NBSOIL
Nature-Based Solutions for Soil Management

All demo sites have already been selected and started gathering data

Milestone 2

27.08.2023

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Milestone [N]	MS Name	
Related Work Package	WP2, WP1	
Milestone led	BOKU	
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Summary

Milestone 2 has selected all demonstration sites for nature-based solutions to restore soil health in different human-affected ecosystems. The demonstration sites in the project have several aims within the implementation of the project, in particular:

Provide **practical demonstrations of nature-based solutions** to restore soil health **can be implemented** and thereby assess the required knowledge and technologies for their application.

Compile available and add novel data on the impact of nature-based solutions for soil health to better evaluate the expectable impact in case of their larger-scale implementation in the course of EU soil health strategies.

Elaborate on-site teaching and demonstration material for soil advisers to be integrated in the NBS Academy (WP3) formats.

Establish testing and implementation sites for innovative soil sensing and mapping tools (WP4) that allow soil advisers a more targeted management of soil health restauration combining available mapping and sensing information with on-site datasets.

Following the focus of the project, demonstration sites have been identified for different ecosystems where NBS are practiced for (i) agricultural soils, (ii) peat soils, (iii) forest soils, and (iv) urban and industrial soils. Specifically, the nature-based management solutions demonstrated at the selected sites include:

- For agricultural sites: Organic fertilizers from biowastes (Task 2.3) and cover cropping (Task 2.4)
- For peat soils: Paludiculture (Task 2.5)
- For forest soils: Forest diversification (Task 2.6)
- For urban and industrial soils: Bioremediation (Task 2.7) and urban greening (Task 2.8).

Figure 1 gives an overview of the location of the demonstration sites for the four human-influenced ecosystems where nature-based solutions for soil are tested and demonstrated.

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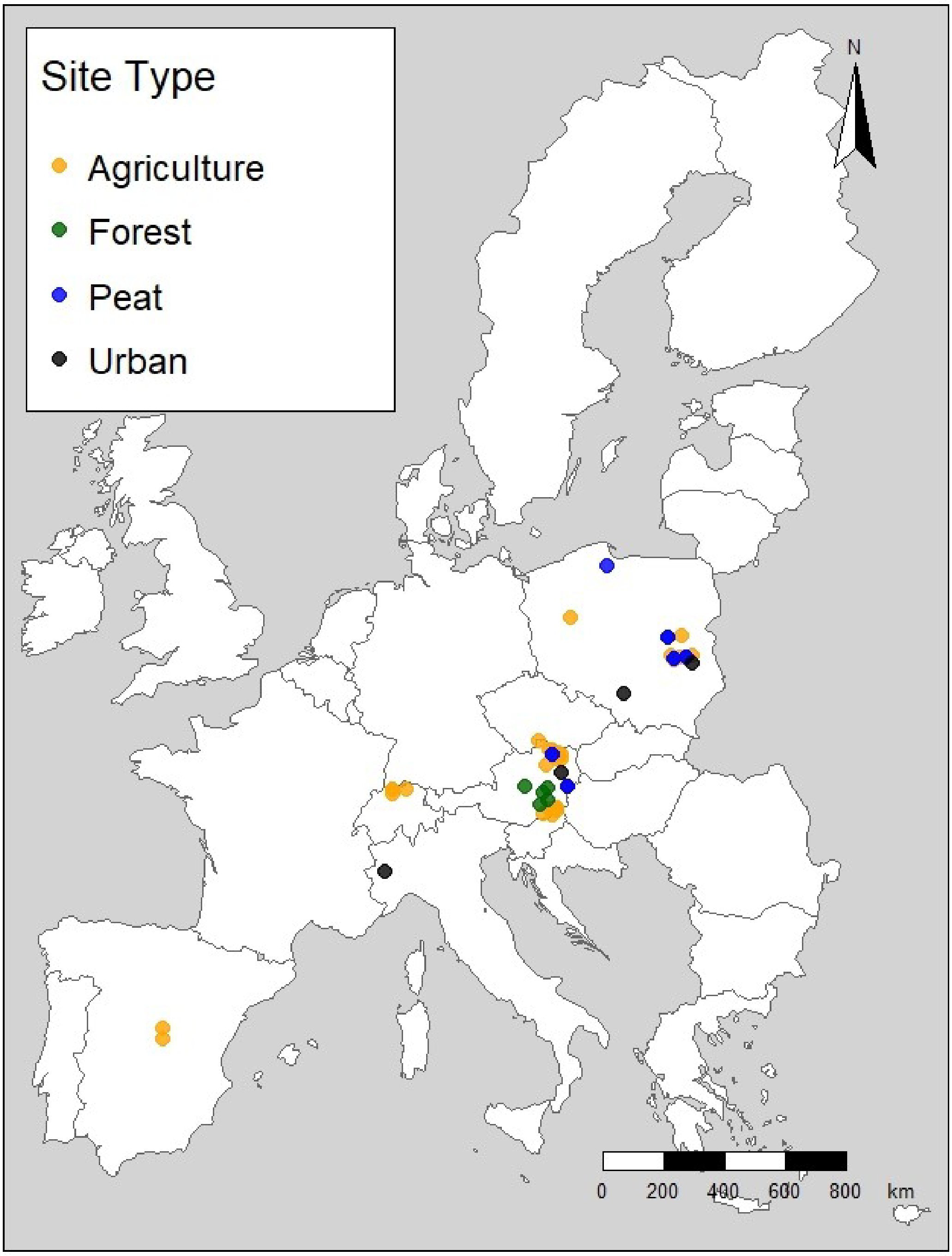

Figure 1. Map with NBS demonstrations sites.

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1. Agricultural demonstration sites

1.1 Site selection criteria

The agricultural demonstration sites have been selected as practical implementation examples for nature-based solutions to enhance soil health. Within the overall strategies of regenerating soil health at a system level, the agricultural demonstration sites in particular address the specific NBS targets of

- better integration of organic fertilizers to enhance circular usage of nutrients and thereby giving value to locally available biowastes (Task 2.3), and
- advancing towards evergreen farming via improved cover cropping systems (Task 2.4)

The criteria for selection were based on diverse environments (pedo-climatic conditions) as well as a diversity of farming systems. The chosen sites thus represent a wide array of soil types, ranging from sandy to fine-textured soils, and encompass different climate conditions, reflecting semi-arid to humid regions.

Additionally, the selected sites span a spectrum of farming systems, including organic and conventional approaches, as well as arable and mixed systems with livestock. This diversity underscores the versatility of nature-based solutions across various agricultural contexts, necessitating tailored approaches to fertilization, crop rotation, and tillage.

The sites for demonstration, documentation and assessment of nature-based solutions in soils under agricultural land use comprise 16 sites in Austria (Table 1) and 6 sites in Poland (Table 2) that have been selected based on the following criteria:

- Diversity of environments: The impact of nature-oriented soil management solutions for soil health is dependent on the natural site characteristics, particularly basic soil characteristics. Therefore, the sites comprise a wide range of soil types and textures from low-organic matter sandy soils to high organic matter fine-textured soils. The diversity of soils is related to different climatic characteristics, ranging from semi-arid water-limited sites (< 550 mm annual precipitation) to humid sites (> 800 mm annual precipitation), resulting in different site-specific challenges for nature-based soil health management systems.
- Diversity of farming systems: The sites for nature-based management solutions comprise organic and conventional farms as well as arable and mixed systems with livestock, resulting in different approaches in terms of fertilizer type (including organic fertilizers), crop rotation (including intensity and type of cover cropping) and tillage system.

Within the specificity of each farming system, the overall characteristics of the selected agricultural sites aims to mimic natural ecosystems by:

- minimizing the duration of bare soil by an intensive use of cover crops and undersown intercrops, aiming for evergreen farming systems with long-duration of active photosynthesis for provision of root-mediated carbon input into soils,
- minimizing the intensity of mechanical soil disturbance by using shallow non-inversion and no-tillage systems, thereby also conserving a maximum coverage of the soil surface by mulch residues for soil

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protection against water and wind erosion as well as minimizing evaporation losses in dry environments, and

- enhancing the diversity of cropping systems in diversifying main crop rotations, usage of biodiverse cover crop mixtures and fostering landscape elements (hedgerows, biodiversity buffer strips), thereby providing habitats for a range of beneficial organisms that strengthen biological networks and thereby the stability of agricultural ecosystems.

1.2 Site description Austria

The demonstration sites in Austria address several soil health challenges that are common to European agriculture, comprising soil carbon storage, climate change adaptation to limited rainfall, soil erosion and structure degradation as well as nutrient losses towards groundwater. Particularly farms operating in hilly regions with intensive pig and poultry husbandry constitute important demonstration sites for implementation of novel solutions to address groundwater protection and soil erosion mitigation in intensive crop rotations with high proportion of maize, oilseed pumpkin and grain millet.

The selected Austrian demonstration sites are either research-accompanied practical farms, where farmers frequently are active in soil health associations (e.g., Boden. Leben, Humusbewegung, Practitioners' Forum of the Competence Centre for Arable Land, Humus and Erosion Control of the Styrian Chamber of Agriculture), or research sites where specific NBS are tested. Thus, the site selection addresses cases where farmers, extension and research commonly solve locally relevant soil and environmental challenges in a frame of co-creation.

At the sites, the compilation of data including basic soil properties as well as key soil health indicators for chemical, physical and biological soil ecosystem functioning has started, aiming to provide the relevant information and formats for soil advisers to judge the effectivity of the implemented and demonstrated management solutions

Table 1. Agricultural sites for the demonstration of nature-based solutions for soil with location, and short description of the farming systems with the predominant soil type and texture class (in parenthesis) in Austria. Where available, the website of the farms and/or the farmers' association is indicated.

Location	Description
Absdorf, Austria	Organic farm with crop production under minimum tillage, including experience in roller crimper, highly diverse crop rotations, undersowing and diverse cover cover crop mixtures; combined arable farm with market gardening. https://grandfarm.at/ Soil: Calcaric phaeozem (SiL-CL)
Eisgarn, Austria	Organic and regenerative mixed farm following demeter standards. Evergreen farming system with frequent undersowing, minimized tillage, usage of compost and biostimulants.

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	https://humusbewegung.at/ Soil: Leptic Cambisol (SL-LS)
Groß Burgstall, Austria	Organic and regenerative arable farm with high frequent undersowing, minimized/direct seeding and usage of compost and biostimulants. https://humusbewegung.at/ Soil: Leptic Cambisol (SL-SiL)
Grübern, Austria	Conventional arable farm with no-tillage system, diverse cover crop mixtures, innovative management approaches for potatoes with dam-coverage and planting-green wheat. Mineral fertilizeration partially with CULTAN. https://www.bodenistleben.at/ Soil: Calcaric Chernozem (SiL)
Lackendorf, Austria	Conventional mixed farm with no-tillage and strip tillage, evergreen system with permanent coverage via winter hard cover crops and undersowing, fertilization via compost with several mineral (biochar, zeolithe) and microbial soil additives. https://www.bodenistleben.at/ Soil: Cambisol (SL)
Rodingersdorf, Austria	Mixed conventional farm with no-tillage, diverse cover crops, planting-green wheat, usage of compost, precision- fertilization of mineral fertilizer, partially use of CULTAN. https://www.bodenistleben.at/, https://www.winkelhofer.farm/ Soil: Ferric Stagnosol (SL)
Steinabrunn, Austria	Conventional long-term no-tillage farm on high-erosion risk site, permanent soil coverage with high diversity cover crop mixtures and crop residues, dam-stabilizing measures in potatoes, partially use of CULTAN. https://www.bodenistleben.at/ Soil: Haplic Regosol (SiL)
Stockerau, Austria	Organic arable farm with minimized tillage, high-diversity crop rotations with different cover cropping systems including winter hard mixtures and undersown crops, compost and biostimulants for fertilization, hedge rows for biodiversity and micro-climate. https://www.bodenistleben.at/, https://www.facebook.com/Biohof.Schmidt/ Soil: Chernozem, Fluvisol (SL-SiL)

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Umbach, Austria	Conventional long-term no-tillage farm with different types of crop crop mixtures, planting-green wheat and intercropping in rapeseed. https://www.bodenistleben.at/, https://soilify.org/betrieb/betrieb-zauner/ Soil: Luvisol (SiL-L)
Hollabrunn, Austria	Experimental farm with combination of tillage intensity minimization and crop rotation systems for carbon farming and biodiversity und semi-arid conditions. https://lfs-hollabrunn.ac.at/ Soil: Chernozem (SiL)
St. Martin im Sulmtal, Styria	Long-term no-tillage conventional farm with cover crop mixtures, including undersown crops for groundwater protection and soil organic matter storage within a maize-dominated crop rotation. Soil: Fluvisol (LS)
Mureck, Styria	Conventional long-term no-tillage arable farm with diverse cover crop mixtures and partially undersown crops into maize. Soil: Stagnosol (SiL)
Raabau, Styria	Regenerative organic farm with minimized tillage, biodiverse cover crop mixtures and undersown crop and usage of different types of composts. Soil: Gleyic Fluvisol (SiL)
Hatzendorf, Styria	Conventional mixed farm with minimized tillage, carbon farming system with biodiverse winter hard cover crop mixtures and undersown crop, using biochar and microbial additives Soil: Cambisol (SL-L)
St. Anna/A., Styria	Conventional mixed farm with minimized tillage, biodiverse cover crop mixtures and undersown crop for erosion control, fertilization according Albrecht/Kinsey-system for soil structure optimization Soil: Stagnosol (SiL)
Allerheiligen bei Wildon, Styria	Experimental conventional mixed farm with minimized tillage, carbon farming, biodiverse winter hard cover crop mixtures for optimazation soil structure and erosion control Soil: Stagnosol (SiL)

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Mureck, Styria	Conventional long-term no-tillage arable farm with diverse cover crop mixtures and partially undersown crops into maize. Soil: Stagnosol (SiL)
Raabau, Styria	Regenerative organic farm with minimized tillage, biodiverse cover crop mixtures and undersown crop and usage of different types of composts. Soil: Gleyic Fluvisol ((SiL)
Hatzendorf, Styria	Conventional mixed farm with minimized tillage, carbon farming system with biodiverse winter hard cover crop mixtures and undersown crop, using biochar and microbial additives Soil: Cambisol (SL-L)

Figure 2. High-biodiversity cover crop (site Hollabrunn; source: Bodner)

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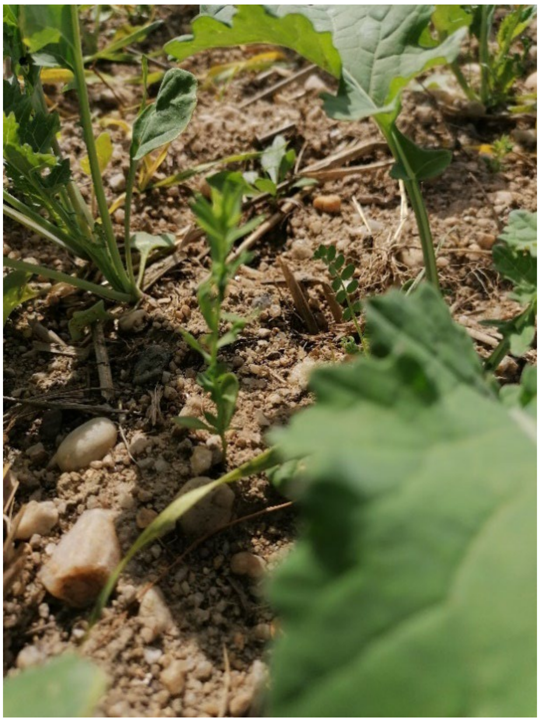

Figure 3. Intercropped cover crop into rapeseed (site Grübern; source: Bodner)

Figure 4. High coverage of mulch residues with minimum tillage system (site Rodingersdorf; source: Bodner)

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Figure 5. No-tillage system to protect soil against erosion (site Steinabrunn; source: Bodner)

Figure 6: No tillage corn planting in winter hard cover crops (site: St. Martin im Sulmtal; source Werni)

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Figure 7. No tillage: oil pumpkin in corn mulch residues (site: St. Martin im Sulmtal, source Werni)

Figure 8. Division of the field in different crops for erosion control (site: Allerheiligen bei Wildon, source: Werni)

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Figure 9: Optimized soil structure (site: Hatzendorf, source Werni)

1.3 Site description Poland

The demonstration sites in Poland are also characterized by varying soil and climatic conditions. The farms are characterized by a high proportion of sandy soils exposed to the following soil health challenges:

- loss of organic matter
- acidification
- water limitation and frequent drought events.

The farms carry out multidirectional crop production with cereals as the main branch. Cereals (winter and spring wheat, winter and spring triticale, winter and spring barley, winter rye, oats), grain maize, winter and spring rape are grown. The share of cereals in the sown area ranges from 50% to 70% depending on the farm, representing a typical share of cereals in the crop rotation for many European countries. Other crops in the rotations include sunflower, legumes, sorghum, hops, fruit trees.

Some of the farms also have animal production, dairy and meat cattle and thereby integration of locally available organic fertilizers. On the farms where livestock production is carried out, in addition to arable land, there are also permanent meadows and pastures and temporary grassland, for some sites also silvipasture is practiced.

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A key instrument that is implemented to address soil health challenges is cover cropping, mainly due to the need to take care of the proper level of organic matter, the supply of which is low due to the sandy nature of most soils. In addition, soil cover with plants plays a key role in reducing wind erosion phenomena and nutrient losses. The use of cover crops is not feasible in the late harvest of corn for grain. In this case, crop residues are left in the field.

Most of the selected farms are located on sandy soils, which are prone to organic matter loss and drought. As a result, most of the activities are aimed at preventing the loss of organic matter and increasing its content. This is done mainly by reducing tillage, applying natural organic fertilization including manure, growing cover crops, and converting arable land into permanent grassland.

Table 2. Agricultural sites for the demonstration of nature-based solutions for soil with location, and short description of the farming systems with the predominant soil type and texture class (in parenthesis) in Poland.

Location	Description
RZD Kępa, gosp. Osiny	Conventional no-tillage arable farm with diverse cover crop mixtures. Soil: Luvisol, Brunic arenosols (S, SL, L)
RZD Kępa, gosp. Osiny	Temporary grassland Soil: Luvisol (S, SL, L)
RZD Kępa, gosp. Osiny	Conversion of arable land to permanent pasture Soil: Gleyic Phaeozems (L)
RZD Kępa, gosp. Kępa	Conventional arable farm with diverse cover crop mixtures. Soil: Fluvisol (L)
RZD Grabów	Conventional arable farm with diverse cover crop mixtures. Carbon farming Soil: Luvisol (SL)
RZD Baborówko	Conventional long term no-tillage arable farm with diverse cover crop mixtures. Conversion of arable land to fallow land. Soil: Luvisol, Brunic arenosols, (S, LS)

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Figure 10: Temporary grassland, RZD Kępa, Osiny

Figure 11: Crop residues, RZD Kępa, Osiny

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Figure 12: Conversion of arable land to permanent pasture, RZD Kępa, Osiny

1.4 Site description Switzerland

Also, the agricultural demonstration sites in Switzerland follow the general site selection criteria of allowing appropriate demonstration, documentation and assessment of nature-based solutions in soils under agricultural land use under diverse environmental conditions and a variety of approaches that fit to individual farming settings.

The selected sits comprise 4 locations on 3 farms in Switzerland with focus on cover cropping and innovative tillage methods.

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Table 3. Agricultural sites for the demonstration of nature-based solutions for soil with location, and short description of the farming systems with the predominant soil type and texture class (in parenthesis) in Switzerland.

Location	Description
Stiegen 2, 8425 Oberembrach	Organic farm with crop production. Strip-trial with different cover crop mixtures between 2 and over ten species to study their effect on different soil health indicators https://www.strickhof.ch/ausbildungs-versuchsbetrieb/biobetrieb-stiegenhof/ Soil type: Loam
Ackerstrasse 113, 5070 Frick	In this organic field, we have been observing the effect of reduced tillage (shallow loosening or turning, 5-10 cm deep) compared to conventional ploughing (15-18 cm deep) in an arable crop rotation since autumn 2002. We also examine whether other factors could promote the adaptation of reduced tillage in organic farming: Manure versus dung compost/slurry. This trial is embedded in the FiBL farm and is being carried out in close collaboration with an advisory group of practising farmers and advisors. Yields, weed development and effects on soil fertility are monitored over the long term. Soil type: Clay
Ackerstrasse 113, 5070 Frick	Agroforestry test site on a organic farm starting in Nov. 2023 on a soil rich in clay (40%, stagnic eutric cambisol). Interaction of trees (fruit and wood) and arable crops and livestock. Soil: Sagnic eutric cambisol (Clay)
Biohof Wolfgrube **Wolfgrubenstrasse 58** **5742 Kölliken**	Organic farm with strip cropping trial. Strip cropping is being investigated as a promising variant for controlling pests and diseases and for a more diverse use of the soil without polluting the soil and the soil life with plant protection products. Soil type: Sandy loam

1.5 Site description Spain

The main challenge to be addressed is the regeneration of soil for a marginal area with low precipitation and soil with very low levels of organic matter. The site represents research plots where to demonstrate the possibilities of soil health improvement and its impact on the agricultural production function for the reginal farming sector under conditions of high-water limitation. Currently the integration of on-farm demonstration trials in the region is evaluated.

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Table 4. Agricultural sites for the demonstration of nature-based solutions for soil with location, and short description of the systems with the predominant soil type in Spain.

Location	Description
Fuentidueña de Tajo, Madrid	Intercropping trial. The crops are guayule, hemp and safflower. The plot is characterized by a large amount of gypsum which makes it of low quality, considered a marginal area, with low organic matter and the area is characterized by low rainfall. Surface area: 0.5 ha. Annual crop rotation every year. Soil: Entisol, suborder Orthent, group 1 Xerorthent and association Haploxerept.
Fuentidueña de Tajo, Madrid	Crop competition trial where one of the factors will be a cover crop between the lanes of the guayule crop. Same plot as in the trial described above.

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2. Paludiculture demonstration sites

As part of the Task 2.5, the occurrence of paludiculture areas in Europe and Poland was analyzed. The main directions of use of wetlands and peat areas were determined. In Poland, a preliminary attempt was made to determine the benefits and losses for the owners of these lands. Areas where agri-environmental programs are implemented were defined (e.g., Poland - 269,000 ha of land in the Natura 2000 area, the vast majority of which is paludiculture land). The directions of activities and use of such lands were defined - agri-environmental programs, extensive cattle and sheep breeding, organic farming, production of green mass, including reeds, agro forestry. In the advisory system, scientists, agricultural advisors, farmers and organizations interested in the problem of developing these lands were invited to cooperate with the project. Initially, a proposal for a two-day training course for agricultural advisors in the field of soil science and agricultural production in wetlands and bogs was prepared. Particular attention will be paid to the problem of rotting of peat soils, their withdrawal from agricultural production, succession. Fields on which research can be undertaken and where the analysis can be carried out have been selected.

Paludiculture – the practice of farming on wet and rewetted peatlands – can provide a win-win for farmers, the climate and biodiversity. Paludiculture is defined as the productive land use of wet and rewetted peatlands that preserves the peat soil and thereby minimizes CO_2 emissions and subsidence. Peatlands store enormous amounts of carbon and are home to wide range of biodiversity. Traditionally, however, farming practices have focused on draining peatlands to gain more space for cattle grazing or growing crops such as corn or potatoes.

This has hugely negative implications for the local wildlife including the many species of plants, mosses, insects, birds and mammals that depend on them. Drained peatlands also lose much of their ability to store carbon, contributing to climate change. The EU is estimated to release as much as 270 Mt CO2 equivalent per year from agriculture on peatlands, globally second only to Indonesia. Restoring these wetland ecosystems, especially peatlands drained for agricultural use, can therefore play an important role in mitigating climate change, as rewetting has the potential to prevent the release of these enormous quantities of emissions, contributing to the aims set out in the proposed EU Nature Restoration Law. It could also potentially sequester carbon in the future. The proposals, published by the European Commission on 22 June, contain targets for the restoration of 30% of drained peatlands under agricultural use by 2030 and 70% by 2050. While this is welcome, a first analysis within the conservation community indicates the proposals do not go far enough. Recent analysis by Ramsar shows that to curtail global warming to 1.5°C above pre-industrial levels all drained peatlands need to be rewetted by 2050.

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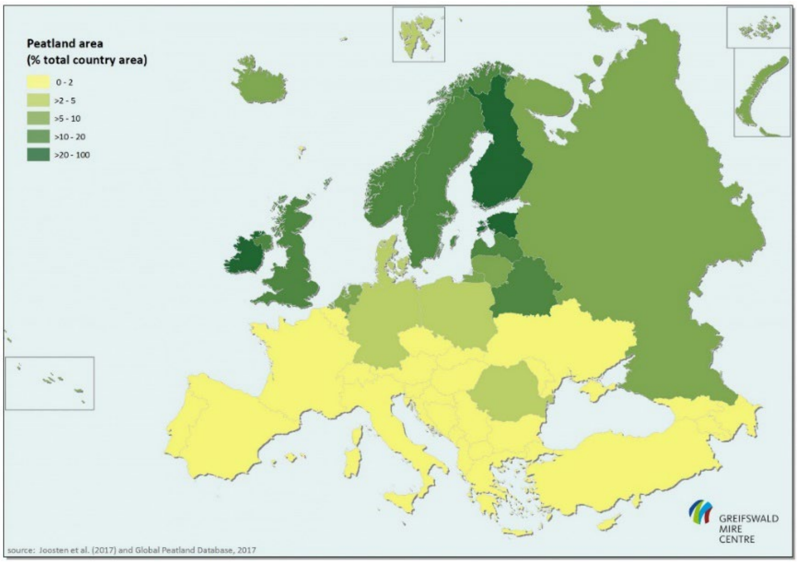

Figure 13. Source: Joosten et al. (2017); Global Peatland Database,2017

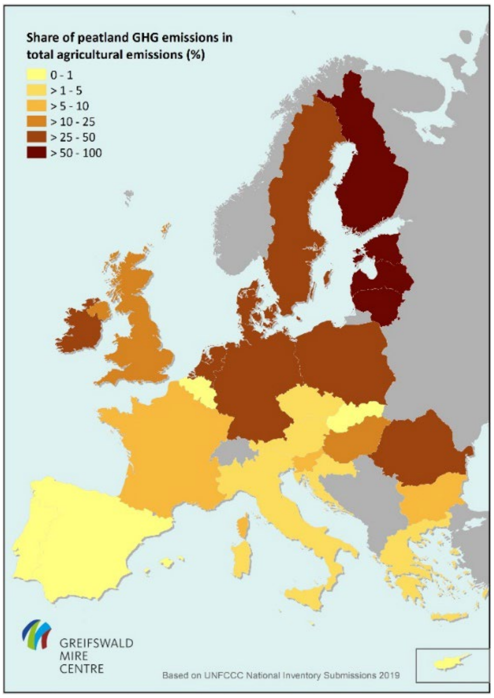

Figure 14. Source: https://europe.wetlands.org

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Reference:

- https://europe.wetlands.org/news/opportunities-for-paludiculture-in-the-cap/
- Opportunities for Peatlands and Paludiculture in the EU Common Agricultural Policy (2023-2027). Recommendations for EU Member States for their CAP Strategic Plans\
- https://onlinelibrary.wiley.com/doi/pdf/10.1002/adsu.202000146 The Power of Nature-Based Solutions: How Peatlands Can Help Us to Achieve Key EU Sustainability ObjectivesFranziska Tanneberger,* Lea Appulo, Stefan Ewert, Sebastian Lakner, Niall Ó Brolcháin, Jan Peters, and Wendelin Wichtmann
- https://data.consilium.europa.eu/doc/document/ST-11004-2021-ADD-1-REV-2/en/pdf
- Annexes https://data.consilium.europa.eu/doc/document/ST-11004-2021-ADD-2/en/pdf

Table 5. Paludiculture sites for the demonstration of nature-based solutions for soil with location, and short description of the applied management systems with the predominant soil type and texture class (in parenthesis).

Location	Description
Całowanie, Poland	A complex of pastures belonging to many farmers, located in a Natura 2000 area, bordering on swampy areas. A very high level of biodiversity, the largest concentration of corncrake in Poland. Under care by NGO's: Polish Society for the Protection of Birds. https://otop.org.pl/naszeprojekty/chronimy/ostoje-iba/wyszukaj-ostoje/pl085/ Soil: Peat-muck soil (Pt-Mck)
Osiny-Kępa	Extensive breeding of Highlander beef cows, pastures and cereal crops are carried out in agroforestry conditions. One of the experimental plants of the Institute of Soil Science and Plant Cultivation (IUNG PIB). The aim of the farm is to get to know and observe the agroforestry system. https://www.iung.pl/o-instytucie/struktura/rzd/kepa-pulawy/ https://www.facebook.com/rzdkepa/ Soil: Podzol-Arenosol (S-SiL)
Grabów nWisłą	Organic and conventional mixed farm with dairy cows beginning to IUNG PIB. The farm has a soil mosaic of mainly sandy soils and areas of gleysoils/peat. Research is being carried out, e.g., varieties in organic farming, crop rotation, erosion. https://www.iung.pl/o-instytucie/struktura/rzd/grabow/ Soil: Luvisol-Gleysol (S-SiL)
Ciasnocha Family Farm, Poland	Ciasnocha Family Farm – a 730 ha regenerative grassland farm in the Vistula delta of northern Poland. carbon sequestration (according to the Cool Farm Tool 6.5 t/CO2e/ha/year over the baseline scenario of not transitioning to grassland), increased biodiversity of species, minimal soil disturbance hence permanent land cover, and minimal use of external inputs in our operation. https://gospodarstwademonstracyjne.cdr.gov.pl/gospodarstwo/gospodarstwo-rodzinne-ciasnocha-family-farms/ Soil: Fluvisol-Peat (SiL -Pt)

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OIKOS Wójcik Farm	Organic farms with production beef cattle, lamb, pasture pigs. The area of farms is approx. 96 ha, of which 82 ha are grasslands, and the rest are forests and woodlots. Production is based on own fodder, natural grasslands characterized by very high biodiversity. The farm implements practices in the field of agroforestry. The farmer carries out various projects on his farm in cooperation with research centers https://www.facebook.com/oikos.krzywa/?locale=pl_PL Soil: Luvisol-Podzol (SL)
Mikołaj Mańkucki Farm, Poland	Mikołaj Mańkucki farm - 15 hectares farm with production of wheat, potatoes, carrot, parsley, red beet and other vegetables on fresh market. The farm has very difficult area for growing plants because of wet soil with lots of springs and ditches.We limit the use of artificial fertilizers and plant protection products on our fields to make the best taste of our vegetables. https://www.facebook.com/profile.php?id=100055718456265 Soil: wet peat and gyttja soils, alkaline

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Figure 15. Grabów n/Wisłą Farm – experiments in organic and conventional systems

Figure 16. Kępa-Osiny farm. Highlander in agroforestry farm.

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Figure 17. OIKOS M.Wójcik Farm – agroforestry and beef cattle production

Figure 18. Ciasnocha Family Farm – production hay for energetic purposes

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Figure 19. Mikołaj Mańkucki Farm - production potataoes and carrots for fresh market

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3. Forest demonstration sites

3.1 Site selection criteria

The sites for demonstration, documentation and assessment of different management situations in special forest land use comprise 5 regions in Styria, Austria that have been selected based on the following criteria:

- Diversity of environments: First geological differences are very important in case of water management. Therefore, the sites comprise a wide range of different geological underground and soil types and textures from low-organic matter sandy soils to high organic matter fine-textured soils. The diversity of soils is related to different climatic characteristics, ranging from semi-arid water limited sites (< 550 mm annual precipitation) to humid sites (> 1000 mm annual precipitation) and different sea level.
- Diversity of harvesting systems: Difference between “close to nature forestry systems” and “clear cut systems” will be explored.

3.2 Site description

- Clear cut system: all trees would be harvested in an area between 0,5 to 1,5 ha with different harvesting methods. The harvesting methods (highly mechanized or manuallywith chain saw) are not in our focus, but the effects to the drain situations in slopes.
- Close to nature harvesting system: a few trees every 7-10 years with great diameter, with high quality or on the other side worst quality would be harvested. A lot of smaller trees are conservedand will grow to a better quality and quantity. Also, natural regrowthwill protect the soil and stop water loss.

Table 6 provides a list of the selected forest sites where we can compare the different harvesting systems on comparable soil types.

Table 6. Forest sites for the demonstration and effects between the different harvesting systems. Where available, the website of the forest owners and/or the farmers’ association is indicated and named.

Location	Description
St. Barbara, Austria	Forest owner CAFS. In the area (350 ha) of the forest school we can compare 2 different sites with different soil types Mr. Krondorfer https://fastpichl.at/ Soil: Silicate rock, low in fine material (mica, feldspar, quartz) and carbonate rock
Kumberg, Austria	Forest owner castle Kainberg, Mr. Wimpffen Mr. Krogger

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	Soil: Intermediate silicate rocks Paragneiss, base undersupplied
Voitsberg, Leschak Austria	Forest owner CAFS Mr. Scherr Soil: Silicate rock
Bruck/Mur, Austria	Forest school. Mr. Hintsteiner https://www.forstschule.at/ Soil: Phyllite schist, base undersupplied
Hall bei Admont, Austria	Forest school. Mr. Tippelreither Soil: Carbonate, Gutenstein limestone and dolomite, base-saturated

Figure 20. Soil profile (source: Krogger J., CAFS)

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Figure 21: Close to nature harvesting system (source: Krogger J., CAFS)

Figure 22: Clear cut harvesting system (source: Krogger J., CAFS)

Figure 23: Discussion about special soil situations in forest (source: Krogger J., CAFS)

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4. Urban and industrial demonstration sites

4.1 Phytoremediation sites

4.1.1 Selection criteria

The sites considered for selection for the bio- and phyto-remediation activities had to have certain characteristics to be considered.

- The sites should have contamination levels that are above thresholds that could be considered normal. In Austrian formal characterization terms, they would be considered sites “with contamination levels of concern”. Ideally some organic contamination (like PAHs) and some heavy metal contamination to allow the demonstration for both contamination types.
- The contamination levels should not be so high that the bio- or phyto-remediation methods would likely be unsuccessful due to excessive phytotoxicity and the time to achieve results would be beyond the time scope of this project.
- The site owner would be willing to participate in the project. Site owner has to agree to a medium to long term remediation strategy that is still perfecting techniques and interventions. Set aside plots for comparison (no intervention) and plots for testing different types of experimental interventions

One such site was found in Lower Austria at a reasonable traveling distance from the company location of Alchemia-nova. The willingness of the owner of the site to offer his location for scientific experiments and helping in developing the NBS approaches to soil remediation where crucial in selecting the site for this project. However, the owner requested a high level of confidentiality, and the exact location of the site will not be publicly disclosed by Alchemia-nova. It was agreed that any public statements about the test site as it relates to the project will only be done by the project owner or subject to his evaluation of content and approval. Alchemia-nova is free to discuss the scientific and technological details of the activities without revealing the test site location.

4.1.2 Site description

The site has been divided into two “sub-sites” since those two places have markedly different levels of contamination. The main inorganic contaminants to be found are moderate levels of Arsenic (As), Lead (Pb) and Zinc (Zn). Organic contaminants apparently mostly derive from bitumen used in an industrial process. The location is characterized by partially abandoned industrial buildings and access roads dividing up plots of soil in a somewhat haphazard way, as the industrial buildings were added over several years in the last century. The open plots of land are overgrown with spontaneously occurring plants or even some pioneer-plants establishing themselves from the adjacent forested areas. Colloquially they would be called “weeds”. These plants are periodically cut back by the owner to resemble a “wild lawn” look. The site is located at the edge of

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a small town and is surrounded by forest in the South and West. A public paved road and further industrial buildings delimit the rest of the area.

The soil structure and quality is rather degraded through the construction and industrial activities of the past, but the original brown earth (e.g. cambisol) can be clearly recognized. The inherent soil fertility seems to be quite high, judging also by the robust growth of the plants encountered there.

The irregular shapes of the soil plots due to adjacent buildings and gravel roads made the division into test plots somewhat difficult and limited the areas that can be reasonably used for bio- and phytoremediation without exploding the costs for manual labour.

Figure 24: Marking out the test plots and the soil-sampling pattern for a representative composite sample for laboratory analysis.

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Figure 25: Taking of soil samples and curious study of “little treasures from the past” found in the soil.

We are currently analysing soil samples collected in 2023 to determine the concentrations of heavy metals. Of the 16 US EPA Priority PAHs with preliminary remedial goals, only Benzo[a]pyrene was found to have a concentration that requires remediation.

Further test sites for inclusion in the bio- and phytoremediation activities in 2024 located in Poland and Italy are being considered. In Poland the best candidate appears to be a former mining site that is currently used for agricultural activities. In Italy a urban/peri-urban industrial site is the most likely candidate.

4.2 Urban green infrastructure sites

4.2.1 Site description Poland

Nature-based solutions play a significant role in maintaining appropriate living conditions and are critical in preserving human health and well-being. Green areas are crucial for counteracting temperature extremes, protecting air quality and biodiversity. Examples of NBS in the city include green infrastructures such as parks, gardens, trees, green roofs, allotments, backyard gardens, ecological corridors and canals.

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The challenge to be addressed by the demo sites is how to involve soil information and soil ecosystem services in spatial planning of urban areas.

Location 1: the LSM District (Lublin, Poland)

Description:

Pilot measurements were carried out in Lublin and Pulawy in order to assess the role of urban greenery in shaping urban local climate. Measurements points (23 in Lublin and 31 in Pulawy) were located in locations with diverse density of sealed areas and vegetation. Sensors were placed in backyard gardens, allotments, parks, tree-lined urban spaces and in suburban areas. The measurements took place in the summer period.

The conducted analysis showed a significant impact of green infrastructure on temperature in the city and thus on the quality of life of residents. The most favourable conditions for humans are found in areas with diversified development and with properly distributed greenery.

A good example of such a place is the LSM District in Lublin. It is located south-west of the city centre. The first housing estates were built in the late 1950s. The housing estates have been designed taking into account the natural relief of the terrain. Lawns, flower meadows and playgrounds were arranged between the multi-family buildings as well as trees and ornamental shrubs.

The housing estate planned in this way stands out from the rest of the city. The measurements carried out showed that although the LSM is located in the middle of the city, the average air temperature is the lowest (at least 2 Celsius degrees lower as compared to the centre of Lublin). Also the number of days with a temperature above 30 Celsius degrees was the lowest, and the heat waves were the shortest.

The challenge to be addressed by the demo sites is how to involve soil information and sokl ecosystem services in spatial planning of urban areas.

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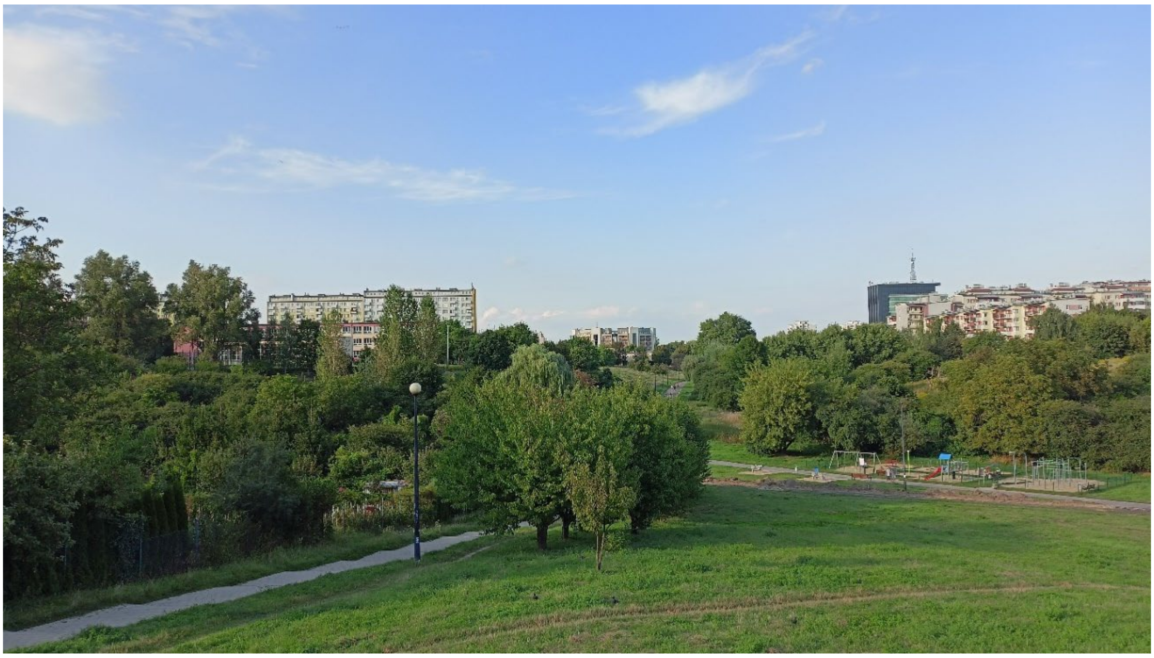

Figure 26. Gorge adopted for a recreational use (LSM, Lublin)

Figure 27. Planting of trees and ornamental shrubs (LSM, Lublin)

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Figure 28. Lawn between multi-family buildings (LSM, Lublin)

Figure 29. Trees between multi-family buildings (LSM, Lublin)

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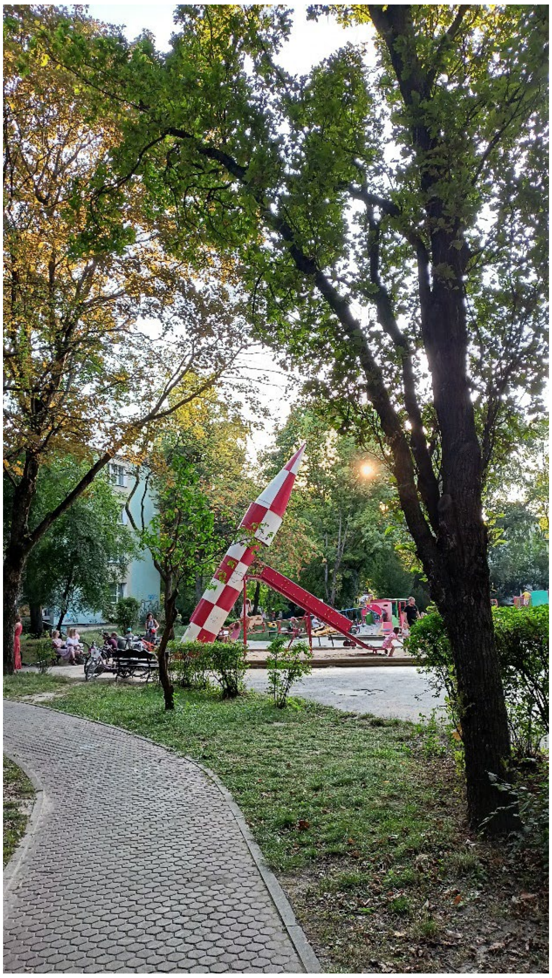

Figure 30. Playground on the Mickiewicz housing estate (LSM, Lublin).

<u>Location 2:</u> nature areas within city borders (Dąbrowa Górnicza, Poland)

Nature areas located within city borders of Dąbrowa Górnicza (Southern Poland) play a substantial role in creating local climate – temperature and humidity. They are also a habitat of valuable and protected plant species, such as *Liparis loeselii* (L.) Rich.

The issue to be explored is the spatial planning considered as an instrument of effective protection of habitats through deliberate shaping of their water management, insolation conditions, reconstruction of micro relief, etc.

Implementation of the above protection assumptions might be based on the following elements:

maintaining optimal distances between building lines and access roads from the protected enclaves;

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topography of the land microrelief conducive to the accumulation of water in limestone habitats;

incorporation of surface and rainwater into a system enabling irrigation of the area in dry periods in order to use water resources to maintain natural vegetation and reduce thermal extremes in the area and adjacent areas - a function important from the point of view of adaptation to climate change;

adaptation of urban and ecological solutions that allow the development of buildings with a residential function that do not deteriorate the aesthetic functions of the area inscribed in the landscape.

Figure 31. Blue and green infrastructure in Dąbrowa Górnicza

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Figure 32. Liparis loeselii growing in an urban area

4.2.2 Site description Italy

Creation of an area of „urban forest“ along the banks of the Sangone river through the use of regenerated soil (New Soil), based on excavated material with the addition of compost, zeolites and innovative bio-stimulants. Plants of different species were planted in the New Soil area and in the adjacent area as a control field. Growth analysis to monitor the effect of new soil on vegetation has been performed during the implementation phase.

Aims & goals

The NBS New soil supports:

- increased sustainability of the urban system
- urban regeneration through improvement of climate change risk management and resilience.
- supports viable business models with employment opportunities for local population.
- Significant technical, social and economic impacts are achievable to support sustainable innovation.
- the conversion of organic fraction of municipal solid waste in certified compost to be applied as fertilizer in the new soil application contributes to reducing GHG emissions.
- the nutrient content of the compost is significant as 1 ton of compost can substitute 37 kg of Urea.
- GHG emissions reduction potential, composting results in 87% of emissions saving with respect to traditional waste disposal.

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Target groups and beneficiaries

- Green department technicians of the City of Turin
- Citizens
- Quarry managers
- Compost producers
- Legislators

Area of implementation

2.000 m2 in Sangone Park, GPS coordinates: 45.009040, 7.641200

Main responsible partner:

Environment Park (private sector)

Other parterns involved

- Dual Srl
- UNITO
- City of Turin

Other stakeholders involved

- ACEA (TLP of Envipark)
- CCS (subcontracting of Envipark)
- Arpa Piemonte (TLP of City of Turin)
- Città Metropolitana di Torino (TLP of City of Turin)
- Private gardeners of adjacent municipal gardens
- Representatives of groups of citizens.

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Figure 33. Living Lab Turin, Italy - New generated soil for urban forestry and urban farming

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