneegans, A., Van Liedekerke, M., Wojda, P. & Montanarella, L. 2023. Forty years of soil research funded by the European Commission: Trends and future. A systematic review of research projects. European Journal of Soil Science, 74.

8. EEA (2025) – Net land take in cities and commuting zones in Europe. www.eea.europa.eu/en/analysis/indicators/net-land-take-in-cities?activeAccordion=546a7c35-9188-4d23-94ee-005d97c26f2b.

9. Nakayama, T., Watanabe, M., Tanji, K. & Morioka, T. 2007. Effect of underground urban structures on eutrophic coastal environment. Science of the Total Environment, 373.

10. Piotrowska-Długosz, A. & Charzyński, P. 2014. The impact of the soil sealing degree on microbial biomass, enzymatic activity, and physicochemical properties in the Ekranic Technosols of Toruń (Poland). Journal of Soils and Sediments, 15, 47–59.

11. Deeb, M., M. Groffman, P., Blouin, M., Perl Egendorf, S., Vergnes, A., Vasenev, V., L. Cao, D., Walsh, D., Morin, T. & Séré, G. 2020. Using constructed soils for green infrastructure - Challenges and limitations. SOIL, 6.

12. Charzyński, P., Plak, A. & Hanaka, A. 2017. Influence of the soil sealing on the geoaccumulation index of heavy metals and various pollution factors. Environmental Science and Pollution Research, 24, 4801–4811.

13. Romzaykina, O.N., Vasenev, V.I., Paltseva, A., Kuzyakov, Y. V., Neaman, A. & Dovletyarova, E.A. 2021. Assessing and mapping urban soils as geochemical barriers for contamination by heavy metal(loid)s in Moscow megapolis. Journal of Environmental Quality, 50, 22–37.

14. IUSS Working Group WRB. 2022. IUSS Working Group WRB. 2022. World Reference Base for Soil Resources. International soil classification system for naming soils and creating legends for soil maps. 4th edition.

15. Zanaga, D., Van De Kerchove, R., De Keersmaecker, W., Souverijns, N., Brockmann, C., Quast, R., Wevers, J., Grosu, A., Paccini, A., Vergnaud, S., Cartus, O., Santoro, M., Fritz, S., Georgieva, I., Lesiv, M., Carter, S., Herold, M., Li, L., Tsendbazar, N.E., Ramoino, F. & Arino, O. 2021. ESA WorldCover 10 m 2020 v100.

16. Karra, K., Kontgis, C., Statman-Weil, Z., Mazzariello, J.C., Mathis, M. & Brumby, S.P. 2021. Global Land Use/Land Cover With Sentinel 2 and Deep Learning. International Geoscience and Remote Sensing Symposium (IGARSS), 4704–4707.

17. Sun, Z., Du, W., Jiang, H., Weng, Q., Guo, H., Han, Y., Xing, Q. & Ma, Y. 2022. Global 10-m impervious surface area mapping: A big earth data based extraction and updating approach. International Journal of Applied Earth Observation and Geoinformation, 109, 102800.

18. Huang, X., Yang, J., Wang, W. & Liu, Z. 2022. Mapping 10 m global impervious surface area (GISA-10m) using multi-source geospatial data. Earth System Science Data, 14, 3649–3672.

19. Langella, G., Basile, A., Giannecchini, S., Moccia, F.D., Mileti, F.A., Munafó, M., Pinto, F. & Terribile, F. 2020. Soil Monitor: an internet platform to challenge soil sealing in Italy. Land Degradation and Development, 31.

20. Cheval, P., Symanczik, S., Lori, M., Basile, A., Beriot, N., Berlin, A., Bünemann, E.K., Creamer, R., Cunha, L., David, F., Di Lonardo, P., Götzinger, S., Hofman, J., Mäkipää, R., Möller, J., Reis, F., Sandén, T., Törmänen, T., Vasenev, V. & Schwartz, C. 2025. BENCHMARKS soil sampling protocol: Guidelines for urban systems. Natural Resources and Bioeconomy Studies 41/2025. Natural Resources Institute Finland. Helsinki. 32 p. Sarah Symanczik ORCID ID, https://orcid.org/0000-0002-2773-387

21. European Commission. 2012. Guidelines on best practice to limit, mitigate or compensate soil sealing. Luxembourg.

22. Séré, G., Lothode, M., Blanchart, A., Chirol, C., Tribotte, A. & Schwartz, C. 2024. Destisol: A decision-support tool to assess the ecosystem services provided by urban soils for better urban planning. European Journal of Soil Science, 75.

23. Cortinovis, C., Olsson, P., Boke-Olén, N. & Hedlund, K. 2022. Assessing Potential for and Benefits of Scaling up Nature-Based Solutions in Malmö. In: Lecture Notes in Civil Engineering.

24. Omgevingsprogramma Riolering 2022 –2027 www.waternet.nl/siteassets/ons-water/omgevingsprogramma-riolering-2022-2027.pdf

25. J-P Grard, B., Chenu, C., Manouchehri, N., Houot, S., Frascaria-Lacoste, N. & Aubry, C. 2018. Rooftop farming on urban waste provides many ecosystem services. Agronomy for Sustainable Development, 38, P. 2, https://doi.org/10.1007/s13593-017-0474-2

26. Ivashchenko, K., Lepore, E., Vasenev, V., Ananyeva, N., Demina, S., Khabibullina, F., Vaseneva, I., Selezneva, A., Dolgikh, A., Sushko, S., Marinari, S. & Dovletyarova, E. 2021. Assessing soil-like materials for ecosystem services provided by constructed technosols. Land, 10, 1185

27. Tams, L., Nehls, T. & Calheiros, C.S.C. 2022. Rethinking green roofs- natural and recycled materials improve their carbon footprint. Building and Environment, 219.

28. Rugani, B., Pölling, B., Della Casa, M., Guidolotti, G., Baldacchini, C., Timpe, A. & Calfapietra, C. 2024. Coupled life cycle assessment and business modelling to estimate the sustainability of using regenerated soils in urban forestry as nature-based solutions. Urban Forestry and Urban Greening, 95.

29. Séré, G., Schwartz, C., Ouvrard, S., Renat, J.C., Watteau, F., Villemin, G. & Morel, J.L. 2010. Early pedogenic evolution of constructed Technosols. Journal of Soils and Sediments, 10, 1246–1254.

30. Urban Atlas Land Cover/Land Use Change 2012-2018 (vector), Europe, 6-yearly, Jan. 2021. DOI https://doi.org/10.2909/949683b7-5795-4c72-845f-77d049010649

ICLEI position paper:
“Cities for an Integrated Landscape Approach - Curbing Land Degradation and Restoring Europe’s Soil Ecosystems”
https://iclei-europe.org/publications-tools/?c=search&uid=c2JErp0q

Authors:

Slava Vasenev, Loes van Schaik
(Wageningen University & Research)

Roger Roca Vallejo
(ICLEI Europe)

Cecile Moisdon
(Nantes Métropole)

Sara Dilonardo
(Istituto di Ricerca sugli Ecosistemi Terrestri del Consiglio Nazionale delle Ricerche)

Rooted in action
Establishing, activating, and empowering glocal ecosystems to restore soil values, roles, and connectivity through science, technology, and creative expression.

SoilTribes

www.soiltribes.eu

Cover image: Pexels / Talhariaz

Funded by the European Union

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Research Executive Agency (REA). Neither the European Union nor the European Research Executive Agency (REA) can be held responsible for them.