URBAN SMS
Soil Management Strategy

Soil in the City

URBAN Soil Management Strategy

CENTRAL EUROPE
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EUROPEAN UNION
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Contents

Foreword

Soils provide a very wide range of ecosystem functions – they offer habitats for below and above ground biodiversity, they clean water which replenish the aquifers, and help regulating the microclimate in compact urban environments; they can also provide aesthetic functions through the landscape. Soil sealing and land take affect all of these functions.

The loss of soil through sealing is one of the degradation processes considered in the Soil Thematic Strategy (COM(2006) 231) and the accompanying proposal for a Soil Framework Directive (COM(2006) 232) adopted by the European Commission in 2006. The Commission proposed to limit soil sealing where possible but in any case to mitigate its effects. More recently, the Commission has adopted a Roadmap to a Resource Efficient Europe (COM(2011) 571) in which it has noted that Europe's economy will require a fundamental transformation within a generation. Preparing that transformation in a timely manner will allow us to further develop our wealth and wellbeing, whilst reducing the impact of our resource use. In that context, we have proposed that by 2020 the rate of land take (i.e. the loss of agricultural, semi-natural or natural land for the development of urban areas and infrastructure) is on track with an aim to achieve no net land take by 2050.

Data collection across Europe shows that land take is still increasing. More than 100,000 hectares of mainly agricultural land are taken annually for urbanization purposes in the 27 Member States. The European Union is supporting urban development as a key factor for economic growth, while at the same time the natural resources as a basis for life ought to be protected. Sustainable development requires a mature management of natural resources in development processes.

Soil protection policies and governance are facing different obstacles. At the legislative level, the Council has still not yet achieved a qualified majority in favour of the proposed Soil Framework Directive. On the local level, municipalities are facing the conflict of (long term) soil protection versus (short term) economic development. As a result, uncontrolled land take, soil sealing and urban sprawl are ongoing, regardless of the negative environmental impacts.

Management strategies and experiences are thus required for the practical implementation of soil protection strategies at regional and local level. The Urban Soil Management Strategy (URBAN SMS) project, funded by the European Regional Development Fund (2007 to 2013), is facing this challenge. A transnational team of eleven partners from seven Central European countries have implemented comprehensive soil management strategies and tools. As a result, the URBAN SMS project provides useful approaches to protect high quality soils and their functions during urban development. Combined with awareness raising activities and a permanent and unceasing commitment on the European, national and local level, these results will lead to a better management and protection of soil resources in Europe.

Karl Falkenberg
Director-General, Environment Directorate-General,
European Commission, Brussels

Speaking one language - definitions of terms

Transformation of agricultural or semi-natural lands into residential, industrial or infrastructural purposes over time is defined as land take, also referred to as land consumption. This process involves the development of scattered settlements in rural areas, the expansion of urban areas around an urban nucleus (urban sprawl), and the conversion of greenfield within an urban area. A greater or smaller part of the land take will result in soil sealing, meaning the permanent loss of soil functions by covering it with an impermeable material; for example through buildings and roads. In most cases the excavated soil losses its functions due to deposition in landfills. Significant parts of a settlement area are actually sealed or excavated; gardens or other green spaces are not sealed. We define urban sprawl as unlimited urban development at the urban fringe.

Soil quality is understood as soil ability to provide ecosystem and social services through its capacities, to perform its functions and respond to external influences. Soils significantly differ in their ability to fulfil soil functions.

EU legislative framework

The EU soil protection policy outlined in the Soil Thematic Strategy (COM (2006) 231) is based on 4 key pillars:

(1) Framework legislation with protection and sustainable use of soil as its principal aim.
(2) Integration of soil protection in the national and community policies.
(3) Closing the knowledge gap in soil protection through research.
(4) Increasing public awareness of the need to protect soil.

The Environmental Impact Assessment (EIA) Directive and Strategic Environmental Assessment (SEA) Directive require the assessment and minimization of any potential negative environmental impacts of projects (EIA) as well as plans and programmes (SEA). Their implementation can improve the consideration of soil in the planning and implementation of projects, plans and programs in the Member States.

Soil sealing

The issue of soil sealing is tackled in the Technical Document on Soil Sealing of the European Commission. It is based on a chain of three successive steps - limiting, mitigating and compensating soil sealing and its effects.

Limitation of soil sealing can basically take two forms: either through a reduction of land take, i.e. the rate at which greenfield is turned into settlement areas, a reduction that could even imply, depending on local circumstances, a need to stop land take altogether; or reusing already sealed land, by, for example, remediation of brownfield sites. Land take should consider the quality of the soil steering towards the use of a lower quality soil for urban development.

Mitigation of the impact of soil sealing should occur at the affected locations and should result in avoidance of significant negative environmental effects despite urbanization taking place. Building on an area of land will inevitably affect the ability of the soil to perform its full range of functions.

Compensation measures are defined as actions taken or instruments introduced in order to compensate/counterbalance soil loss or degradation during urbanization and to sustain/restore overall soils' capacity to fulfil their functions elsewhere.

Urban sprawl near the City of Celje

The need for soil management in urban areas

The role of soil in the urban environment

Soil plays an essential role in the development of human society. Public awareness is focused on soil as a basis for space for housing, industrial and commercial purposes as well as infrastructure, recreation areas and food production. But soils in the urban environment offer far more than these easily visible services:

- sustaining biological activity, diversity and productivity;
- regulating and partitioning water and solute flow;
- filtering, buffering, degrading, immobilizing and detoxifying of harmful substances originating from industrial and municipal by-products as well as from atmospheric depositions;
- storing and cycling nutrients and other elements within the earth's biosphere;
- production of renewable primary products;
- control of microclimate and mesoclimate, and
- providing support for socioeconomic structures and protecting archaeological treasures.

So currently in public awareness there is lack of appreciation for important soil functions securing the quality of human life and the environment.

Impact of land take

The narrowed understanding of soil and its services for ecosystems enhances an uncontrolled land take and soil sealing with tremendous consequences.

For example, across the European continent, 42% of mammals and 15% of birds are threatened by loss of biodiversity. Major processes of the water cycle are deteriorating, in particular the buffer function for precipitation which causes flooding in the event of heavy rain fall. Also, the loss of the filter and buffer function has led to groundwater contamination by persistent chemicals and by pathogens. Especially in inner city areas massive problems occur with air quality affected by gaseous and particulate pollutants. Land take has negative effects on urban and global climate.

A detailed description can be found in "Environmental Impact of Urban Soil Consumption" **[22]**, "Climatic Impacts of Urban Soil Consumption" **[23]**.

Management

From this point of view it should be of high priority to protect soils in the urban environment **[3]**. However, urban planning has to take into consideration many other land use aspects and needs where the protection of greenfields with high quality soils and the related functions listed before is only one of these. Therefore, a sustainable soil management approach can only be developed through multidisciplinary methods. Soil protection is facing the challenge of allowing urban development while at the same time avoiding or minimizing, or where this is not possible, mitigating or compensating land take and soil sealing.

Anthropogenic soil in the city

Natural Luvisol from loess in an urban area

The URBAN SMS project

The general goal of soil management in areas under urbanization pressure is to secure the sustainable use of soil resources considering soil quantity and quality in order to maintain healthy environment conditions and sound ecosystems. This can only be achieved by implementing this goal into the urban planning procedure.

In consequence, the target groups of URBAN SMS are municipal authorities and regional governments practically involved in urban planning procedures. Likewise, consultants and agencies in the fields of urban planning and environmental protection are addressed. Activities to raise awareness are targeted to an extended group comprising city council members and the wider public.

The state of knowledge and existing technical capacities relevant for soil protection in Europe were evaluated at the European Land and Soil Alliance (ELSA) annual conference 2007 in Stuttgart. Results were laid down in the "Stuttgart Declaration", which outlines the urgent need to develop a soil management concept focused on the applicability in urban planning procedures.

A transnational team of eleven partners from seven Central European countries was formed under the leadership of the Stuttgart Department for Environmental Protection. Experiences and contributions of five soil science institutes, two regional authorities and four municipalities with soil and urban planning experts involved were integrated in the project. Different legislative frameworks, several levels of competences and wide ranges of organization structures and city areas were represented. These framework conditions guarantee that the project results can be applied under a broad range of local circumstances.

To define, design and develop effective soil management, appropriate strategies and best practice examples were compiled **[4, 5, 6]**. Based on this, software tools needed for the implementation were developed. In addition facts, arguments, and methods to raise awareness of soil were elaborated. The URBAN SMS strategies and methods have been tested in a set of 15 pilot sites in partner cities or regions, and experiences of these tests were analysed to further improve the initial approach.

The project team at the kick off meeting in Stuttgart

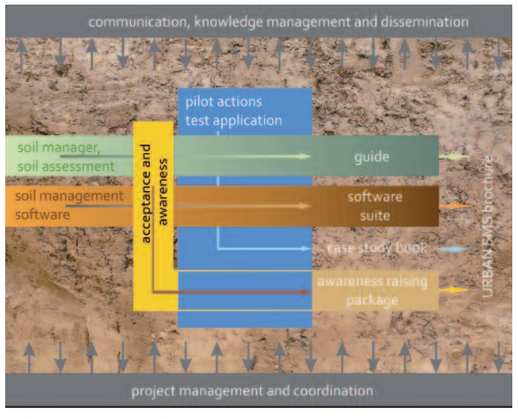
All results are available in an electronic version and can be downloaded from the project homepage www.urban-sms.eu.

They are guiding the implementation of soil protection strategies in urban planning processes. Application of these strategies enables an assessment of land use options and balances the exploitation and conservation of land resources.

"Guide Municipal Soil Management" **[8]** as a core result is a handbook with descriptions of the goals, strategies and tools.

"Guidance for Soil in the Strategic Environmental Assessment (SEA) and the Environmental Impact Assessment (EIA)" **[7]** was established.

The "Soil Manager Suite" **[11]** involves two IT applications ready for use within urban planning. 1) The desktop application for a non-spatial soil data evaluation and 2) the Web GIS application, both supporting the evaluation of soils for planning purposes.



Fields of actions and outputs

The "Handbook for Measures Enhancing Soil Function Performance and Compensating Soil Loss During Urbanization Process" **[16]** describes methods enhancing soil function performance. The methods can be used to mitigate the negative effects on soil functions, or to compensate the loss of soil functions in the area under urbanization pressure.

"Awareness Raising Package" **[16 - 28]**. To attract the attention of city council members, the municipalities, experts and the wider public, several awareness raising products were developed. They contain various documents, figures, maps and movies providing facts and arguments for different target groups.

"Pilot Action Case Study Book" **[29]**. Descriptions of the experiences collected from the test applications of the URBAN SMS tools in the partner cities.

The subsequent sections provide descriptions of the most important project outcomes and the experiences gathered by the project partners during the implementation phase.

URBAN SMS – Soil in the City

Municipal soil management

Sustainable soil management means stewardship of soil resources on a regional as well as on a local level in a way that allows development balanced in environmental, social and economic dimensions. To implement this, appropriate strategies and tools are necessary as stated below.
A three-step approach is needed involving: (1) identification of the most important general goals, (2) selection of appropriate and feasible strategies, and (3) application of suitable tools in order to implement the strategies.

Goals

The major goals of soil management should be a reduction of the net soil sealing rate and consideration of soil quality in current and future development.

Goals to secure sustainable use of soil resources:

Goal 1 (G1)
Reduction of quantity of soil consumption rate and soil sealing

Goal 2 (G2)
Sustainable use of soil considering soil quality (provision of soil functions)

Strategies

The selected urban soil management strategies are based on existing European and national legislation **[1, 2]** as well as guidelines. They follow the guiding principle of limiting soil consumption as the first assumption, if not possible mitigation of soil sealing effects, or at least compensating the soil sealing. The most helpful strategies for urban soil management have been identified as follows:

1. Applying sustainable soil management in spatial and urban planning at all levels. Avoiding land take requires target agreements on the general level of regional and urban planning.

2. Improving legislation in terms of soil protection. To implement soil protection, general political decisions of regional and local governments are necessary.

3. Raising awareness of soil as a natural resource. Any kind of political decision or planning activity is based on the awareness of the actors.

4. Establishing regional co-operation in soil management. Soil protection in one region should not lead to an increasing land take in other regions.

5. Involvement of stakeholders and decision makers at the early stage of management. Soil protection aspects should be provided and considered in every preparation process regarding land take before the first decisions are made and to ensure that alternatives are still possible.

6. Improving management of degraded urban areas. Building activities on low quality soils such as brownfields and contaminated sites are reducing the consumption of high quality soils. However, building activities on those low quality soils may require remediation measures.

7. Introducing compensation measures and validation of soil functions as a market instrument. Arable high quality soils usually have underestimated market values. To avoid uncontrolled land take, this weakness has to be erased by appropriate measures like payment of fees.

8. Increasing inner urban development. To steer urban development onto low quality soils, a cadastre of brownfield sites and revitalization activities is necessary.

Tools

Tools developed in the project URBAN SMS can be listed as:

- Soil quality evaluation tools
- Supporting tools for the implementation of strategies
- Tools for awareness raising.

They cover guidelines and software tools delivering basic information for planning procedures. The tools should be selected according to the local conditions and needs.

The soil evaluation tools are compiled in a software application, the "Soil Manager Suite" **[11]** produced in order to structure spatial soil information and to implement user-friendly tools. They help to identify the capacity of soils to fulfil various soil functions in urban areas. This knowledge helps to achieve the overall goals to consider soil quality sufficiently in municipal spatial planning and reduce soil consumption.

Tools supporting implementation of strategies encompass guidelines for successful inclusion of soil in Strategic Environmental Assessment and Environmental Impact Assessment **[7]** as well as measures for mitigation and compensation of soil loss.

The report "Brownfield Redevelopment as an Alternative to Greenfield Consumption in Urban Development" **[19]** points out the potential of brownfields to substitute greenfields in urban development and describes obstacles to overcome and good examples of brownfield redevelopment in an effective and sustainable way.

Several awareness raising products are documented in brochures and media, compiling the arguments and reasons for better soil protection in urban development procedures.

Implementation and monitoring

The coherence of goals, the appropriate strategies and tools in the particular local situation can be illustrated by mind maps (example of Vienna see below). Different mind maps are compiled in detail in the "Experience Report" **[30]**.

The basic requirement to implement soil management in a municipality or a region is a political decision which can be facilitated by awareness raising, directives or administrative regulations.

For the practical implementation of soil management the following steps are recommended:

1. Data collection on soil quality including contamination and land take.

2. Evaluation of soil quality, current land use, existing urban development concepts and plans.

3. Definition of goals for soil protection; threshold for accepted land consumption and the resulting needs for soil management.

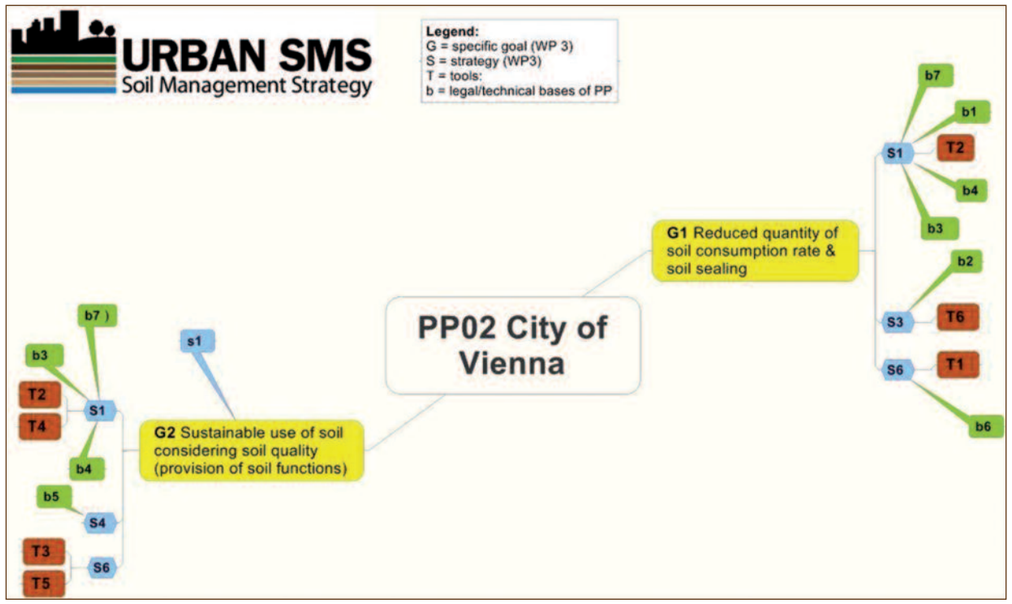
4. Selection and application of the most promising strategies and tools for urban soil management.

5. Monitoring of soil management implementation.

6. Evaluation of goals achievement.

An urban soil management concept needs permanent monitoring of the progress in order to evaluate the effects of its implementation. The monitoring results enable adjusting the process and steering the soil management according to the goals.

In the "Guide Municipal Soil Management" **[8]** all available instruments as well as successful approaches to attain the implementation of soil management are described.



Mind map with goals, strategies and tools, example of Vienna

URBAN SMS – Soil in the City

Soil assessment in urban planning

Guidance for Soil in Strategic Environmental Assessment (SEA) and Environmental Impact Assessment (EIA)

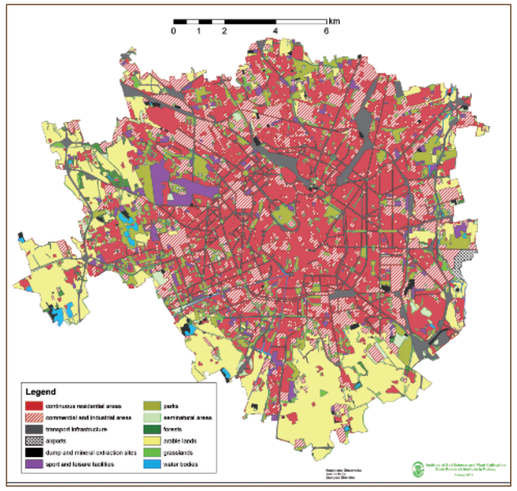
Under the URBAN SMS project the "Guidance for Soil in SEA/EIA" **[7]** was developed as soil is an often underestimated resource in the environmental assessment (EA) of spatial planning. The main objective was to support the consideration of soil within the SEA and EIA processes by proper evaluation of this environmental media. Current regulations and decisions in this context refer to general effects on environmental media; soil is specifically quoted, but not defined. The focus of this guidance is placed on upcoming planning processes and decisions. Target groups are municipalities and planning agencies considering soil in planning processes.

Greenfield development at the urban fringe

Guidance contents

In the first part of the guidance a collection of general soil management approaches, needs and applications for SEA and EIA in the participating partner states are illustrated. The guidance includes the legal requirements at all administrative levels from the EU to single regional legal matters with their gaps and needs according to soil protection issues. Practical case studies through the experience of the project partners have been analysed and are provided.

The second part of the guideline provides an instrument for integrating soil as a subject of protection into processes like land use planning, spatial planning and the design of development plans, programmes and specific projects. These processes are adequate to influence the use of land and the sealing of soils. They also contribute to the reduction of land consumption and urban sprawl.



Land use map of the City of Milan

To consider soil starting from the screening, the guidance offers a set of tables to identify typical sources of significant effects on soils like construction activities. Many questions are listed to help with the identification of typical assessment criteria like soil quality, contamination, sealing and erosion. The guidance empowers the protagonists to appreciate the environmental report or the environmental impact study and to predict the impacts on soils.

Also the obligatory consideration of the inter-relationship of soil with other topics like human health and climatic parameters is mentioned.

For the EIA process a description of soil sensitivity in the project area is proposed. One may find detailed lists of possible impacts on soil in the guideline, based on the interaction of soil sensitivity and magnitude of change.

Superior planning targets

Urban development has to be steered on low quality soils at the policies and plans or programmes (SEA) level. Soils with a very high and high quality in terms of soil functions have to be protected. Soil consumption needs to be steered and land consumption minimised by inner urban development. Deficits in compensation measures may be supported by economical instruments like, for example, appropriate payments per square metre. Impact assessment on soil functions would suit a topical approach.

New fair construction site near Stuttgart

Environmental assessment demands

Environmental assessment is a procedure ensuring that environmental implications of decisions are taken into account before the decisions are made. It can be undertaken for plans, programmes and policies ('Strategic Environmental Assessment') or for individual projects, e.g. dam, motorway, airport or factory ('Environmental Impact Assessment').

The environmental report for SEA has to document the identification, description, and evaluation of likely significant effects on the environment. For EIA projects, the impacts on the environment have to be documented in the Environmental Impact Study (EIS). This comprises an assessment of all negative impacts on the environment listing soil explicitly and includes measures for avoiding, minimizing or compensating negative impacts.

Communication prospects

The main gaps regarding soil protection are not in the legal foundations of soil protection. Due to organizational difficulties, demands of soil conservation, authorities and their acceptance for the decision making process are not sufficiently integrated into plans, programmes (SEA) and projects (EIA). Additionally, soil is only mentioned as one of 12 subjects of protection.

Sufficient open space and green space areas need to be protected, preserved, restored, and upgraded. Therefore, basic ground work, basic and frontier research, data collection, inventories and sufficient monitoring as well as evaluation of monitoring results is needed to improve evaluation schemes and method or indicator development. Additionally a data platform (e.g. databases or maps) for all useful soil information is necessary to gain sufficient knowledge about soil quality and describe the current state of soil. Impact assessment matrices in which the effects on soil, namely on soil quality are mentioned can be an adequate support tool.

Moreover, there are semantic differences for soil related terms used by spatial planners and soil experts; spatial planners consider soil in general as land consumption, whereas soil experts consider the qualitative and quantitative loss of soil.

Therefore, a common strategy between city planners and soil experts in the regional authority and an exchange between experts is a necessity. This can be achieved by implementing a platform for experts on soil and spatial planning via teaming up these two separate fields for planning purposes.

Opportunities for soil protection

Perhaps the plan or the project which has to be a subject of environmental assessment has no impact on soils – but who knows? The SEA/EIA Guidance provides a range of descriptions, lists and examples for every phase of the process from screening to monitoring. If all the items are gone through and it is decided whether they can play a role in a particular case, it is assured that no important aspects are missing. Because the guideline is based on an engaged composition of all existing basic principles and all needs and gaps are reviewed from experts, all relevant items are included. As a result, even non-experts of soil are able to handle an environmental assessment including all soil relevant aspects of evaluation.

Software suite

Soil information is of major importance for integrating soil issues in urban planning. Generally for urban and suburban areas we are currently facing a lack of sound soil information. When available, however, the information is difficult to be adequately interpreted and used by non-soil experts such as planners and decision makers. Information about soil quality, contamination, texture, infiltration rate, accompanied by focused interpretations, should be available within an end-user oriented system, providing evaluation and risk assessment tools.

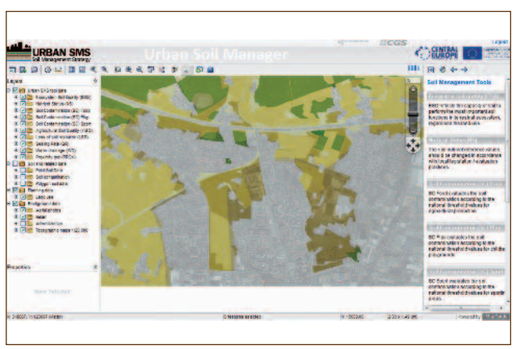
General approach

The Soil Manager Suite represents a practical GIS solution aimed at delivering soil information relevant for urban planning to non-soil experts. The software visualizes, processes and interprets soil data. The outputs are in a form easily implemented within the SEA/EIA procedures described in the previous chapter and can also be used for awareness raising purposes.

The Soil Manager Suite comprises a web-application and a desktop application. Technical instructions are written down in the "Soil Manager Suite Handbooks" **[12]**.

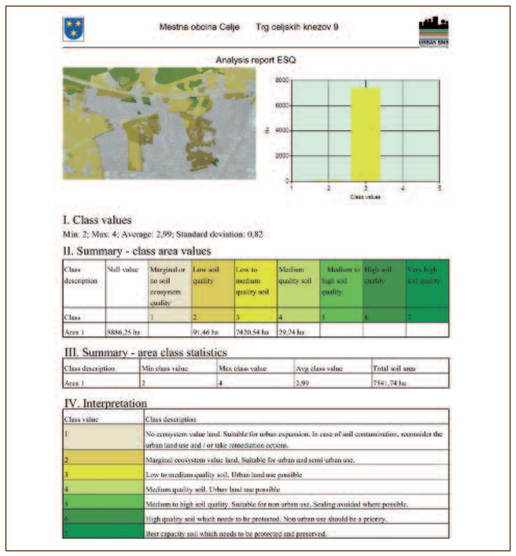
The web application is designed as a web portal where end users can review the spatial information (maps) and run pre-defined algorithms (tools). The system is composed of two pages:

The "Admin page" is used by system administrators to technically define input data sets and structures. Soil experts play a key role to interpret measured soil data in terms of soil quality and land use suitability; to adjust data evaluation algorithms if needed, set the threshold values and to predefine reports with planning and soil management suggestions.



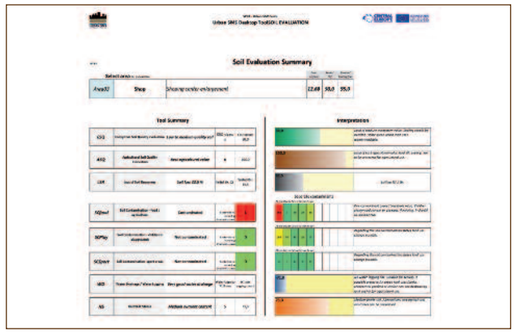
User GIS page

The "User GIS page" enables viewing soil and other spatial information for the municipality area, to query datasets on soil quality and land suitability and, most importantly, to perform analyses of the areas of interest and subject of spatial planning. Planning scenarios are compared by running individual tools. The result of each evaluation is in the form of a pdf report which summarises soil information and recommendations for the use of land. The tools were designed in a flexible way to allow adjustments to specific local conditions and data availability. For each test case specific data sets can be implemented, and algorithms and threshold values modified according to local management/planning practices and legislation.



Example of a pdf report

The desktop tool application is designed in Microsoft Excel for a non-spatial soil data evaluation. Sometimes the information is needed however no spatial data is available. Also setting up and maintaining the GIS web system requires technical, human and financial resources. These resources might not be available, especially for small communities. The application consists of two working sheets. User defined or default data form databases implemented in calculation tables can be used to make an assessment. Databases working sheets contain sets of all data linked to tables in URBAN SMS working sheets. The tools are based on semantics equivalent to the URBAN SMS web application.



Desktop tool application

The list of GIS tools

All tools evaluate measured or estimated soil properties which are usually widely available in existing soil databases. Each tool algorithm utilizes soil information for calculating a result/index which summarises and presents the quality or suitability of the selected area.

The tool development process was coordinated with the Soil Management Guide concept. The **Ecosystem soil quality tool** evaluates the quality of soil in its broadest sense. It reflects the capacity of soil to perform the most important ecosystem soil functions regardless of the land use. The result is an index reflecting the environmental quality of soil.

The **Loss of soil resources tool** evaluates the loss of soil when it is sealed. Information on soil quality of the potentially sealed area is provided. The index/score for selected planning areas is used to compare different planning scenarios and soil loss in the case of sealing.

The **Agricultural soil quality tool** elaborates soil quality in the function of distance from existing sealed areas. When using these results, a spatial planner can protect the soil resource more efficiently and direct the planned urban development to areas with lower agricultural soil quality adjacent to existing urban areas.

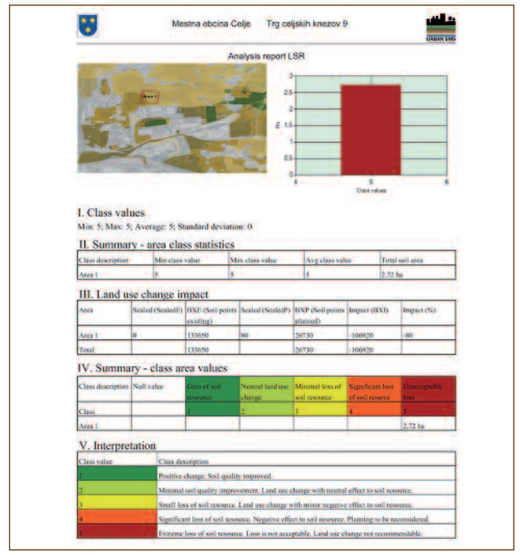
The **Soil contamination tool** compares information on contamination with legal threshold values and assesses the suitability of the planning area for three different land uses: children's playgrounds, sports areas and food production areas.

The **Sealing rate tool** assesses the distribution of green areas within the urban area. The tool visualizes the distance to green areas and calculates the ratio of sealing – the rate of unsealed/sealed soils within the selected area.

The **Water drainage tool** estimates potential water-logging areas. The location and the extent of soils with low water infiltration rates and, under certain circumstances, areas less suitable for development are identified and visualized on the map along with basic statistics.

The **Proximity tool** measures the availability of green areas to urban population and is used for planning green zones as a necessary component of a balanced and safe urban environment, including accessibility of parks and playgrounds to the citizens.

The **Connectivity tool** evaluates whether planned green areas are properly distributed in order to form green corridors with the existing green locations. The suitability of new planned green area is expressed as the number of cadastral parcels to be bought to connect green areas in the form of a corridor. The tool is useful in compact cities suffering from a lack of green zones.



Report of the Loss of soil resources tool

Transferability of URBAN SMS semantics

Some cities already possess advanced IT systems and therefore the introduction of new software would require unacceptable changes of a well-defined work flow, software and/or additional cost. The semantics of the modules are well described and can be transferred in such cases to existing software/IT systems. Such approaches were implemented for some modules in Stuttgart "Technical Concept Soil Indicator Stuttgart – Application" **[13]**, Vienna, and Milan.

URBAN SMS – Soil in the City

Measures mitigating or compensating loss of soil functions

The total loss of soil functions by sealing or degradation is practically irreversible. Therefore, it is essential to limit soil consumption as far as possible because it is not possible to fully mitigate or compensate loss of soil functions.

Zinc, lead and cadmium contaminated smelter wasteland in Piekary, PL reclaimed through liming and biosolids application

Nevertheless, the "Handbook for measures enhancing soil function performance and compensating the soil loss during urbanization process" **[16]** introduces compensation measures with the potential to restore or improve soil functions in a sustainable and measurable way.

The handbook helps to select the proper method of compensation for the defined decline of a given soil function. It starts with a description of soil properties important for soil quality and soil functions to be protected followed by a description of widely available soil treatments and other measures. Knowledge on the environmental role of such soil properties as pH, organic matter content, texture, and contaminant content is key for the proper utilization of soil spatial information in the SEA/EIA procedures **[7]** or GIS assessments **[11]**.

Application of topsoil near the village of Möglingen (Baden-Württemberg)

The description of each of the compensation measures includes a short technical description, information on implementation conditions and restrictions, benefits in terms of soil functions and disadvantages of the method. A rough estimation of the attainable compensation effects of the single measures is presented in reference to the total loss of a high quality soil.

The list of available compensation measures described and evaluated includes:

Soil recovery treatments

- Removal of sealing
- Soil decontamination
- Recultivation/reclamation
- Removal of landfills

Treatments improving soil functions

- Application of topsoil
- Re-irrigation (restoration of natural biotope)
- Extensification of arable land use
- Depth loosening / decompaction
- Erosion prevention
- Soil liming

Measures without direct link to soil

- Green roofs
- Covering of physical structures.

At the end of each compensation measure fact sheet the relationships between the described compensation measures and the soil functions performance are discussed.

Generally, most soil recovery treatments applied to restore soil profiles, are beneficial for the **biodiversity** of soil and a whole landscape since they improve conditions for the growth of plants and soil organisms. It must be noted, however, that often soils with extreme properties (e.g. wet, dry or with low nutrient availability) are habitats for rare plant species. Re-irrigation might restore conditions for some uncommon species.

There is a wide range of measures improving or protecting the water **retention** function of soil: these measures include topsoiling, erosion prevention, decompaction, forestation and soil recovery treatments such as recultivation and removal of sealing or landfill. Generally, soil water retention is closely related to management of soil organic matter content and compaction of soil.

The **buffer and filter** function of soil is substantially improved by remediation treatments of contaminated soils as well as treatments improving soil sorption capacity

Cultivation with deep rooting plants (Lucerne) after top soil application

(liming, topsoiling, humus application) or regulating water circulation (decompaction).

Air quality might be adjusted by measures reducing the presence of contaminants and soil particles in the air (soil contaminants removal or stabilization, erosion reduction) and through the provision of plants adsorbing and inactivating particulate matter (PM). Green coverage of roofs and other surfaces improves air quality through enlargement of plant surface of dust adsorption.

Measures increasing water storage capacity of land would be helpful in mitigating **temperature** extremes in the summer period. These measures would include, to some extent, indirect measures such as green covers of roofs and other surfaces.

Landscape **aesthetics** are generally improved by measures restoring the soil returned to use after the removal of sealing or contaminant removal and recultivation. Green roofs or grass coverage of physical structures also improve landscape exterior.

Remediation of soil contamination may improve the **health** of the population since the residents are less exposed to contaminants through a variety of pathways. Soil liming and other remediation treatments generally reduce bioavailability of such toxic elements as lead or cadmium in contaminated soils and, consequently, in urban dusts. Certain plants growing on soil have a great potential to inactivate particulate matter harmful for human health.

The **production** function, deserving protection in suburban zones, is improved by measures increasing soil fertility (topsoiling, liming, decompaction) or recovering the soil permeability.

In order to assess the amount of compensation needed to counteract loss of soil functions, it is necessary to collect information on the performance of soil before and after the encroachment (compensation demand), ideally in the spatial digital form. It is important to further develop spatial information layers characterizing soil and other environmental data. With the URBAN SMS "Soil Manager Suite" **[11]** it is possible to assess the loss of soil functions and to delineate areas suitable for compensation.

Compensation activities can be, theoretically, framed into a tool in the soil management. Proposal of such an approach is provided in the report "Compensation measures for encroachments on soil – Stuttgart Assessment" **[17]**. This approach involves calculating the need for compensation and the benefit of the compensation measure based on index-points as proposed in the soil protection concept of the City of Stuttgart.

Mechanical deep loosening of fallow land

URBAN SMS – Soil in the City

How to raise awareness

Awareness of stakeholders and the whole of society on the role of soils for environmental safety and quality of life in urban areas is a precondition for more effective soil protection. In the URBAN SMS project we have established a network of stakeholders, raising their awareness of soil by initiating a discussion on the consequences of current limited soil protection. A range of reports containing facts and arguments and media materials were prepared which now can be used as instruments in a dialogue with stakeholders. The materials will constitute the "Awareness Raising Package" **[16 - 28]**.

Soil as a basis for crop production

Facts and arguments

- Especially for those who are not familiar with the environmental media soil, a short leaflet "Soils in and around the cities" **[27]** is available, showing the essential functions of soils for humans and the environment. A description of soil functions is given. Furthermore, the leaflet highlights soils as a beautiful piece of art of nature.

- An assessment of historical soil consumption trends was performed as an example of identifying consequences of soil protection scenarios. The report " Assessment of soil protection efficiency and land use change" **[18]** based on analysis of land use change pattern within 15 years revealed that expansion of artificial surfaces in the test areas took place mostly on arable lands. Soil management systems in these cities did not efficiently protect the best soils until 2006; also the pool of available low and medium quality soils is much greater than the land demand for urbanization.

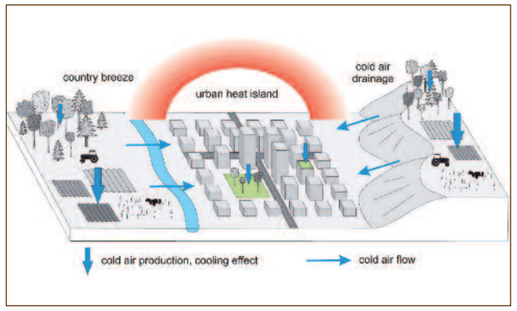
- Its obvious that land take and soil sealing may cause environmental problems. But the question is what are the real negative effects on the environment and the living conditions in urban areas? The report "Environmental impact of urban soil consumption" **[22]** contains approaches to quantify the value of soil functions as well as to measure the consequences of soil sealing. What are the costs for a city to manage the surface run off? What is the impact on food production or on the management of organic wastes without soils as a media for their recycling? These are some of the questions the report answers and provides ways of calculating the economic and environmental effects of soil sealing.

Habitat function of soil

- Urban structures generate climatic effects on air temperature and air quality. One of the major effects is the well documented "Urban heat island". Besides the aspects of the impact on global climate, the report "Climatic Impacts of Urban Soil Consumption" **[23, 24]** clearly shows the general positive influence of soils covered with vegetation on temperature and air quality. A model calculation of what happens if one hectare of soil is sealed gives an impression of the impact of soils on climate in cities.

- In most of our cities there are derelict areas, which could be regenerated as an alternative to consump

Flooding in Perg, Austria



Transport paths of cold and fresh air from the surrounding countryside into the settlement area

tion of greenfields. The remediation of Brownfields is one of the most promising methods to minimize land take. The guide "Brownfield redevelopment as an alternative to greenfield consumption in urban development" **[19]** gives some astonishing figures about the potential in our cities for an inner urban development. For example in Stuttgart the area of Brownfields with potential for regeneration is estimated at more than 400 hectares, which is comparable to the decade rate of sealing in the city.

- Ex-ante modelling can be used as a powerful tool for recognizing conflicts between urbanization and soil protection. We applied the Cellular Automata-based Metronamica model for spatial modelling of urban sprawl under different soil protection scenarios "Baseline scenario analysis – Modelling future urban sprawl in pilot cities" **[20]** and "Forecast of urban sprawl under alternative soil protection scenarios" **[21]**. At the end, through combining the modelled information and soil quality maps, we obtain knowledge on soil loss under "no change" and alternative protection scenarios. The analysis clearly revealed that the lack of a system for protecting the most valuable soils would result in the continuation of non-sustainable soil transformation trends, especially when spatial distribution of valuable soils favours their sealing.

- The summary of messages obtained through spatial analysis of past and forecasted soil management trends in the cities of Central Europe is provided in the leaflet "Current Soil Management is not sustainable" **[31]**.

Media and Actions

- Discussion with stakeholders is a direct method of awareness raising. In the project we utilized 'participatory impact assessment' that was based on collecting opinions of stakeholders on possible urbanization consequences. The stakeholder group should include urban planners, decision-makers, urban architects, land owners, environmental engineers, NGOs, and residents in order to represent a balanced impact of different sides of interest. The procedure leads the stakeholders through the steps of impact assessment in order to bring together their opinions in a semi-quantitative form. On the other hand, the awareness of stakeholders on soil protection needs is raised through discussions on soil functions and the impacts of uncontrolled land take. The action summarised in the report "Stakeholder network for impact assessment of soil protection scenarios" **[25]** revealed that in all the cities continuation of current soil protection regulations would lead to loss of all environmental soil functions whereas strengthening of soil protection would not limit the economic development.

- The movie "Soil at risk" **[26]** was produced in Stuttgart and Bratislava. It illustrates the essential soil functions particularly as a habitat for soil organisms, as the basic resource for food production and as a balancing medium for the water cycle. In addition, solutions are presented on how to strengthen inner urban development and how soil quality could be taken into account in urban planning processes.

- In the leaflet "Actions and events to make the young generation sensitive to soil" **[28]** the project partners collected good examples already tested in practice. Some examples are the installation of a soil stele or a campaign with school children called "colours of the earth". All actions and events presented in the leaflet can be easily put into practice by communities, schools or private organizations.

Soil stele in an outdoor museum

URBAN SMS application in pilot areas

Eight case studies were conducted on project partner's sites in order to implement strategies and tools under real conditions. Results of these studies enabled further testing and optimization of the initial versions of URBAN SMS tools.

The pilots covered a wide variety of soils and types of problems in different urban areas. Sites differed in size, soil quality, location and land use. Each project partner selected suitable strategies and applied the tools which supported the implementation of strategies on these sites. In the following selected examples of pilot areas the tested tools are described with the focus on only one or two tools. The following table gives an overview of strategies and tools selected by partners. The examples described in the following pages are highlighted. The main aim of the eight pilot applications is to formulate recommendations on how to support the implementation of soil management strategies and to improve the URBAN SMS tools. Due to internal reasons at the project partner´s level the pilot no. 8 had to be excluded from this brochure. Extended information about pilot applications in this brochure can be found in the "Pilot Action Case Study Book" **[29]**; also, additional pilot sites of partners with more test applications are described in the document.

Aimed goals, applied strategies and tested tools

	Bratislava	Celje	Milan	Prague	Salzburg	Stuttgart	Wrocław
Aimed goals							
Reduced quantity of soil consumption rate & soil sealing	x	x	x	x	x	x	x
Sustainable use of soil considering soil quality (provision of soil functions)	x	x	x	x	x	x	x
Applied strategies							
Applying sustainable soil management in spatial and urban planning on all levels	x	x	x	X	X	x	X
Improving legislation in terms of soil protection as well as proposing a unified legislation approach in Central Europe					x		
Raising awareness of soil as a natural resource	X	x	X	X	x	X	x
Establishing regional cooperation in soil management							X
Involvement of stakeholders and decision makers at an early stage of management		x			x	X	
Improving management for degraded urban areas	X	X					
Introducing compensation and validation of soil functions as a market instrument			x		x	x	
Increasing inner development				x		x	
Tested tools							
Guidance for soil in SEA/EIA				x	X		
Soil Manager Suite (software) including several tools	x	X	X		x	X	x
Guidance on how to introduce and apply compensation measures to be used as a market tool						x	
Recommendation for successful stakeholder participation	X						x
Awareness rising package providing a collection of facts and arguments	x	x		X	x	x	X
Guide brownfield redevelopment		x		x			

Pilot 1: City of Bratislava (Slovakia)

Chemical waste dump Vrakuna (4.65 ha)
The pilot case study focused on urban development on the chemical waste dump Vrakuna. The area is currently partly used as commercial-residential area, is partly an abandoned area, and a residential area is planned. Currently construction activities have been stopped. The waste dump belongs to the municipal government of Bratislava city because former owners are not willing to deal with the environmental problems.

General view of Vrakuna dump site

Position of the Vrakuna dump site

Aerial photo of the Vrakuna dump site

Situation of the test area

Mlynske rameno was originally a dried river branch of the Danube serving as a sink for sewage dilution from a chemical factory since 1966 without any protection measures. The dump site was finally abandoned in 1979 with an estimated volume of 90,000 m^3 and a thickness of 1.5-2.5 m. In 1989 it was covered with a 2-3 m layer of inert building rubble. The chemicals reached the ground water table which was contaminated to a depth of 40 m. After the construction of the large Gabcikovo Waterworks in 1992, the ground water level rose and reached the soil surface. Despite groundwater contamination, construction activities started on this area.

URBAN SMS activities

Activities aimed at improving the management of degraded urban areas and raising the awareness of decision makers and the public of the environmental hazards of this area. The local municipality and the hydrologist who investigated this area in the past were contacted. Results of the URBAN SMS tools (including the contamination module of the Soil Manager Suite) enabled visualization of how improper the former urban planning on this site had been. A local workshop for stakeholders, developers, municipality decision makers and broad professional public was organized (7th July 2011). At the workshop information about the URBAN SMS Project, the results of investigations on the pilot site as well as solutions for environmentally safe land uses of the site were presented and discussed.

Results and experiences

The case study demonstrates management methods for contaminated sites in spatial urban planning and what is the inevitable prerequisite for correct decisions regarding remediation and land use. Participation at the workshop encourages consideration of soil as a precious resource in urban land. For the future of Vrakuna the best solution was found: this site joins the EU program for remediation of contaminated sites. Experts from the Soil Science and Conservation Research Institute in Bratislava proposed that the environmental impact assessment (EIA) "Guidance for Soil in SEA / EIA" **[7]** should be applied for every Brownfield redevelopment without any exception.

Pilot 2: City of Celje (Slovenia)

Teharje - Celje East (193 ha)
Celje municipality (96 km², population 50,000) is characterised by dense structure in the old city centre and urban sprawl at the outskirts. Pressure for new housing areas is still present. The Teharje pilot is one of three test pilots in Celje (area 3), located between open agricultural land, the city border line and an industrial area. It has a direct connection to the highway and is therefore very attractive location for different services. On the other hand, its pollution is in direct conflict with the current mainly agricultural use.

Situation of the test area

Since the last change of the municipal master and land use plan the majority of the area has been dedicated to agricultural use and expansion of housing area, especially on its west side, where there is a neighbouring chemical company. Previous soil contamination samples have shown higher concentration of heavy metals, especially cadmium, which defines this area as a contaminated site and demands carefully chosen future land use with good redevelopment management of the area.

URBAN SMS activities

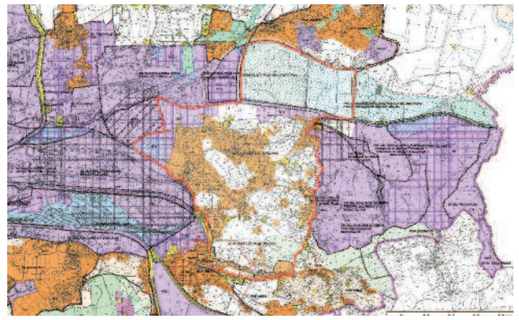
The main focus was given to improving the management of degraded urban areas. In the assessment of selected soil evaluation tools (based on the software tools Soil Contamination and Ecosystem Soil Quality) we have upgraded existing soil data with their spatial component. On the basis of these results the current land use plan and spatial trends were assessed.

Results and experiences

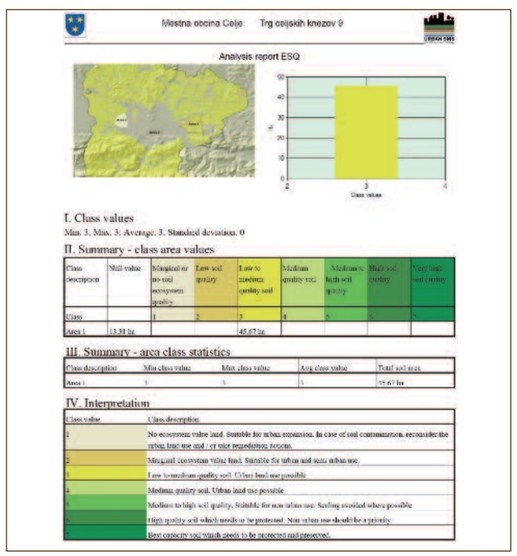
Soils on this area represent medium to high quality in terms of their natural functions, but with heavy metal pollution. Therefore, the soils are not appropriate for agricultural use. Consequently, changing the land use into an industrial or residential area is the only fitting solution, after thorough remediation of the site to reduce the contamination related risk. The tool evaluation results are useful for an optimized spatial positioning of appropriate land use. This could minimize land take on areas with soils of high quality, suitable for food production or other sensitive land use and lead towards more sustainable spatial planning.

Natura 2000 view on the northern part of pilot site

Location of the three pilot sites in Celje



Land use plan of test area and surrounding (orange: housing area; white: agricultural use; violet: industrial, commercial use)



A result of ESQ tool assessment (Ecosystem soil quality)

Pilot 3: City of Milan (Italy)

EXPO Area (98.5 ha)
The pilot area has been designed by the Municipality as a location for the upcoming 2015 universal exposition. It is located in the northern part of Milan, in a highly urbanized area. The land use is agricultural now, and it is planned as an exposition area for agricultural issues (an agro-botanical garden) in 2015; the land use after the end of the exhibition is still unknown.

Situation of the test area

Many people have protested because of the already congested territory (the area is side by side with the new Milano fair) where green land is rapidly disappearing due to the new fair, the ancillary highway links, roads, railways and suburban trains. In the meanwhile the area is no longer cultivated and spontaneous vegetation is growing. An initial environmental survey showed no chemical contamination.

URBAN SMS activities

Samples of agricultural land were collected and chemico-physical analysis performed in order to produce data sets needed by the URBAN SMS software. The evaluation of soil quality with the software tool performed on the area and results were used in dissemination of the project around Italy. The data is necessary to improve consideration of soil in spatial and urban planning on all levels. It supports planners and other stakeholders in the decision process.

Results and experiences

Urban sprawl in northern areas of the city is very intensive. For this reason it is considered of primary importance to direct urban planning towards soil protection.

Application of the Soil Manager Suite produced indicators which describe how to plan the development of the area in order to minimize the impact on soil resource and to optimize its consumption and can be readily introduced in local SEA/EIA procedures.

For example, the run of Agricultural Soil Quality localises the most suitable soils for agricultural use. This suggests that the expo-area development should preserve these soils from sealing and from removing, steering towards uses that allow an agricultural reconversion, after the 2015 expo event.

EXPO area location in north-western part of the city

Present view of the EXPO site

Pilot 4: City of Prague (Czech Republic)

"Meadow" near the botanical garden (9.5 ha)
The demand for new residential areas in the City of Prague generates huge pressure on green areas and the few remaining natural soils within the urban area. There is an urgent need to develop concepts and tools to decrease the quantitative consumption rate of soils and to integrate the soil quality parameters into the sustainable soil use methodology. The pilot area "Meadow" exemplifies the difficulty between the development interests of the private owner and the need to safeguard high quality green areas.

The pilot area in the green belt area north of the Vltava River

Situation on the test area

The test area is located in the northern city district of Troja which is considered a prestigious and highly desirable area for family housing, and is hence under constant pressure from developers. It is expected that the privately owned "Meadow" which is currently under agricultural use will shortly be sold to a construction company to establish new dwellings. For that purpose the owner will have to go through the land use change procedure according to the Czech Act. In contrast, the area is characterised by its high ecological function and its importance for the urban green concept.

URBAN SMS activities

Due to the fact that there are no practicable tools and concepts for handling soil quality in the urban planning process the soil functions of the pilot area needed to be evaluated and visualized. Improving the consideration of high quality soils as well as awareness raising at a local level was the focus of the pilot study to limit, and where this was not possible, to compensate soil losses. "Soil Manager Suite" **[11]** together with "Guidance for Soil in SEA/EIA", **[7]** "Brownfield Redevelopment as an Alternative to Greenfield Consumption in Urban Development in Central Europe" **[19]** and "Awareness Raising Package" **[16 – 28]** were used in consultation with local NGOs and with municipal representatives to achieve better implementation of soil protection in the decision making process. The soil quality of the "Meadow" site from both production and ecological aspects was evaluated and compared with a nearby Brownfield area close to the Vltava River to find a potentially less valuable area for construction.

Results and experiences

Application of the tool demonstrated the unique properties of the pilot site, especially its ecological value. The comparison with the Brownfield site near the Vltava River shows that the "Meadow" is characterised by a much higher need for protection. Due to the lower soil quality and moderate contamination at the Brownfield site the future urban development should be concentrated there instead of at the pilot area "Meadow". However, if a change in the land use will be realised, possible measures to limit soil sealing and to compensate the soil consumption are already specified.

Pilot area "Meadow" in the northern city district of Troja in the City of Prague

Pilot 5: Region of Salzburg (Austria)

Salzburg City and hinterland (261 km²)
The area is the main industrial and commercial centre of the Land of Salzburg and a transport intersection. A regional development program has been established in order to secure a commonly agreed spatial development. Considering soil protection in these processes is necessary because already much cropland and grassland with soils of high quality have been converted into a residential area in this region.

Situation of the test area

The regional association of City of Salzburg and ten surrounding municipalities are responsible for the test area in terms of regional spatial planning. In this region high rates of land consumption on medium to high quality arable soils due to urban and suburban development have been observed during recent decades. In future, land use changes due to (sub)urban development can be expected to continue as in the past.

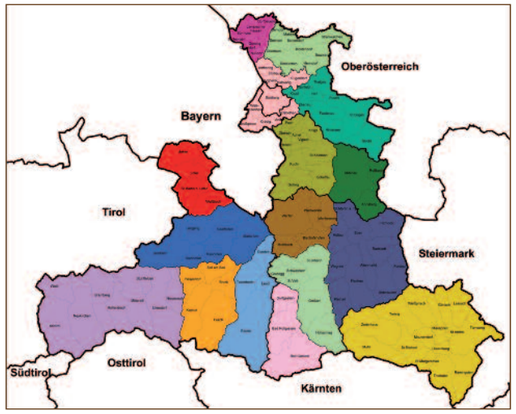
The number of inhabitants is about 200,000 with an increase of 14% between 1981 and 2010. Several nature protected areas and natural spots are located in this area and the nature protection regulations are strong against land use conversion.

URBAN SMS activities

During the project the selected software tools for soil evaluation were applied with some limitation of available data regarding soil parameters. Soil quality was assessed in relation to past and future regional and local land planning as well as the Strategic Environmental Assessment. Special focus was laid on already built on land or areas with land use just changed (dedicated for building development by land use plans) assessing their relation with the total agricultural land and the soil quality.

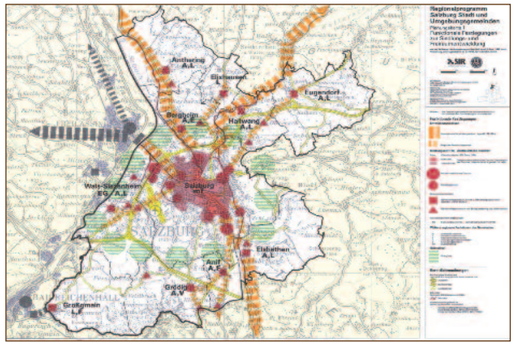
Results and experiences

Now a comprehensive knowledge base about soil quality and its suitability for different land use exists. The results of the case study helped to steer regional land planning towards the most suitable areas for certain purposes. Minimization of soil consumption, in particular of valuable agricultural land, is possible in future development.



Map of test area in the Land of Salzburg

Photo of northern part of test area in the Land of Salzburg



Functional determination of development of settlement areas and open space (part of regional development program)

Pilot 6: City of Stuttgart (Germany)

"Langenaecker-Wiesert" (8.8 ha)
In Stuttgart the main problem is the increasing pressure on high quality soils outside the settlement area. The chosen pilot area is an example of this negative development. According to the local building plan a residential area with 260 units is planned on arable land with soils of high quality.

The pilot site on the northern border of the densely populated city of Stuttgart.

Situation of the test area

Current use of the area is arable land and garden plots on high and very high quality soils. It is already bordered by settlement areas on three edges. It is part of a 46 ha contiguous area with soils of also high and very high quality. The building plan is in the process of being developed at the moment.

URBAN SMS activities

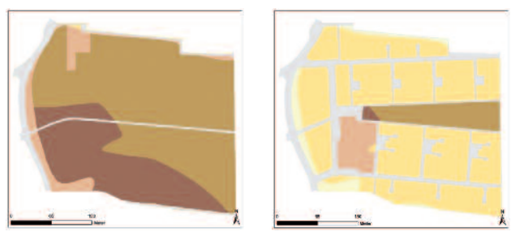
The most important strategy in this pilot case is to raise awareness of the huge loss of soils with high quality and to involve stakeholders/decision makers at an early stage of planning. The URBAN SMS Awareness raising package is therefore a helpful tool, e.g. the report "Environmental impact of urban soil consumption" (ahu, 2011). For calculation of the loss of soil quality the "Loss of Soil Resource" (LSR)-tool was applied on the basis of the soil quality map and the soil protection concept (BOKS) of Stuttgart. The technical implementation to calculate the current soil quality and also the prognosis of the loss of soil was carried out with the adapted LSR-module for ArcGIS "Technical Concept Soil indicator Stuttgart – Application" **[13]**. The result is a certain number of "soil index points", which are calculated by multiplying the score for soil quality (0 to 5) with the area size [ha]. This corresponds with the compensation demand.

View of the area "Langenaecker-Wiesert" in Stuttgart-Stammheim

Results and experiences

The test area "Langenaecker-Wiesert" is an example of where the overall goals of soil protection defined in URBAN SMS are not achieved. However, with URBAN SMS software modules it is possible to make the loss measurable and visible. After implementation of the planned building activities there remains a calculated deficit of 22.4 soil index points compared to the current status. This is more than the whole loss of soil quality in Stuttgart between 2007 and 2011! Only measures of mitigation are possible in this case, for complete compensation these measures are insufficient. There are not enough areas available to realise adequate measures. This problem is described in detail in "Compensation Measures for Encroachments on Soil – Stuttgart Assessment" **[17]**. But with the mentioned strategies and tools we are able to provide the decision maker with the information about the consequences of the planning activities so that they are aware of the negative impacts and avoid future losses.

Soil quality currently **Soil quality after building**



Visualization of the loss of soil quality with the LSR-tool

Pilot 7: City of Wrocław (Poland)

Wrocław LAU-2 region (293 km²)
The city of Wrocław was taken as a test area covering roughly 293 km². Agricultural lands still cover 43% of the total area whereas the area of sealed surfaces has reached 39%. Forests cover 7% and water bodies 3.5% of the total area.

Situation of the test area

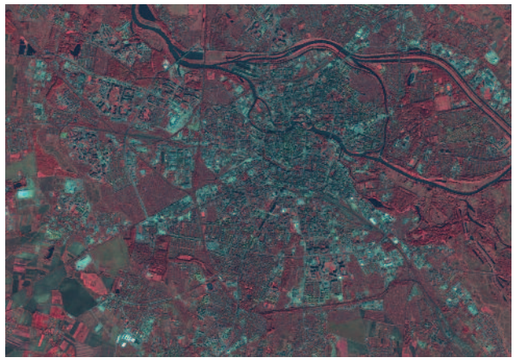
There are instruments in national legislation aimed at protecting high quality agricultural soils (The act on agricultural and forest land protection). The protection mechanism is based on fee payment of the developer and obligatory permission by the ministry to transform the best soils into non-agricultural uses. Soils within urban administrative borders are, however, currently excluded from this regulation; this fact creates additional risks for loss of valuable soils in Wrocław. Consequently, there is significant pressure on high quality soils located especially in the southern part of the city.

URBAN SMS activities

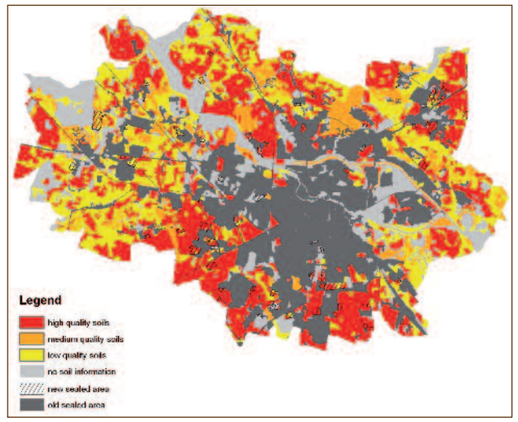
The project GIS web system has been applied and tested in the Wrocław pilot area, whereas SEA/EIA guidance and awareness raising materials where delivered to stakeholders. Extensive spatial analyses were performed to assess the land use change trends within the city, and losses of soil resources and various modelling approaches were applied to predict future consequences of current soil management. The results of these analyses were provided to the stakeholders in order to raise their awareness of the role of soil in urban zones as well as current trends in soil consumption and impacts of limited soil protection on environmental and socio-economic issues. The meetings were organized with a representative group of stakeholders as an example of effective stakeholder participation in the impact assessment process and discussion on soil management issues.

Results and experiences

The knowledge provided during meetings helped to raise awareness and reach a common understanding of soil protection goals and conflicts between urbanization and environment quality. The stakeholders expressed a strong need for further development of spatial digital information on environmental issues useful in better management of soil resources. There was a common agreement on the need for revision of soil protection regulations and more successful inclusion of soil issues in urban planning.



Satellite image of the pilot study area (Wrocław LAU-2 region)



Urban sprawl in Wrocław between 1991 and 2006 on soil quality map

Stakeholder meeting aimed at raising awareness and gathering information on key sustainability issues in the city

URBAN SMS – Soil in the City

Lessons learnt and how other cities can benefit

The project implementation phase showed the potential to use URBAN SMS tools within a variety of sites regardless of the soil quality, size of the area and other local circumstances. The test areas varied from high quality soils to heavily contaminated soils, varying in size from almost 30,000 hectares to areas with only 4.6 hectares. A combination of different tools on diverse pilot areas offers a wide range of scenarios and results, and hence useful experience for planning further activities.

The investigations and applications at the pilot sites have clearly revealed that their different characteristics and planning levels require appropriate strategies and tools. In Salzburg, for example, the pilot area comprises a whole region which offers an opportunity to steer the development to low quality soils at an early stage of the planning procedure. A different situation exists in Stuttgart where on small pilot areas there is no potential to steer within the sites, but to evaluate and analyse. This offers, on the other hand, the opportunity to select alternative areas for land take to have a steering effect, as the pilot sites of Prague show.

The testing of the SEA/EIA guidance proved that the assessment of soil quality in these processes is feasible. This supports the strategy of applying sustainable soil management in spatial and urban planning at all levels. But in some cases the application of SEA/EIA processes are not possible according to national regulations. As a result, in these cases soil issues are not considered in an appropriate way.

The experiences showed that the urban planning departments, as key actors in land take, highly welcome aspects

	Bratislava	Celje	Milan	Prague	Salzburg	Stuttgart	Wrocław	Vienna
Pilot areas	Chemical waste dump Vrakuna	Teharje (Celje East)	Expo 2015	Meadow in the vicinity of the botanical garden	Salzburg City and hinterland	Langenaecker-Wiesert	Wrocław LAU-2 area	Rothneusiedl
Area (ha)	4.65	193	98.5	9.5	26,100	8.8	29,300	105
Land use	Commercial-residential area, partly abandoned area	Mainly agricultural, partly housing area	Agriculture, actually not cultivated	Grassland, pasturage	Residential, commercial, industrial, agricultural, forests, gardens	Agriculture use, garden plots	Agricultural land, sealed surface, forests, recreation area, water bodies	Agriculture use
Plans	Housing development	Spreading of residential area and development of industrial area	Expansion of urban settlements	Develop residential area	Urban and suburban development	Develop residential are	Expansion of urban settlements	Develop residential area
Main issue	High soil contamination, bad environment	Threat of agriculture soil as well as protection area Natura 2000 development. Soil contamination	No legal constraints to preserve the agricultural area from urban sprawl	Threat of high quality soil development, area with important ecological function	High quality soil consumption	Threat of high quality soil development	Urban soils are excluded from legal protection	Threat of high quality soil development

Basic description of pilot areas

of soil protection in planning procedures, but they themselves cannot implement the URBAN SMS strategies and tools due to lack of time and competence. Therefore, they need a provision of facts, data, arguments, and figures ready for the planning and approval procedures prepared by soil experts.

The „Soil Manager Suite“ **[11]** was successfully applied to evaluate and visualize soil quality in every pilot case. To adjust the local data to the software application is challenging but in the end leads to a comparable presentation of the analyses results. The Soil Manager Suite provides the stakeholder with adequate spatial information in an appropriate scale and visualizes the required soil data.

The application of the Awareness Raising Package **[16 – 28]** leads to broad acceptance of soil protection efforts by different target groups.

During several events organised in different partner cities the stakeholder responded with interest and engagement to the provided facts and arguments. The successful stakeholder participation in Bratislava confirmed the high value of the developed maps and reports in the planning phase and in the decision making process. It could be shown that the software modules are helpful in raising awareness of soil protection. The stakeholder concluded that there is no strong conflict between soil protection goals and land use requirements due to the economic development of cities. The pool of available brownfields and low or medium quality soils can even be larger than the land demand for urbanization.

Improving management of degraded urban areas is an appropriate strategy to limit land take and preserve high quality soils. As a synergy, the remediation of contaminated soils can be realised. In the cases of Celje and Prague the steering of urban development on brownfields provides an acceptable alternative to the consumption of greenfields, especially on the city borders. The URBAN SMS guide “Brownfield Redevelopment as an Alternative to Greenfield Consumption in Urban Development” **[19]** shows several approaches for a successful brownfield redevelopment.

The assessment of the measures described in the “Handbook for Measures Enhancing Soil Function Performance and Compensating Soil Loss During Urbanization Process” **[16]** was verified when applied in Stuttgart. It was demonstrated that complete compensation fails especially in cases in which high quality soils are lost.

Despite the tool applications, in many cases land take and soil sealing could not be limited in the pilot sites. The main reason for this might be the absence of a political decision. Still, the value of soil and its performance of several functions in urban areas are underestimated. The advantages of limiting land take and soil sealing on urban greenfield, in particular the positive effects of soil protection for the municipalities, have to be continuously communicated and properly targeted. Amongst other things, when starting a dialogue within the municipality and among decision makers, the following arguments have to be emphasised:

- Soil protection enhances the attractiveness of the city, in particular in terms of quality of life and recreation.
- Soil protection is one cornerstone in maintaining a healthy environment, e.g. protection of microclimate conditions (cooling function) and adhesion of fine dust.
- Soil protection supports the maintenance of natural environmental mechanisms like infiltration of precipitation and thus reduces direct costs for discharge.

Positive side effects:

- Sustainable urban development leads to optimized density and compactness in terms of the most effective use of infrastructure, minimising of traffic.
- Anticipatory urban development avoids overcapacities and deterioration of property values.

A member of the URBAN SMS team summarises the benefits: “The role of soil with its numerous functions is not sufficiently evaluated in planning procedures, which causes the main impact on excessive loss of soil functions. Joining an international consortium of research institutes combined with municipal teams was a big incentive for us as we now have strategies and tools at hand which help us to give a certain value to our soils. From a practical point of view the incorporation of soil into the urban planning process is possible with our project outputs.”

Still, the biggest challenge is to enhance local policies from short-term needs to a policy of long-term goals respecting sustainability. The URBAN SMS project has demonstrated the general feasibility of this approach. It enables European cities to remain competitive without unsustainable soil consumption. Public surveys reveal that the citizens feel comfortable in such cities.

URBAN SMS – Soil in the City

Guide to available URBAN SMS products

All products are published with free access on the project homepage www.urban-sms.eu

[1] Collection of (policy) instruments influencing the use and protection of soil from the partners of the project URBAN SMS. (EN)
Overview of international, national, regional and local policy instruments in all URBAN SMS partner countries and their impact on soil.

[2] SWOT Analysis – Analysis of Strengths, Weaknesses, Opportunities and Threats of (Policy) Instruments Regarding the Protection of Soil from the Partners of the Project URBAN SMS. (EN)
SWOT analysis of existing policy instruments in all URBAN SMS partner countries regarding the protection of soil.

[3] Identification of scientific and practical needs for consideration of soil issues in planning processes. (EN)
Collection of soil aspects that should be considered in spatial planning from a scientific and practical view.

[4] Existing Soil Management Approaches within Urban Planning Processes. (EN)
Overview and transnational synthesis of existing soil management approaches within urban planning procedures by considering specific regulatory requirements regarding spatial planning.

[5] Framework "Soils in Spatial Planning". (EN)
Description of needs and approaches for soil management within urban planning procedures by considering specific regulatory requirements regarding spatial planning.

[6] Soil Management Approaches in Urban Planning Procedures – Summary of stakeholder consultation. (EN)
Summary of stakeholder consultation on the concept of soil management in urban areas with definition of further needs and expectations.

[7] Guidance for Soil in Strategic Environmental Assessment and Environmental Impact Assessment (SEA/EIA Guidance). (EN)
Guidance on how to include various soil protection aspects practically in SEA and EIA.

[8] Guide Municipal Soil Management. (EN)
Guide how to perform sustainable urban planning regarding soil compiled in one concept for soil management in urban areas.

[9] Review on Past Efforts. (EN)

[10] SWOT of Existing Tools. (EN)

[11] Soil Manager Suite. (EN)
Software suite comprising a web-based and a desktop application. Both systems visualize processes and interpret soil data in the context of urban planning.

[12] Soil Manager Suite Handbooks. (EN)
Four manuals each with a short introduction are available and guide the user through the installation, data preparation, and running of the software: 'Software installation Manual', 'Tools & Data Description manual', 'Web Admin User Manual' and 'Web User Manual'.

[13] Technical Concept "Soil Indicator" Stuttgart-Application Concept. (EN)
Description of the ArcGIS-solution for the URBAN SMS software tool "Loss of soil resource", based on the soil protection concept of Stuttgart.

[14] Soil Evaluation Method Recording and Documentation of Archive Functions of Soils in the Stuttgart City Area. (EN)
The acquisition and documentation of archive functions of soils and their evaluation in terms of natural and cultural history. The City of Stuttgart acts as an example.

[15] Review of Existing Soil Compensation Measures. (EN)
Review and classification of compensatory instruments supporting protection of soil and soil functions that exist in Central European countries.

[16] Handbook for Measures Enhancing Soil Function Performance and Compensating Soil Loss During the Urbanization Process. (EN)
A document helping to select measures enhancing soil functions. It contains a list of measures/soil treatments and a description of their impact on soil functions.

[17] Compensation Measures for Encroachments on Soil – Stuttgart Assessment. (EN)
Example approach for calculating soil loss compensation needs and compensation measure benefits based on an index-point system corresponding to the soil protection strategies of the City of Stuttgart.

[18] Assessment of Soil Protection Efficiency and Land Use Change. (EN)
The report contains spatial information on land transformation into urban purposes in CE cities over a 15-year period and quality of soils lost during the urbanization process. The efficiency of soil protection regulations existing in CE countries is discussed.

[19] Brownfield Redevelopment as an Alternative to Greenfield Consumption in Urban Development in Central Europe. (EN)
Overview of regulations, guidelines and funding opportunities concerning brownfields in Central Europe. The report provides information on the scale and type of problems related to brownfields and defines bottlenecks for their regeneration.

[20] Baseline Scenario Analysis – Modeling Future Urban Sprawl in Pilot Cities. (EN)
Forecast of urbanization sprawl in the project pilot cities up to the year 2030 for the baseline scenario assuming no limitations for soil consumption related to soil quality.

[21] Forecast of Urban Sprawl Under Alternative Soil Protection Scenarios. (EN)
A report containing ex-ante analysis of urban sprawl in pilot cities under scenarios with improved soil protection and its comparison with the effects of no soil protection.

[22] Environmental Impact of Urban Soil Consumption. (EN)
A report providing examples of how to quantify a value of soil functions and evaluate consequences of soil loss in urbanization process. Consequences of water management, local climate and food production are discussed.

[23] Climatic Impacts of Urban Soil – Executive Summary. (EN)
A report containing information on mechanisms of soil sealing impact on local climate and air quality as well as its contribution to global climate change. An example procedure for quantification of the sealing impact is provided.

[24] Klimarelevante Einflüsse urbaner Bodeninanspruchnahme. Langfassung. (DE)
An extended report in the German language containing information on soil sealing impact on climate and air quality. An example procedure for quantification of the sealing impact is provided.

[25] Stakeholders Network for Impact Assessment of Soil Protection Scenarios. (EN)
The report on establishment of a stakeholder network within the pilot cities of the project. It contains opinions of stakeholders on key sustainability issues in cities of Central Europe and an impact assessment of soil protection scenarios.

[26] Road movie "Soil at Risk". (EN/DE with subtitles in CZ, PL, I, SK, SV)
A movie raising awareness of the role of soil in urban areas. It presents important soil functions and risks for soil resources related to urbanization.

[27] Soils in and around our cities. (EN)
A leaflet presenting soil functions essential for the environment and quality of human life.

[28] Actions and events to make the young generation sensitive to soil. (EN)
The leaflet presenting examples of raising awareness on soil importance within young generation of urban inhabitants.

[29] Pilot Action Case Study Book. (EN)
The document provides the description of the pilot sites in which the URBAN SMS tools were tested. The report contains also the description of results and experiences from the testing process.

[30] Experience Report. (EN)
The report summarizes the inventory of the sites information like questionnaires, evaluation templates, mind maps and analysis as basis for the URBAN SMS tools testing.

[31] Current soil management is not sustainable. (EN)
A leaflet summarizing assessments of the past and forecasted soil management trends in cities of Central Europe. It utilizes spatial data and information gathered through participatory impact assessment.

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