SOILS4EU

Policy brief

"Soil quality in spatial planning"

Content

1 Why considering soil quality in spatial planning

Soil quality is an account of the soil's ability to provide ecosystem and social services through its capacities to perform its functions under changing conditions[1]. Traditional spatial planning does not consider soil quality sufficiently. Land and soil are finite resources facing growing pressures and conflicts over their use. Land use planning and soil management should balance the supply of ecosystem services with society’s demands.

Figure 1.1: production function of soil

Soils play an important role in both urban and rural areas. By taking its’ characteristics consciously into account in spatial planning on different scales, the benefits can be optimized. For example, saving the most fertile soils for agricultural use and avoiding urban sprawl on these soils contributes to food security. On a smaller scale, soils in urban areas can be used for climate adaptation. By maximizing the presence of green infrastructure and limiting sealing, rainwater can be buffered by soils avoiding costs for the over-dimension of sewer systems and for damage as a result of flooding. Using soil quality as a planning parameter for industrial or urban land can stimulate reuse of urban or brownfield land instead of using greenfields and contributes to zero land take objectives. In section 2, a broad range of examples throughout Europe and their benefits are elaborated.

Urban and rural spatial planning and management should safeguard multi-functional and healthy soils - locally and globally to maintain natural capital while satisfying the needs of a prosperous society.

[1] Tóth, G., V. Stolbovoy, et al. (2007). Soil Quality and Sustainability Evaluation – An integrated approach to support soil related policies in the European Union. Luxembourg, Office for Official Publications of the European Communities.

To understand the relation between soil and land management (including spatial planning), the INSPIRATION[2] conceptual model can be used (figure 1.2). The conceptual model considers land and the soil-sediment-water (SSW) system as goods and natural capital stocks that have to be used (**Demand**) in a way that maximizes non-depletion of our ecosystems (**Natural Capital**). There are conflicting interests regarding land use among societal stakeholders, such as farmers, spatial planners, developers, manufacturing industry and residents. For instance, regarding the productivity of areas and/or protecting natural resources. Sustainable **land management** must seek to balance the demand and the supply, with the latter being based on the resources provided by our natural capital. As an integral part of such a sustainable soil management model, the **net impact**, meaning the local to global footprint of human land management decisions, must be assessed and minimised[3].

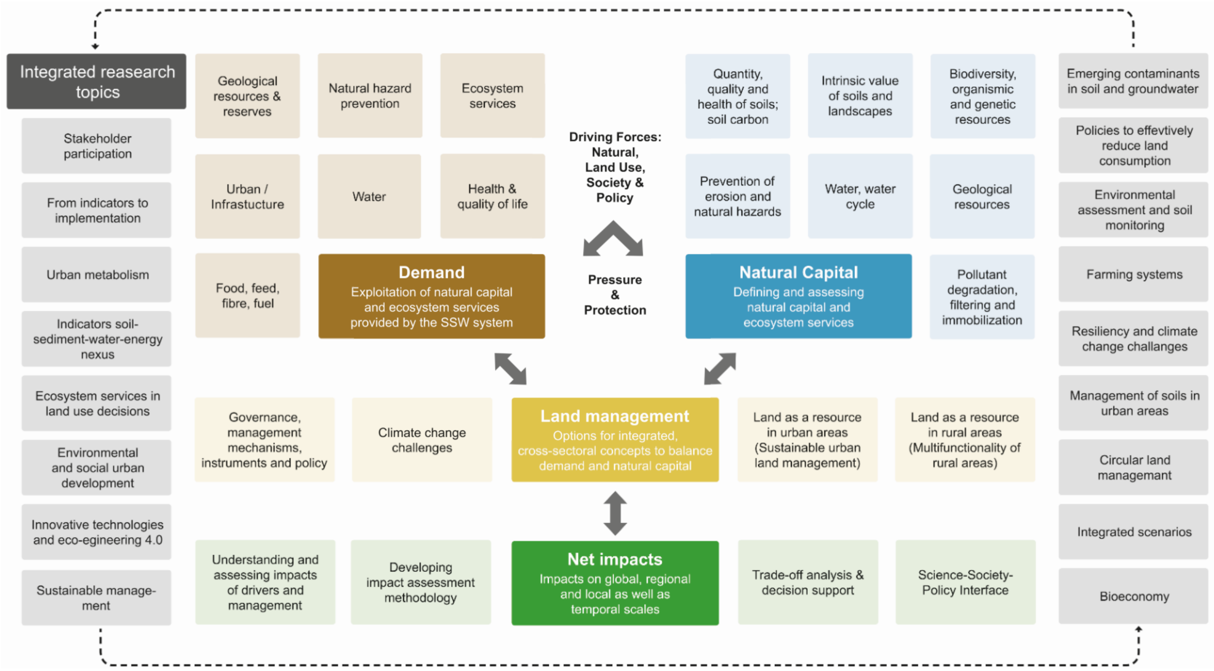

Figure 1.2: INSPIRATION conceptual model including research topics[4]

The INSPIRATION Strategic Research Agenda addresses several research needs (figure 1.3) related to spatial planning considering soil quality. The research questions aim at getting more insight on value of ecosystem services in land use decisions, finding land use scenarios contributing to societal challenges, “better” urban and brownfield planning and spatial planning as an instrument for coping with effects of climate change.

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[2] The Horizon2020 project INSPIRATION was a coordination and support action funded by the European Commission in order to develop a Strategic Research Agenda (SRA) for Europe on soil, land use and land management. It ended in February 2018.

[3] Bartke, S., et al. 2018. Soil and land use research in Europe: Lessons learned from INSPIRATION bottom-up strategic research agenda setting. In: Science of the total Environment, 622, 1408-1416.

[4] Makeschin, F., Schröter-Schlaack, C., Glante, F., Zeyer, J., Gorgon, J., Ferber, U., Villeneuve, J., Grimski, D., Bartke, S., 2016. INSPIRATION Report Concluding 2nd Project Phase: Enriched, Updated and Prioritised Overview of the Transnational Shared State-of-the-art as Input to Develop a Strategic Research Agenda and for a Matchmaking Process. Public version of the Final Version as of 30.10.2016 of Deliverable D3.4 of the HORIZON 2020 Project INSPIRATION. EC Grant agreement no: 642372. UBA, Dessau-Roßlau, Germany., http://www.inspiration-h2020.eu/sites/default/files/upload/images/conceptual-model-dec2015_0.jpg

Soils as a robust basis under the UN Sustainable Development Goals

The "Sustainable Development Goals (SDGs)" of the United Nations[5] are internationally agreed goals. A substantial amount of these sustainability goals depends on the ecosystem services provided by resilient and healthy soils. Using the most fertile soils for agriculture and avoid land take, contributes to goal 2 “End hunger, achieve food security and improved nutrition and promote sustainable agriculture”. Goal 11, “Make cities and human settlements inclusive, safe, resilient and sustainable”, depends on taking soil quality into account in urban planning. Spatial planning can be used as a tool to match demands and potential supply of soil energy (e.g. Aquifer Thermal Energy Storage ATES) and to adapt and mitigate climate change. This contributes to goal 7 “Ensure access to affordable, reliable, sustainable and modern energy” and goal 13 “Take urgent action to combat climate change and its impacts”. At the same time, goal 15 “Life on Land” focuses on combating and avoiding land and soil degradation. For long term sustainable use of the soil and avoiding soil degradation, balanced decisions need to be made. Considering soil quality, by matching demand and supply, and the soil’s constraints and boundary conditions in spatial planning, is therefore essential.

Figure 1.3: the Sustainable Development Goals

[5] https://sustainabledevelopment.un.org/

What do we mean with spatial planning taking into account soil quality

Many comparisons between spatial planning systems in European countries were made[6] and they differ a lot. Planning systems are typically driven by national policies while the detailed land use decisions are implemented at a local level. Local decision making and local plans are thus important[7]. The planning system can be described as follows (figure 1.4).

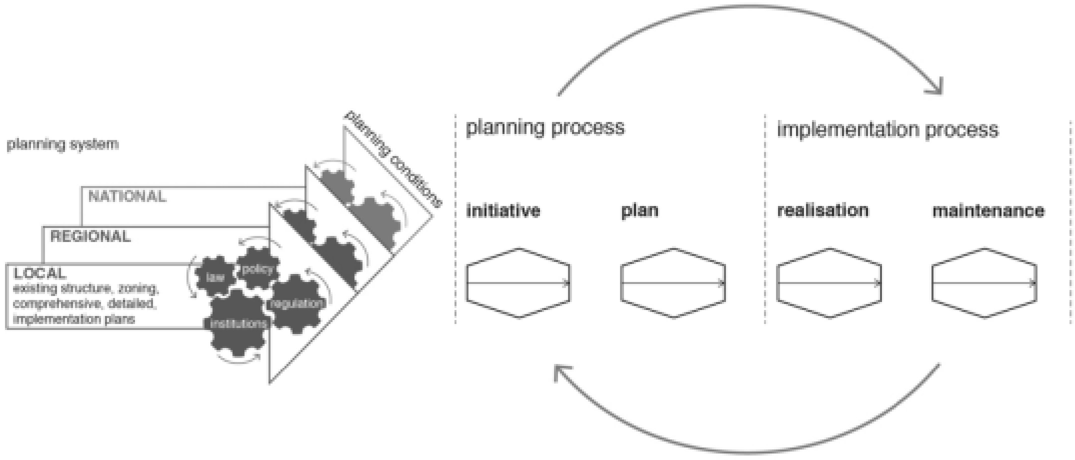

Figure 1.4: overview of planning system, planning and implementation process[8]

It shows how the planning system is a process in which law, regulations, policy and institutions work together on different scales. They influence each other and set the planning conditions. The initiative and plan phase are part of the plan process, the realization and maintenance phases of the implementation process. In the plan phase, it is important for soil experts interact as soon as possible with the planners to ensure timely input of soil quality to the planning process. The planning process is never linear, as it consists of a series of iterations where several exchanges on environmental topics (as soil) are needed (figure 1.5). It is also important to realize that planning processes take place on different scales, from a regional scale (master plans, zoning plans) to project level (project master plans, permitting). The information required and the role of the soil experts will be different in those phases and on different scale levels.

The Balance4P project conducted an inventory of policies and regulations for soil and subsurface to find out what aspects of soil are mandatory to take into account during the planning process and which are optional. In the three studied countries (Netherlands, Belgium (Flanders) and Sweden), best opportunities for subsurface integration in current planning systems were found in: heritage, environment, nature and water (Figure 1.5).

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[6] Commin 2007 www.commin.org,
Oxley Michael, Tim Brown, Vincent Nadin, Dr Lei Qu, Lidewij Tummers, Ana María Fernández-Maldonado, 2009. Review of European planning systems. Centre for Comparative Housing Research Leicester Business School. https://www.dora.dmu.ac.uk/bitstream/handle/2086/7536/NHPAU%20Planning.pdf?sequence=1,
Reimer, M. Getimis, P., Blotevogel, H.H. (eds) 2014., Spatial Planning Systems and Practices in Europe: A Comparative Perspective on continuity and changes. Akademie fur Raumforschung und landesplanung (ARL) ISBN 13: 978-0 – 415-72723-5,
Norrman, J., Volchko, Y., Maring, L., Hooimeijer, F., Broekx, S., Garção, R., Kain, J.-H., Ivarsson, M. Touchant, K., Beames A., 2015a. Balance 4P: Balancing decisions for urban brownfield regeneration – technical report. Report 2015:11. Department of Civil and Environmental Engineering, Chalmers University of Technology. Gothenburg, Sweden

[7] Oxley et al., 2009 (full reference in footnote 6)

[8] Normann et al, 2015a (full reference in footnote 6)

TOPICS IN SURFACE PLANNING →		heritage | environment | nature | water
CHANCES FOR ENHANCING THE SUBSURFACE BY	law and regulation	*chances for* - including the subsurface in planning regulations about heritage, environment, nature and water - including the subsurface in Environmental Impact Assessment and Water Assessment Test - subsurface in zoning plans through paragraphs about heritage, environment, nature and water
	policy and vision	*chances for:* - visions on the subsurface in local and regional plans, local policies, as well as in individual projects
	knowledge exchange	*chances for:* - interdisciplinary cooperation - developing new knowledge by cooperative learning
	design / construction	*subsurface in plan and design process needs:* - better frame of reference - better instruments (subsurface potential map)
CATEGORIES OF SUBSURFACE QUALITIES →		civil constructions soil | civil constructions soil water energy | water soil energy | water soil energy

Figure 1.5: summary of chances for enhancing subsurface into the current planning systems with regard to four aspects: heritage, environment, nature and water.

Traditionally, soil quality (other than the legally obligatory themes in different countries such as soil contamination, nature, water and archaeology) are not taken into account. In many cases, soil only becomes a topic when in the implementation phase "surprises" arise such as low carrying capacity, seepage, unexpected obstructions in the subsurface. The soil expert is then involved to solve the issue. In many cases this is done by implementing technical solutions.

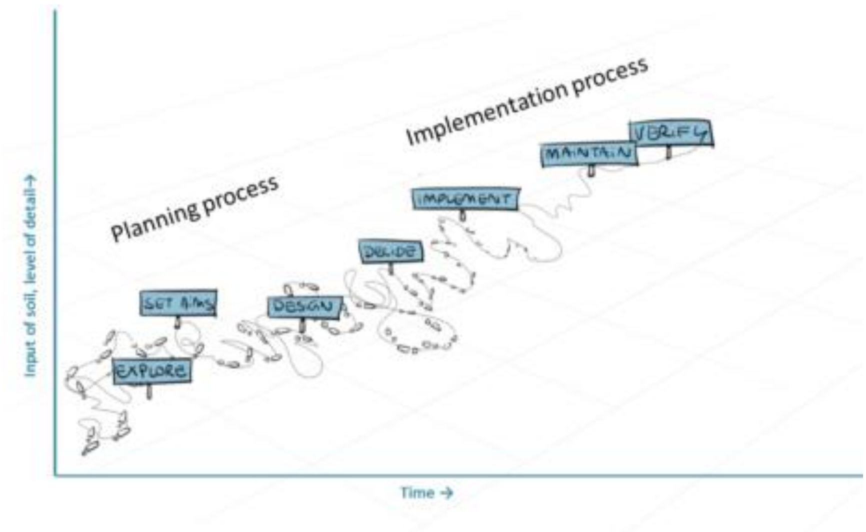

Figure 1.6: iterative planning process[9]

[9] Derived from the original figure in the Hombre final brochure (HOMBRE, 2014)

Figure 1.7 shows the model developed by the city of Rotterdam (The Netherlands) which can help in making spatial considerations for new functions, considering the soil. This starts with an assessment of the existing aboveground (1) and underground (2) functions and the relationship between them. Which functions need to be preserved and where is space for new functions? Which new aboveground (3) and underground (4) functions are required? Where are the natural physical conditions best suited for these new functions? What is the connection between new under- and aboveground use of space and what is the influence of the new development on existing functions? Do different types of underground functions compete and which has priority?

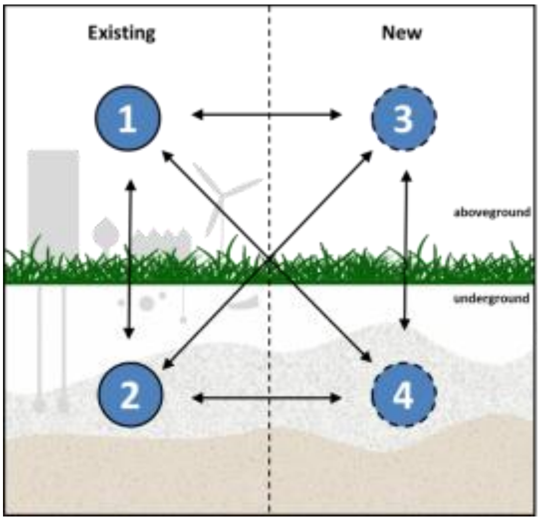

Figure 1.7: model for spatial planning of above- and underground use functions[10]

In the next section a series of examples in which spatial planning has taken soil quality into account are given for both agricultural and urban land.

[10] Derived from the original figure of SKB and municipality of Rotterdam, The Netherlands (unpublished)

2 Examples of case studies of spatial planning considering soil quality

Parties involved in spatial planning considering soil quality are land and soil users and specialists, spatial (urban and landscape) planners and policy makers in the field of spatial planning and soil. To give more insight in how they can act, examples from different countries in Europe are given below. All examples are case studies showing policies, projects or methodologies where soil quality (figure 2.1) and spatial (urban or landscape) planning were linked.

The case studies are divided in two categories:

- Spatial planning considering soil quality in **agricultural forest and natural land**
- Spatial planning considering soil quality in **urban and industrial** land

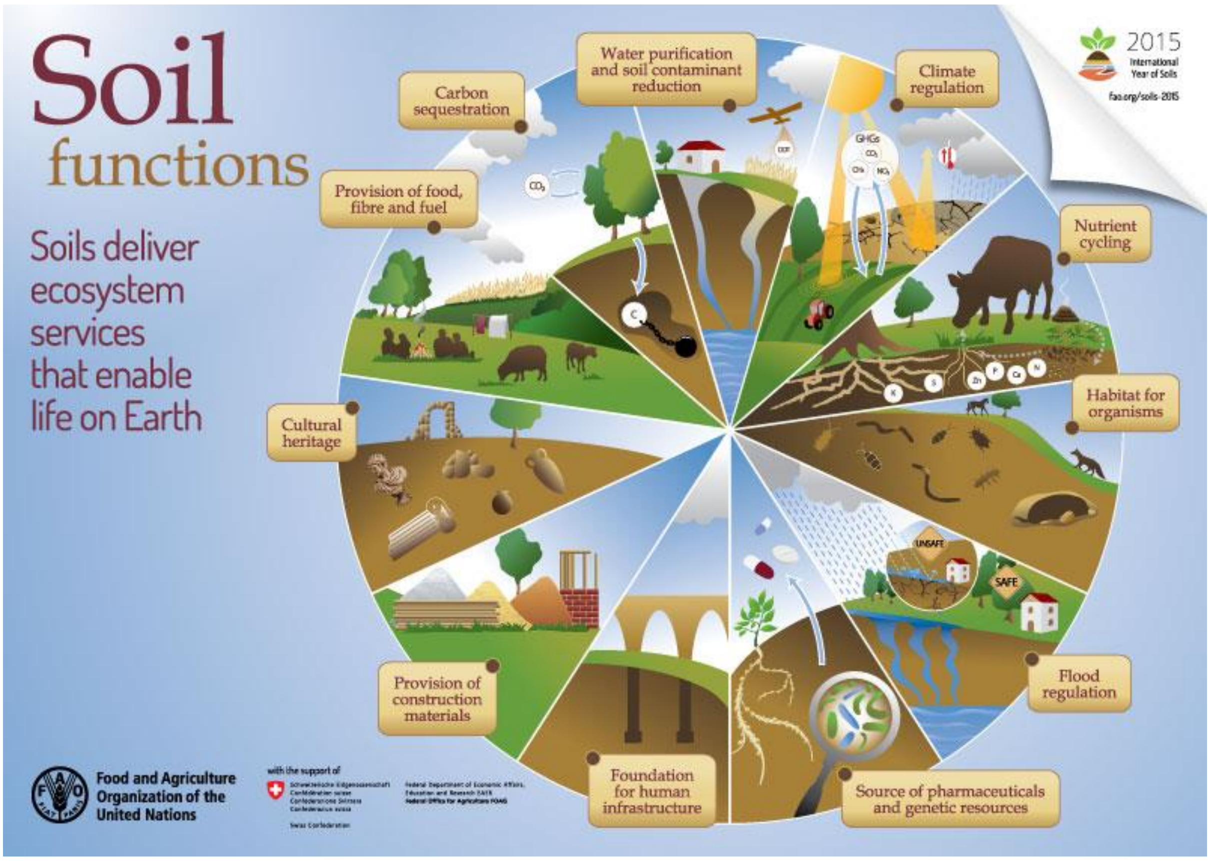

Figure 2.1: examples of soil functions[11]

Mapping soil quality is seen as a powerful ingredient for spatial planning. There are many examples using the concept of ecosystem services to take soil into account. Regulation or "zoning" is seen in both agricultural and urban land in multiple countries. There are examples taking soil quality into account from a broad perspective as well as examples considering soil from a narrow point of view focusing on one aspect such as soil contamination or the role of soil in climate adaptation.

[11] Source: http://www.fao.org/resources/infographics/infographics-details/en/c/284478/

Examples in agricultural, forest and natural land

Agriculture, forests and natural land depend on soil to provide ecosystem services. The type of soil and its condition determine the suitability for a specific crop, tree or natural environment. When the soil quality does not match a planned land use function, many interventions are needed. Unsustainable agriculture is considered as a major threat for soil functions and a key driver of soil degradation processes[12] such as soil erosion, soil contamination, loss of soil biodiversity and soil organic matter. The voluntary guidelines for sustainable Soil Management (VGSSM)[13] give guidelines on how to avoid unsustainable land use practices.

Figure 2.2: agricultural land

Soil ecosystem services

Taking soil quality into account in land use decisions for agricultural land is common in several countries. In the Links4Soils Interreg project[14], sustainable spatial planning methods include the evaluation of soil ecosystem services. Case studies that integrate the Soil Ecosystem Services (SES) approach into the spatial planning of municipalities are located in upper Bavaria (Germany) and Tyrol (Austria).

Land capability and soil suitability maps

The Emilia-Romagna region in Italy uses land capability maps[15] in agricultural planning since the 70s (figure 2.3). Land capability classification is a system of grouping soils primarily on the basis of their capability to produce common cultivated crops and pasture plants without deteriorating soil quality over time. The maps are also used to promote soil measures in relation to soil functions with the objective to: increase soil organic matter; promote conservation and organic agriculture; promote organic agriculture; restore degraded ecosystems; protect biodiversity; manage extensive grasslands sustainably; afforest agricultural lands; manage animal manure sustainably. Poland uses soil suitability maps, including the soil profile texture, relief and water regime, overall fertility and suitability for different crop types. In the spatial planning process, the maps depict boundaries of both organic soils and the most fertile agricultural land, which is legally restricted for urban development.

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[12] Adhikari, K., Hartemink, A. E. 2016. Linking soils to ecosystem services – A global review. Geoderma, 262, 101-111

[13] http://www.fao.org/3/a-bl813e.pdf

[14] https://alpinesoils.eu/best-practices/spatial-planning/

[15] https://applicazioni.regione.emilia-romagna.it/cartografia_sgss/user/viewer.jsp?service=pedologia&bookmark=1%22

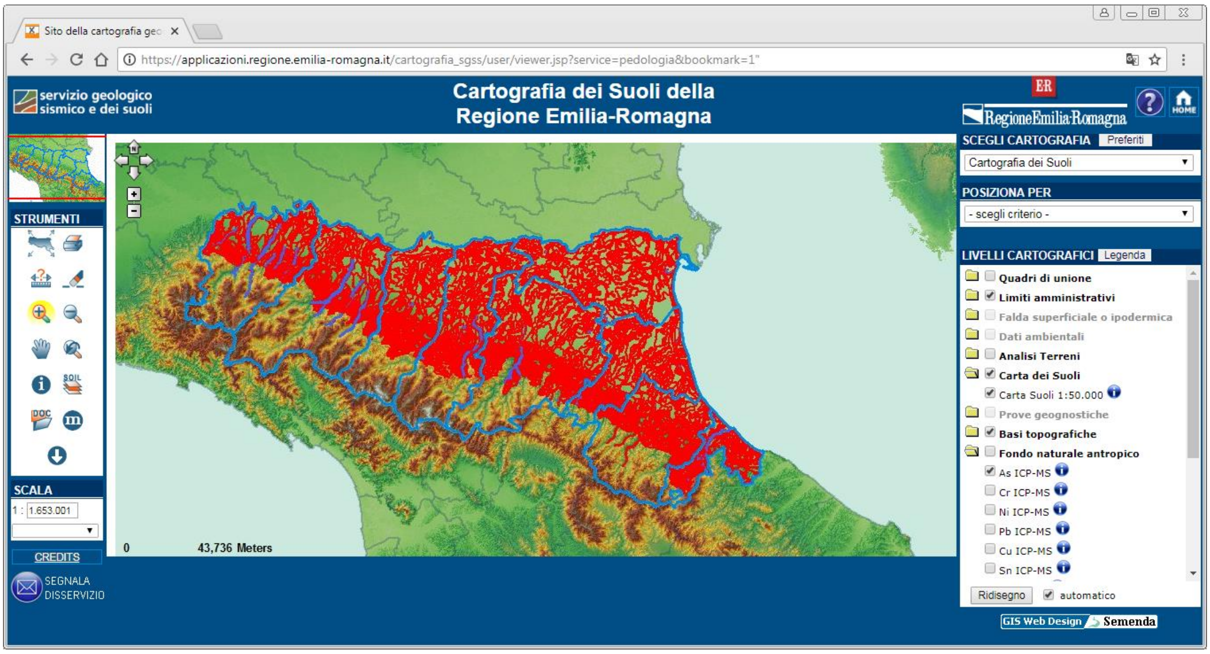

Figure 2.3: land capability maps for the Emilia-Romagna region in Italy

Regulation to avoid urbanisation and land take of good agricultural soils

The use of zoning to prohibit the development of urban land on good agricultural soils and to avoid land take and sealing is common in, for example, Portugal, Spain, Austria and Slovakia. In Portugal[16] soil capability is always considered in (urban/rural) spatial planning. The soil is divided in 5 capability classes, with the first two to be agriculture reserve and the last ecologic reserve. These capability classes and other restrictions and conditions related to protected areas are the basis for urban/regional spatial planning. In Spain[17] a "land use matrix" with categories for potential land uses in non-developed land is used. This matrix considers, amongst others, the ecological processes related to soil protection and aquifer recharge and also high agrological value soils. For each of the categories a specific use regulation is applied: 1) Favourable, 2) Admissible, 3) Forbidden. In the Austrian province Steiermark, Tirol, Oberösterreich and Salzburg, soil function maps are made. Municipalities have to use these maps in spatial planning. For instance, a new settlement area cannot be zoned in an area where soils have many functions at high level. Slovakia protects the best agricultural land with compensation payments. Conversion of protected agricultural land to building land requires a fee, depending on the quality of the affected soil, ranging from 6 – 15 Euros per m².

Planning of land use functions considering impact on soils

There are also examples where the location of a land use function is planned taking into account the environmental impacts on a certain location. For example, in The Netherlands this was done when searching the best locations for bioenergy production[18]. The method includes the function's impact on soil quality indicators (SOC, soil erosion) together with water, GHG emissions and biodiversity.

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[16] http://epic-webgis-portugal.isa.ulisboa.pt/

[17] EAEko Lurralde Antolamenduaren Gidalerroen Berrikuspena, 2018. Revisión de las Directrices de Ordenación Territorial de la CAPV. Spain. Available in spanish on: http://www.euskadi.eus/contenidos/informacion/dots/es_1165/adjuntos/APROBACION%20INCIAL/Diligencia%20de%20la%20Aprobaci%C3%B3n%20inicial%20de%20la%20revisi%C3%B3n%20de%20las%20DOT.pdf

[18] Van der Hilst, F., Lesschen, J.P., van Dam, J.M.C., Riksen, M., Verweija, P.A., Sanders, J.P.M., Faaij, A.P.C. 2012. Spatial variation of environmental impacts of regional biomass chains. Renewable and Sustainable Energy Reviews 16, 2053– 2069.

Examples in urban and industrial land

Urban and (former) industrial areas are, in many cases, artificial environments separated from their surrounding landscape and the natural environment. Urban and industrial areas are often heavily sealed, with the result that the natural functions of the soil-water system are lost. Examples are the water storage function that can reduce flooding after heavy rainfall and the production function for growth of plants and trees for a greener city that is less affected by, for example, heat stress. Many examples can be found where chemical soil quality is considered in urban planning. Fewer examples can be found where broader soil functions are taken into account. In some of those cases an ecosystem services framework was used.
The Cost SUBURBAN network, consisting of cities and geological surveys, was entirely dedicated to improve the "sub-urban" planning, by explaining the importance of the subsurface in the urban environment to urban planners. This action has collected many good examples and developed a toolbox[19].

Figure 2.3: flooding by heavy rainfall in urban land

Masterplans and development plans considering subsurface

In Helsinki, a masterplan was developed for the subsurface[20]. The Helsinki Underground Master Plan includes the (potential) locations of underground rock caves, facilities and traffic tunnels and their mutual compatibility. Soil energy heating and cooling are becoming more and more common. The underground city planning pays attention to possible conflicts between several ways to use the bedrock resources. Also the Lisbon Master Plan (PDML) considers a set of underground aspects[21] and in Glasgow (UK)[22] there are plans to incorporate the subsurface environment and resources in the planning policy framework in the new City Development Plan. In Oslo[23] there were plans to develop a municipal sub-plan for the underground. The "Oslo subsurface project" has started the development of such a plan, similar to Helsinki.

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[19] http://sub-urban.squarespace.com/

[20] https://static1.squarespace.com/static/542bc753e4b0a87901dd6258/t/5707847d37013bb703023e29/1460110490550/TU1206-WG1-007+Helsinki+City+Case+Study.pdf
http://sub-urban.squarespace.com/s/TU1206-WG1-007-Helsinki-City-Case-Study.pdf

[21] http://sub-urban.squarespace.com/s/TU1206-WG1-015-Lisbon-City-Case-Study-amn7.pdf

[22] https://static1.squarespace.com/static/542bc753e4b0a87901dd6258/t/57078ac3044262231705b636/1460112086450/TU1206-WG1-005+Glasgow+City+Case+Study.pdf and
http://www.bgs.ac.uk/research/engineeringGeology/urbanGeoscience/Clyde/askNetwork/home.html

[23] https://static1.squarespace.com/static/542bc753e4b0a87901dd6258/t/5707869ae707eb820b4118a5/1460111042910/TU1206-WG1-012+Oslo+City+Case+Study.pdf

Methodologies for urban planning considering a broad range of soil functions

As demonstrated by the URBAN SMS project[24] policies provide more efficient protection of the most fertile land in urban landscapes in Germany, Austria and Italy, as compared to Poland, Czech Republic and Slovakia. It is well established that the integration of unsealed fertile and higher water storage soils in the urban development process also contributes to a reduction of flooding and of air pollution trough wind erosion. In general, fertile soils with well-developed profiles support a higher biodiversity, a larger plant biomass which contributes to water retention, runoff and fugitive dust reduction and provide an efficient cooling effect for heat waves.

SAGISonline[25] from Land Salzburg (Austria) is a methodology for the assessment of individual soil functions that should enable the integration of protected soils into spatial decision-making processes. The approach was developed for municipalities together with planning offices.

The System Exploration Environment and Subsurface[26], that was tested in the Balance4P project in The Netherlands, Belgium and Sweden, was developed by soil scientists together with urban planners and municipalities. It combines aboveground layers with subsurface considerations to be discussed in a workshop with both the planners and soil experts. By exchanging information in an early stage it exposes which opportunities and challenges should be considered in urban and or brownfield (re)developments (figure 2.4).

A Belgium example[27] shows how the natural soil quality was taken along in the design of a housing project ('living in the wastine" = rangelands). The plan was designed together with the neighbourhood and other stakeholders. The soil and water conditions and the ecosystem value of this area were taken along in the plans to enhance nature and biodiversity. In this case traditional spatial planning for the development of rural residential communities was not favourable due to the specific characteristics of the area and therefore a new approach was chosen.

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[24] Blumlein P., H.J. Kircholtes, M. Schweiker, G. Wolf, B. Schug, I. Wieshofer, Sigbert Huber, M. Parolin, F. Villa, A. Zelioli, M. Biasioli, P. Medved, Tomaz Vernik, Borut Vrščaj, Grzegorz Siebielec, Josef Kozák, I. Galuskova, E. Fulajtar, Jaroslava Sobocká, S. Jaensch, 2012 Soil in the City. Urban Soil Management Strategy. ISBN: 978-3-943246-07-0, City of Stuttgart – Department for Environmental Protection, Germany, http://www.umweltbundesamt.at/en/services/services_resources/services_soil_spatial/en_urbansms/urbansms_casestudies/

[25] https://www.salzburg.gv.at/sagisonline/(S(rpsurzeb45bolbt30ejwlmnn))/init.aspx?karte=basis&geojuhuschema=Adressen/Namensgut&defaultlogo=agrarwald&gdiservices=Landnutzung/Landbedeckung&gdiservices=rohstoffe_und_geologie&gdiservices=landforstjagd&gdiservices=raumordnung&gdiservices=hoehen&gdiservices=umwelt&gdiservices=natur&gdiservices=boden&sichtbar=Nat%C3%BCrliche%20Bodenfruchtbarkeit&massstab=50000&koord=434000;306000

[26] Norrman et al., 2015a (full reference in footnote 6)
Norrman, J., Volchko, Y., Hooimeijer, F., Maring, L., Kain, J-H., Bardos, P., Broekx, S., Beames, A., Rosén, L., 2016. Integration of the subsurface and the surface sectors for a more holistic approach for sustainable redevelopment of urban brownfields. Science of the Total Environment, 563-564, pp 879–889.,
Hooimeijer & Maring (2018) . In: Journal of Urbanism: International research on placemaking and urban sustainability. pp 1-12
https://publicwiki.deltares.nl/display/SEES/HOME+English (consulted July 2018)

[27] https://www.oostkamp.be/download.ashx?id=44139

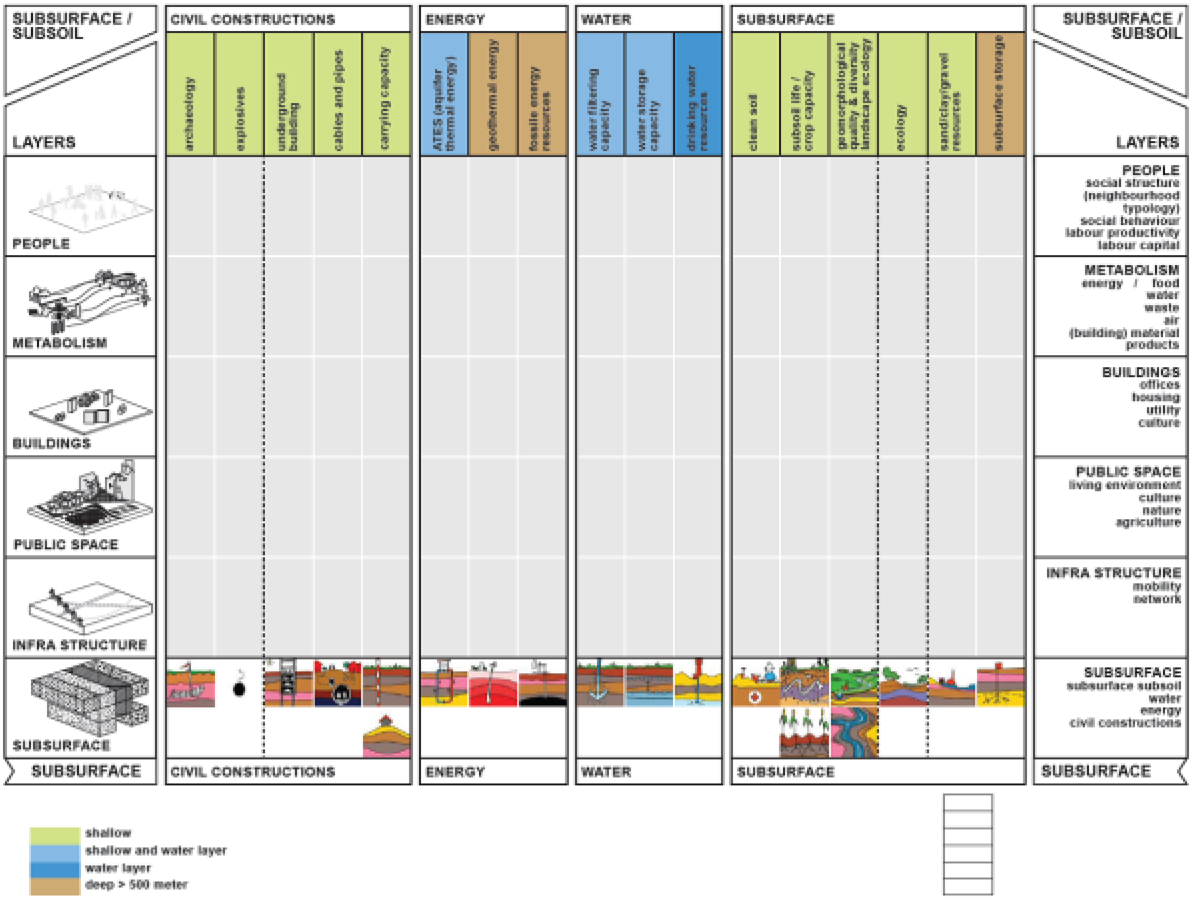

Figure 2.4: system exploration environment and subsurface

Soils and climate change adaptation in urban planning

In recent years there have been few studies[28] demonstrating the important role of the soil in combating the urban heat island effect. Processes are the solar energy absorbed by different urban surfaces that warm up the air above these surfaces, the evaporation of moisture and the storage of heat by different land covers (different soil and plant habitats, artificial surfaces, waters etc). Soil properties such as water holding and capacity to buffer urban heat are important assets to adapt to effects of climate change. The protection of the best soils in urban development should be considered as an important adaptation measure to climate change, contributing to the comfort and wellbeing of citizens.

A tool that supports planning climate change adaptation measures in urban areas is the Dutch Adaptation Support Tool (AST)[29]. Amongst other themes, the AST considers soil quality in terms of its storage capacity and unsealed area. The AST is applied in case studies in Berlin, London, Utrecht (figure 2.5) and Amsterdam.

[28] E.g. Santamouris M. (2014) Cooling the cities - a review of reflective and green roof mitigation technologies to fight heat island and improve comfort in urban environments Sol. Energy, 103: 682-703. http://dx.doi.org/10.1016/j.solener.2012.07.003 or Gunawardena K.R., Wells M.J., Kershaw T. (2017) Utilising green and bluespace to mitigate urban heat island intensity. Science of The Total Environment Vol. 584–585: 1040-1055
https://doi.org/10.1016/j.scitotenv.2017.01.158

[29] ast.deltares.nl

Figure 2.5: in Utrecht the AST was used to create one of the most green, sustainable, healthy and climate resilient urban districts in Europe.

Spatial planning to avoid soil sealing and land take

Soil sealing is one of the main causes of soil degradation in the EU and very much related to the spatial planning practice. The European Commission has formulated best practices to limit soil sealing or mitigating its effects[30]. There are many examples reducing soil sealing and land take, either through policy as e.g. in Austria, Germany, Belgium, Luxembourg, Netherlands and the UK, either by financial support for strategic land development as in Belgium /Flanders and Germany.
In different Member States quantitative limits for annual land take exist. In Austria and Germany the limits are defined in hectare per day for a target year. In Belgium (Flanders), Luxembourg and the Netherland, limits are based on inner urban development: 60% of new developments should be planned within defined inner urban boundaries. The Soil Compensation Account from Dresden (Germany) sets a limit for built-up land for settlements and traffic that is confined to 40% of the total urban land. New developments on undeveloped land require compensating de-sealing or “greening” measures somewhere else but within the city boundaries.

The regeneration of brownfield land is another strategy to avoid the further development of green areas and urban sprawl. By recognizing land and soil as vital resources and with a broad view on opportunities, networks such as CABERNET[31] and research projects such as Hombre[32] and Timbre[33] have contributed to strategies for brownfield regeneration, where the opportunities delivered by soil quality are taken into regeneration of this derelict land, preventing land take elsewhere. The United Kingdom (England) limits its land take by promoting brownfield redevelopment; new housing should be planned on already developed land.

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[30] Prokop, Gundula, Heide Jobstmann, Arnulf Schönbauer 2011. Report on best practices for limiting soil sealing and mitigating its effects. European Communities Technical Report 2011 - 050 doi : 10.2779/15146

[31] Ferber, U, Grimski, D, Millar K., Nathanail, P. (2006-II). Sustainable Brownfield Regeneration: CABERNET (The Concerted Action on Brownfield and Economic Regeneration
Network) Network Report

[32] Zerobrownfields.eu

[33] http://www.timbre-project.eu/en/brownfield.html


Figure 2.5: permeable pavement in a parking area as a measure against soil sealing

Urban planning considering chemical soil quality
Spatial planning and land management decisions should be made in consideration of the effects on risks that arise from contaminated soils. In Italy, a method was designed to indicate the potential level of human health risks due to heavy metal concentrations in urban soils, accounting for the potential impact of land use on such risks and providing suggestions on the most suitable land use to reduce the risk, including agricultural use. Soil data and information were taken from a soil survey and the effects of different types of land use on soil properties and on the capacity of the soil to fulfil certain functions were taken into account[34].

The Site Assessment and Re-use Planning Tool (SAT) was developed for brownfield land in the TIMBRE project[35]. It is a web-based tool optimizing and visualizing of re-use options, based on contamination data. It shows the consequences of the re-use options with respect to criteria such as remediation costs, sustainability, market values, etc. and it enables the communication between stakeholders. It was applied on cases in Poland and Germany (figure 2.6).

[34] Poggio, L., Vrscaj, B., Hepperle, E., Schulin, R. Marsan, F. 2008. Introducing a method of human health risk evaluation for planning and soil quality management of heavy metal-polluted soils—An example from Grugliasco (Italy). Landscape and Urban Planning 88, 64-72.
[35] http://www.timbre-project.eu/en/site-assessment-tool.html

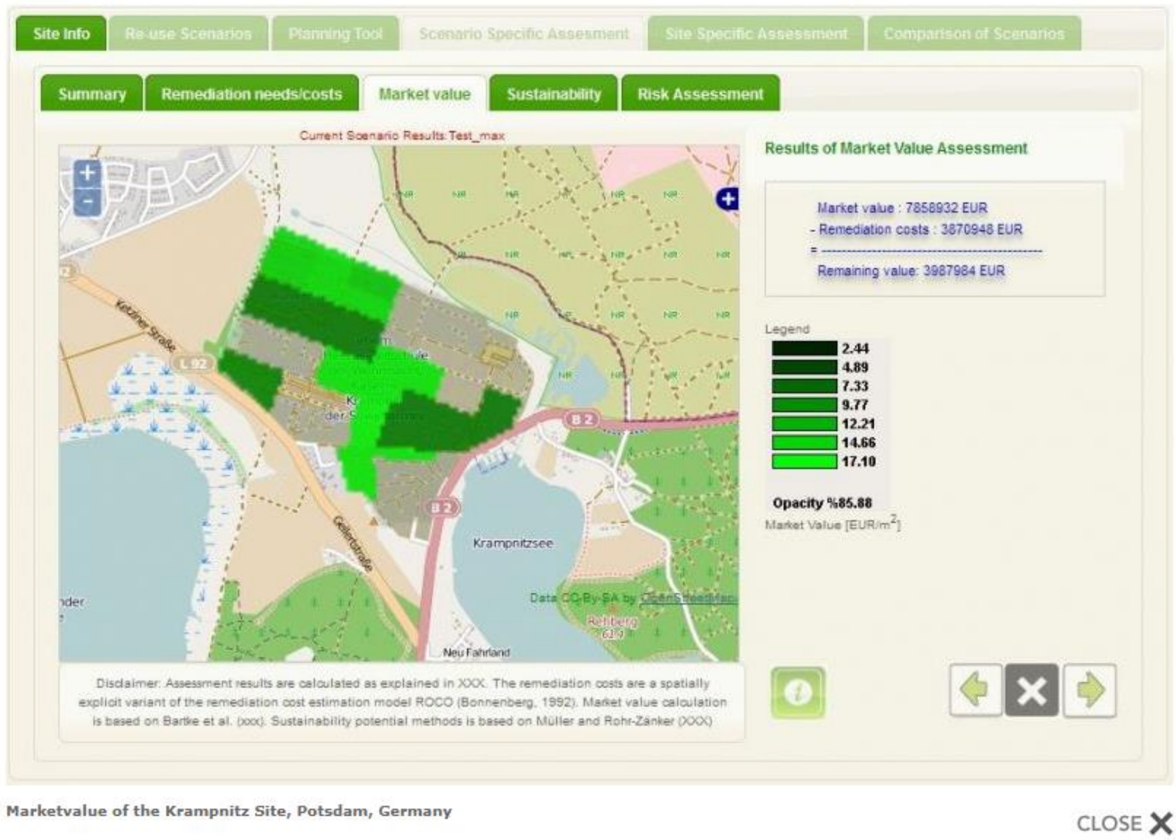

Figure 2.6: Site Assessment and Re-use Planning Tool (SAT)

The main need of city planners in relation to the geochemical quality of soils and subsoils is to have reasonable and representative visualisation of the data in a form, which enables them to be used effectively and in an integrated way with other datasets (socio-economic, health, etc.). 2D and 3D mapping of soil geochemistry are useful tools, where 2D topsoil acquisition is particularly well suited for addressing health issues. 3D geochemical knowledge is still uncommon but can be very useful in optimizing urban redevelopment projects, anticipating contamination problems, and managing excavated materials (e.g. local reuse possibilities, disposal costs etc.). Because all of these aspects can have important economic, environmental and social consequences, they are considered essential for urban sustainable development. The cost suburban network has made an overview of good practice and best efforts[36].

[36] http://sub-urban.squarespace.com/new-index-1/#geochemistry-wg-26

3 Main barriers

In the examples above many benefits are described of spatial planning considering soil quality and soil functionalities. What are the reasons that it is not done yet on a wide scale? A (non-exhaustive) summary of the main barriers are given here. In section 4, the main recommendations for action are given.

No law, policy, regulation and/or institutions

- There is a lack of regulatory and policy support specifically aimed at integrating soil quality in the planning phases. When there is no rule or policy that asks for the effort to take soil quality into account, it depends on the specific public administration at different levels (local, regional) and / or project/process manager if they consider the topic to be important.
- The complexity of governance and fragmentation of responsibilities regarding spatial planning hampers possibilities to integrate soil quality in the spatial planning practice.
- The lack of a common approach to risk assessment in many jurisdictions is some countries resulting in development on sites which pose a risk to a human health or/and ecosystem functioning.
- Environmental assessment (EA) is the assessment of the positive and negative environmental consequences of a plan, policy, program (strategic environmental assessment SEA), or actual project (environmental impact assessment EIA), prior to the decision to move forward with the proposed action. The impacts on people, human health, fauna and flora, soils, land use, material assets, water quality and hydrology, air quality, climate, noise and vibration, the landscape and visual environment, historic and cultural heritage resources, and the interactions between are described for the different alternatives. Although helpful tools for assessing the impact on soil by spatial plans, EIA and SEA traditionally have a limited scope in scale and time (direct and on-site) and on the topic soil. Their role in the planning process and influence on spatial decisions is limited.

Figure 3.1: land slide hazard

No awareness on the topic, continue traditional practice

- Who is in the lead when taking soil quality into account in spatial planning? The soil specialist or the spatial planner?
- When involving the soil expert, it is in many cases the person who knows about soil remediation. By considering soil quality just as contamination, spatial planners interpret "soil" as extra costs, time and work and not as an opportunity.

- There is limited interest of stakeholders and planners in including soil quality and sustainability assessments in early planning due to complexity. Adding more topics to the planning process without seeing the added value complicates the project. [40].
- The cultural background of professionals, their education and training, knowledge and experience play an important role in how they do their work. Deviation from traditional practice should be substantiated with examples and added value.

Financial arrangement, division costs and benefits

- In most cases there is limited urban planning project budget and unbalanced risk cost distribution between developers and planners. This hinders a broader investigation of the soil quality's barriers and opportunities in the planning phase, which in many cases can lead to unexpected events during the development and maintenance phase. Other ways of tendering and contracting (e.g. Design Build Maintain contracts) can help to overcome this obstacle.

Insufficient (availability of) data and tools

- Information on soil quality is not always available. The development leads to extra costs.
- Data and (decision support) tools considering soil quality are not always specifically targeted to spatial planners. The data and tools can be hard to find and to use and their added value is not always clear to the spatial planner.
- Compatibility of IT systems is needed to exchange information, map layers and data.

Lacking communication and collaboration, lacking information and knowledge exchange

- The multidisciplinary dialogue between planners and soil experts is often hampered by the difference in language and jargon.
- The quality of the information transfer is not secured during the redevelopment process when the actors and/or regulatory frameworks change. In many cases huge information loss is the result.
- Networks and education play an important role in knowledge exchange. It requires more time and effort to acquire knowledge about innovation, experiments and new methods. In contrast to people with a specific interest or task on the topic, the "peloton" is insufficiently involved in these networks and exchanges.

Figure 3.2: soil erosion

4 Recommendations for action

Integrate the topic in law, policy, regulation and/or institutions

- Policymakers on both spatial planning and development issues and on soil and water issues have a joint responsibility to enhance the practice of spatial planning by taking soil quality into account. This can be done by introducing this in their policies and as a requirement in the task description for area and urban developments.
- Turpin et al., propose in their assessment of policies affecting Sustainable Soil Management in Europe, to embed public and/or private interests affected by the management of agricultural soils in policy frameworks. These public and/or private interests include in the first place the protection and improvement of the soil itself, notably the integrity and quality of soils for use in agriculture and in the provision of other ES. The quality of soils relates to the status of the soil itself. Among these, the retention of topsoil by protection against erosion by water and wind, the protection of soil structure against compaction, and the conservation and enhancement of soil organic carbon (SOC) and soil biodiversity can be distinguished. Besides their obvious importance to farming, additional interests can be mentioned that include the provision of landscape- based ecosystem services such as water quality, air quality, and (aboveground) biodiversity[37].
- Integration of soil quality in a broad sense (e.g. soil ecosystem services) in Environmental Impact Assessment (EIA) and Strategic Environmental Assessment (SEA) can be an opportunity for better integration in spatial planning, because plans, policies, programs and projects will take the integration of soil quality into account in their assessment.

Figure 4.1: collaboration between spatial planners and soil experts

Increase awareness on the topic, continue traditional practice

- To integrate soil quality better into spatial planning, it requires a new field of interdisciplinary research. In urban renewal and the redevelopment of brownfield land, the subsurface and surface, and particularly where the natural and man-made systems connect, should not merely co-exist but work together. Turning to an approach that starts from the merits of natural systems and balance these out with state-of-the-art technology will lead to innovative solutions. This approach involves a change in attitude, organization and design in urban projects, and it requires close cooperation between urban designers and engineers[38].

[37] Turpin et al., 2017 An assessment of policies affecting Sustainable Soil Management in Europe and selected member states

[38] Hooimeijer and Maring, 2018, see footnote 29

- The Balance 4P project[39] concluded the following. Next to “people, planet and profit”, the fourth P: the process is crucial for the success of sustainable projects. This includes a process leader who stays on top of the objectives and boundary conditions that are set for the project. This includes being specific that all parties involved should take soil quality into account when performing their tasks. Otherwise this will end up on the end of the list as “extra work”, or “complicating” or “difficult”.
- Soil quality is more than contamination. By recognizing this, a broader range of relevant soil experts can be involved at the beginning of projects and initiatives: e.g. engineers with knowledge of the hydrogeological, geotechnical and ecological aspects, soil energy, and civil engineers.
- Exchange, show and tell: Awareness is needed on the fact that the soil, subsurface and planning sector can benefit from each other’s practices. The policymakers and practitioners in spatial planning and development issues and on soil and water issues need to be aware on, and communicate about the contribution of soil quality in spatial (urban and land scape) planning. This can be done by education, by showing added value or costs and damage when soil quality is considers, or neglected by spatial planning, and by exchanging examples on good and bad practices.

Ensure sufficient (availability of) data and tools

- Soil data must be accessible and understandable. The development of soil databases is therefore required when not yet available in member states. Data and figures are also needed to show the added value of spatial planning where soil quality was considered. Research programs and projects should give priority to disseminate the data and results to enhance the collaboration between planning and soil on both policy as practice level.
- There are methodologies and tools available. Making them available for planners and practitioners and initiatives such as learning by doing might help changing business as usual.
- There is a multitude of tools developed in the EU and member states. The choice which tool fits best depends on data availability, project phase, ability, legal framing but also personal taste. The most important aspect when choosing a tool is that stakeholders involved accept the tool and its outputs. A good design matters for sustainable solutions. It is worth to spend the perceived extra effort in the beginning of the project for a better, more resilient and robust design. This avoids unexpected events and pays off in the maintenance phase[40].

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[39] Norrman, Jet al;., 2015a (full reference in footnote 6)

[40] Overviews of tools for soil in spatial planning are made in e.g.:

- the URBAN SMS project: http://www.umweltbundesamt.at/fileadmin/inhalte/urbansms/pdf_files/Final_Conference/Posters/PP07_AIS_tools_description.pdf ,
- Balance 4P project, Normann et al., 2015a footnote 7

The HOMBRE and TIMBRE projects have developed and made overviews of tools for brownfield regeneration (www.zerobrownfields.eu, http://www.timbre-project.eu/)

The EC has worked on tools such as the Voluntary Guidelines for Sustainable Soil Management and the best practices for limiting soil sealing and mitigating its effects. http://www.fao.org/3/a-bl813e.pdf

Also tools such as SIA and EIA are valuable.

Figure 4.2: "augmented reality" as a tool to show subsurface information on site

Improve financial arrangement, division costs and benefits, Private-public ownership

- In development projects, other ways of tendering and contracting (e.g. Design Build Maintain contracts) can help to overcome the obstacle that soil and subsurface characteristics are ignored during the planning phase. In this case, the developer would avoid potential costs arising in the maintenance phase (e.g. due to building on soils with a low carrying capacity, figure 4.3) by alternative building methods and materials (which might involve higher realization costs, that will be earned back during maintenance).

Improve communication and collaboration, information and knowledge exchange

- For researchers, policy makers and practitioners in the fields of soil and subsurface and spatial planning, better collaboration, earlier knowledge exchange and tools and policies support the collaboration.
- Knowledge exchange is key to success in sustainable (re)development projects. It is not only of importance of which knowledge is delivered, also how and when. People should be capable to understand the information delivered and be able to use it for their specific task. Therefore it is also important not to overload people involved with all information in the beginning of the project, but dose the information supply: the right information to the right person in the right time, and give an explanation when needed. Knowledge exchange is a continuous activity that needs planning.
- Networks (existing and new) could give an impulse to collaboration between spatial planners and soil experts. An example is the Cost SUB-URBAN network[41] where Geological Surveys, Cities and Research Partners work together to "improve how we manage the ground beneath our cities".

[41] www.sub-urban.eu

- It starts with education. Soil scientists should understand the planning system in a country and planners should get some introduction on soil and water. At BOKU, the University of Natural Resources and Life Sciences, in Austria, all Landscape Planners have to learn soil science (4 European Credit Transfer System) when starting their bachelor. The urban planning students at the Technical University of Delft (Netherlands) get lectures on soil and water (Sustainable Urban Engineering of Territory). In Italy the Polytechnic University (POLITO), besides Engineer and Architecture, has since about 10 years a course for the degree in Urban Planning, which includes a couple of exams on geology. Chalmers university in Sweden includes in the education program for "landscape architecture" some basic quaternary geology and basic soil science. And the other way around, at the University of Nottingham, the environmental management and contaminated land management students get an introduction on spatial planning.

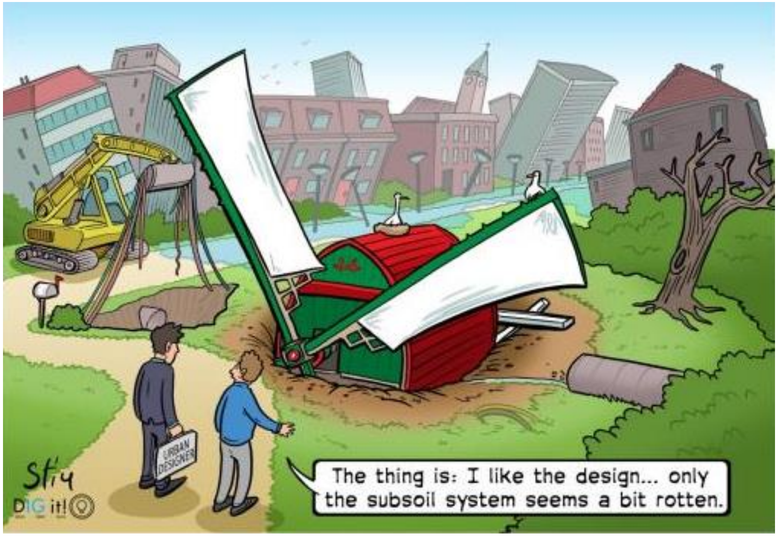

Figure 4.3: Cartoon 'Building on soils with a low carrying capacity in the Netherlands' (©Hooimeijer)

Colofon

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This policy brief was written by Linda Maring (Deltares) with contributions of Carmen Castañeda del Álamo (CSIC), Jorge Alvaro Fuentes (CSIC), Tomasz Stuczynski (IUNG), Nina Hagemann (UFZ), Victoria Dietze (UFZ), Stephan Bartke (UFZ).

It was reviewed by Lena Niel (Deltares) and approved by Henriette Otter (Deltares).

Date	Version	Prepared by	Review by	Approved by
6-2-2019	1	Linda Maring Deltares	Lena Niel Deltares i.a.	Henriette Otter Deltares

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Disclaimer

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