01.12 Soil Functions (Edition 2018)

Overview

When the Federal Soil Protection Act came into force in 1999 (BBodSchG), soil as an environmental medium was protected by its very own specific law, as was already the case for water, air and nature conservation. This law aims at “permanently safeguarding or restoring the functions of the soil”. For this purpose, “precautions against adverse effects upon the soil [are] to be undertaken. In case of measures which impact upon the soil, impairment of its natural functions and its function as an archive of natural and cultural history should be avoided to the extent possible” (BBodSchG Section 1). The Federal Soil Protection Act distinguishes the following functions of the soil:

1. Natural functions
   a) as the basis of life and habitat for people, animals, plants and soil organisms
   b) as a component of the ecosystem, particularly with its water and nutrient cycles and
   c) as a medium for decomposition, balance and restoration in response to material effects as a result of its filtering, buffering and substance-converting properties, in particular, too, for the protection of the groundwater.
2. Functions as an archive of natural and cultural history, as well as
3. Use functions
   a) as raw-materials storage
   b) as land for settlement and recreation
   c) as land for agriculture and forestry
   d) as land for other economic and public uses, such as transport, supply and waste disposal.

Exercising these use functions can restrict or block the natural functions and the archival function of the soil. The main focus of sustainable soil protection (only in German) is thus on protecting these natural soil functions.

Targeted soil protection measures presuppose knowledge of the efficacy, protection level and sensitivity of soils and their functions. The assessment process of soil functions, i.e. the determination of the efficacy of soils as part of the ecosystem, will highlight those soils in Berlin that need to be protected first and foremost.

The functions addressed in Maps 01.12.1 through 01.12.5 were selected based on Tab.1 and the functions listed in the Federal Soil Protection Act:

Soil function as per Section 2 BBodSchG	**Specific soil function** (Environmental Atlas Map no.)	**Criteria for the practical implementation in Berlin**
A. Basis for life and habitat		
• for humans:	pollutant load	not evaluated in this context due to a lack of comprehensive data
• for animals:	closely correlated with vegetation; no separate evaluation	
• for plants:	A. habitat for near-natural and rare plant communities (cf. Map 1.12.1) B. yield function for cultivated plants (cf. Map 1.12.2)	near-natural and unique extreme locations typical of Berlin water supply and nutrient storage capacity
• Soil organisms:	currently not evaluable for methodological reasons	

B. Component of the ecosystem:		
• water balance:	regulatory function for the water balance (cf. Map 1.12.4)	exchange rate of soil water
• nutrient balance:	close connection to the habitat for plants (natural soil fertility); already shown there.	
• decomposition, balance and restoration function:	buffering and filtration function (cf. Map 1.12.3)	substance-binding capacity and depth to groundwater
C. Function as an archive		
• for natural history	archival function for natural history (cf. Map 1.12.5)	distinctive natural characteristics and regional rarity
• for cultural history	not relevant for Berlin	

Tab. 1: Soil functions as per the Federal Soil Protection Act (BBodSchG) and their assessment in terms of their specific functions for Berlin

The evaluation of the efficacy of the soils is an important criterion for preventive soil protection in urban-construction planning (only in German).

Methodology

For the evaluation of the soil functions, the soil characteristic values (cf. Map 01.06) derived from the Soil Associations Map (cf. Map 01.01) and the associated dissertation by Grenzius (1987) were the main source. The quality of these basic data decisively determines the quality and authoritativeness of the evaluation of soil functions. From these and other information, criteria were derived (cf. Map 01.11) to permit an evaluation of the soil functions (cf. Fig. 1). The method of evaluation was developed in the context of the conceptual work on soil (Lahmeyer 2000), and later applied to the whole city (Gerstenberg and Smettan 2001, 2005, 2009). The maps presented here are based on updated basic data and improved methods of evaluation (Gerstenberg 2013).

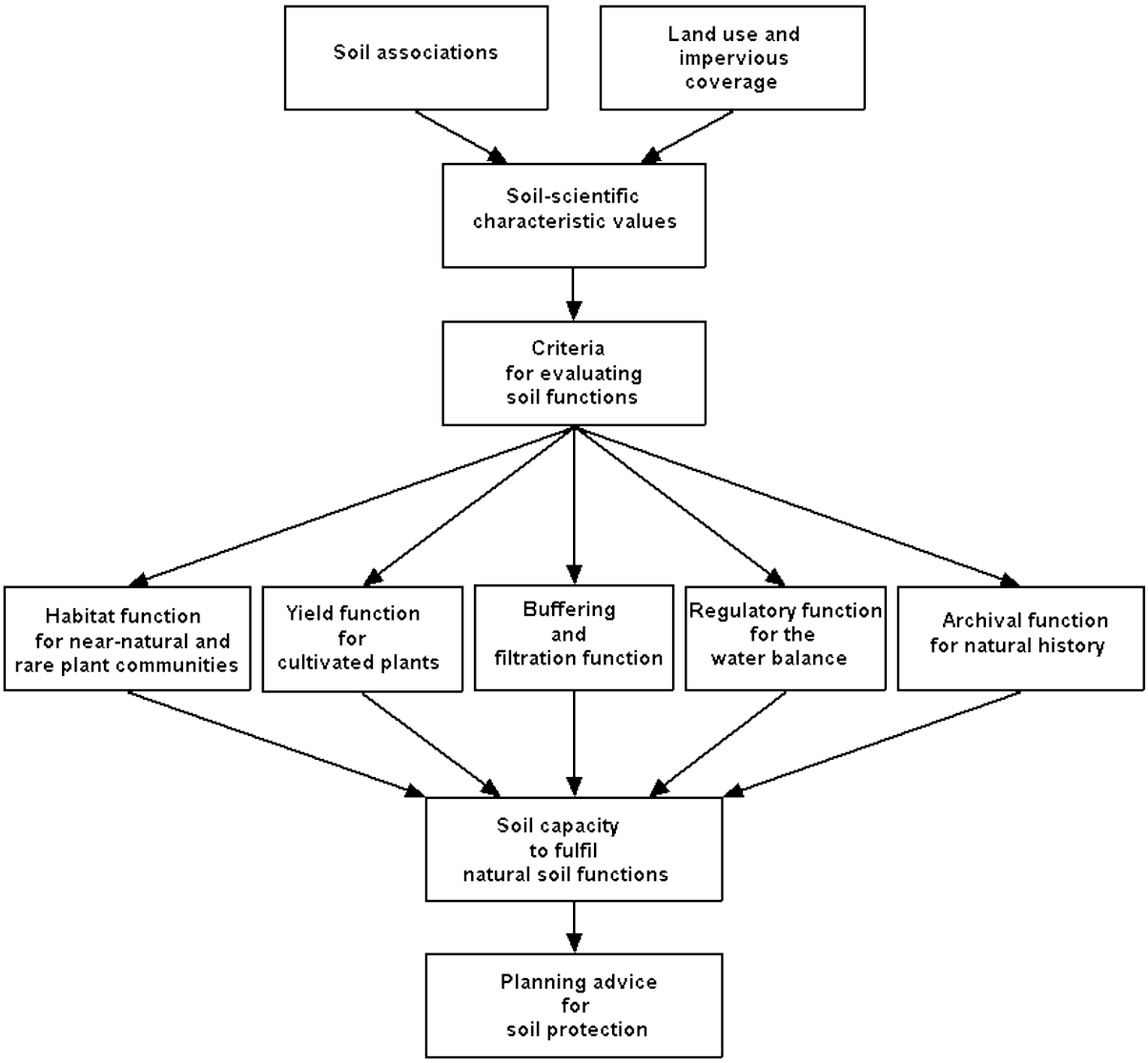

Fig. 1: Diagram to evaluate the soil functions

The map of soil associations at a scale of 1 : 50,000, and thus also the maps for the evaluation of soil functions, are general maps which are useful for state-level planning. This generalization, based on the scale, means that detailed information cannot be displayed on the map. This includes a detailed differentiation of soil categories, which are indeed ecologically relevant, and which commonly occur, as well as their functional evaluations. The map can therefore not provide detailed, lot-precise information, due to its scale. Large-scale detailed mappings would be required here. The present maps may however be used for an initial assessment.

The soil units represented in the soil map describe soil associations. These are different soil types which are categorized into landscape segments distinguished by their geology, geomorphology, water balance and their use. Just as the soil types vary, the ecological properties that are examined here may vary greatly for the individual soils of a soil association.

In some cases, soil associations are evaluated based on the occurrence of individual soil types. This is the case, for example, when wet soils are marked as potential high-quality locations for vegetation. It must be noted here, however, that such soils may accompany or be subordinate to other soil types within their soil association. This map cannot be used to pinpoint accurate borders for the different ecological properties within the same soil association, due to its scale.

Parameters are used to evaluate individual soil functions, which were not measured but determined as characteristic values. This method is commonly used in soil science and for large-scale studies, as it allows for comprehensive statements for larger areas. Key input variables to determine characteristic values are soil texture, humus content and pH value. These variables are available in sufficient detail in the file of characteristic values linked to the map of soil associations.

The soils capacity to fulfill the five soil functions was evaluated based on the three-point scale "high", "medium" and ”low.” Evaluation variations arise due to the fact that soil associations frequently consist of pedologically (soil-scientifically) and functionally different soil types. These variations have been generalized.

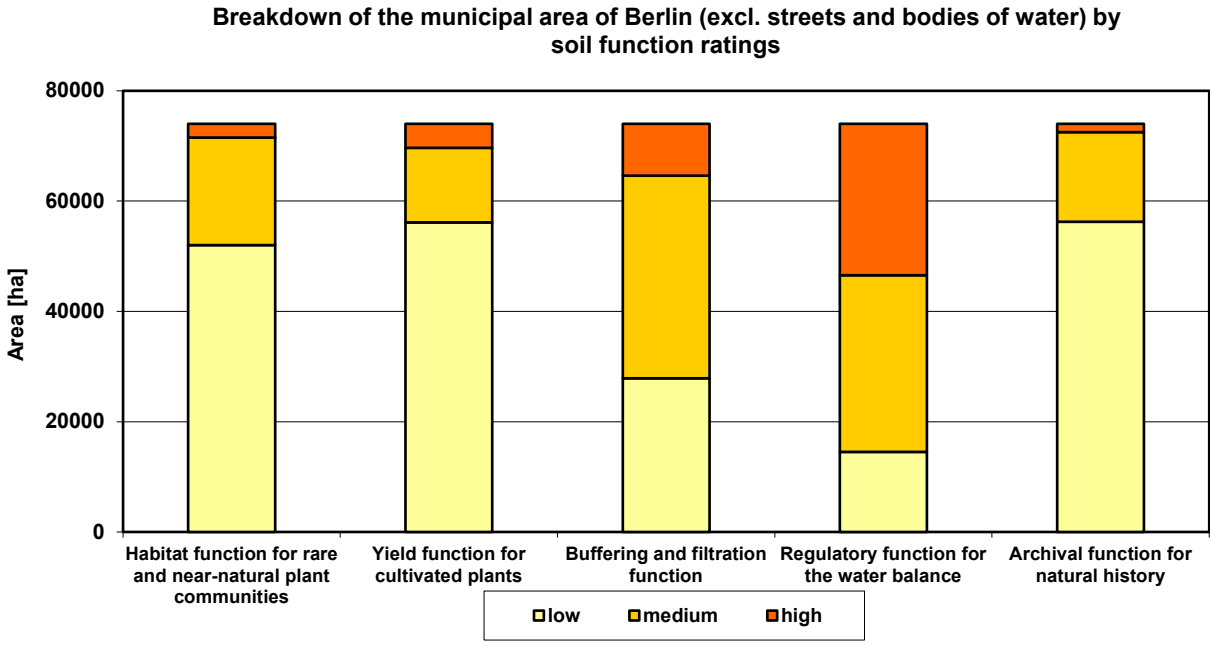

Fig. 2: Breakdown of the municipal area of Berlin (excl. streets and bodies of water) by evaluation of the different soil functions

As a result, the assessments of the areas between the individual soil functions are distributed rather unevenly (cf. Fig. 2). This uneven breakdown of soils of low, medium and high capacity to fulfil a function, results from the function itself:

- With regard to the habitat function of near-natural and rare plant communities, the protection of endangered biotopes is generally examined, and these and their habitats are by definition rare.
- Natural soil fertility is generally rather low in Berlin.
- The buffering and filtration function in Berlin is much more pronounced on the plateaus. This differentiation and the regional frequency of the plateaus and valley sand areas are reflected by many areas with "medium" and "high" ratings in the distribution. In addition, many near-natural bog sites are included because of their high carbon-storage capacity.
- The regulatory function for the water balance is evaluated on the basis of the exchange rate of the soil water, and its similarity to "natural" drainage conditions, which are characterized by high evaporation and low rates of percolation. This is the case in large parts of forest and farming areas, so that, thanks to the relatively high share of these uses, many areas are assessed as "medium" or "high. "
- The archival function protects primarily the soil associations, which are specific to a region and give the same a distinct i.e. unique character. This then is by definition not "normal" or common, resulting in a “low” rating for most areas here.

These differences in evaluation are intentional because they correspond to the natural conditions of the landscape and reflect the differences in importance of the functions.

In Map 01.12.6, the five individual maps were combined to form a complete map "Capacity of Soils to Fulfil the Natural Soil Functions and the Archival Function."

01.12.1 Habitat Function for Rare and Near-Natural Plant Communities

Description

Almost all soils are generally potential growth sites for plants. Therefore, they provide a habitat for plant communities. Differences in efficacy arise from the evaluation of the vegetation potentially growing on the soil in question, with rare species or plant communities being rated higher, primarily from the viewpoint of nature conservation.

Changes in the soil caused by excavation, aggradation and translocation, by nutrient inputs and decreased groundwater levels largely mitigate the characteristics specific to a site. Rare specialized plant species are thus deprived of their habitat. Poor and dry sites with the comparatively rare dry grasslands, which root here, constitute a special case that is not uncommon. Their occurrence in the Berlin area, however, is tied to a low degree of anthropogenic influence.

The assessment of the habitat function carried out here develops the concept developed by Lahmeyer (2000) further. Especially soil associations with extreme water balance conditions and rare soil associations are classified as valuable here. Rare and wet sites fall into the category of special sites. Locations that are particularly valuable from an ecological point of view can thus be highlighted, as can potential sites for the development of lea associations, wet meadows and bog areas.

Extremely dry and nutrient-poor dunes and anthropogenically created young soils represent potential sites for valuable dry grasslands. As a special natural space, these areas receive a "medium" rating, regardless of their near-natural quality.

Overall, the evaluation represents the potential of the soil to sustain specific types of vegetation, and does not assess the current vegetation.

Methodology

The following criteria are used to assess the habitat function for rare and near-natural plant communities: near-natural quality (cf. Map 01.11.3), regional rarity of the soil association (cf. Map 01.11.1), dampness of the site (cf. Map 01.01 and 01.06.4) and nutrient supply (cf. Map 01.06.9) (cf. Fig. 1). "Special sites" can be identified based on these criteria.

Special sites include:

- Areas on which the site dampness was indicated as "wet"
- Areas on which the regional rarity of the soil association has been rated "very rare to rare"
- Areas with dry, nutrient-poor soils.

As shown in Tab. 1, the evaluation of the habitat function for near-natural and rare plant communities is carried out according to three categories (low (1), medium (2), high (3)), taking into account the near-natural quality. Rare and wet classes are rated considerably higher than dry locations, which are less sensitive because they are able to regenerate more easily. The latter are assigned exclusively a medium potential for development, regardless of their near-natural quality. "Normal" locations are assigned a medium capacity only if they are very close to being near-natural.

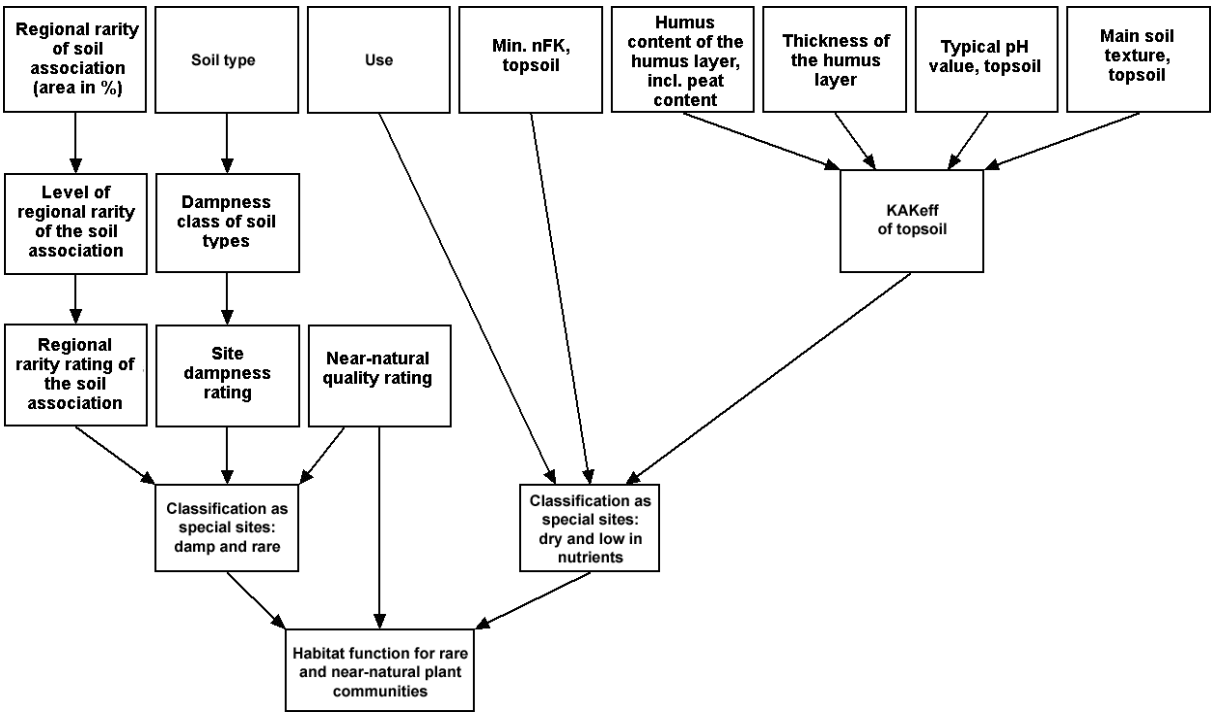

Fig. 1: Diagram to evaluate the function as a habitat for rare and near-natural plant communities

Special site	Near-natural quality			
	high	**medium**	**low**	**very low**
very rare to rare	high	medium	low	low
wet	high	medium	low	low
dry and nutrient-poor (excl. construction site use)	medium	medium	medium	medium
not a special site	medium	low	low	low

Tab. 1: Evaluating soils as habitats for rare and near-natural plant communities, based on their near-natural quality and their special (or non-special) site class (Gerstenberg 2017)

Map Description

Areas that are important habitats for rare and near-natural plant communities (rated as high) are restricted almost exclusively to the outskirts of Berlin. Very few areas fall into this category. They contain soils characterized by high groundwater levels, such as lower bog, lea and gleyic associations in meltwater channels, river lowlands and valley sand areas. The lime-mud area in Teerofen should also be highlighted here, as should the podzoluvisol soils with arenic dystric cambisol on the boulder marl plateaus in Frohnau in the forest. Only areas that are highly near-natural have a great impact on near-natural and rare plant communities. These areas are predominantly located in forests; with a small number located on cemeteries (cf. Fig. 2).

The following soils receive a medium rating: near-natural soils of lower bogs, lea and gleyic associations located in valley sand areas; dystric cambisols on ground, end and push moraines, and gleyic areas located in meltwater channels. The same applies to luvisols with arenic dystric cambisols that can be found on loamy plateaus, and, to the former sewage-farm areas of Gatow, characterized by gleyic luvisols combined with gleyo-arenic dystric cambisols. Dry sites are, as expected, found predominantly in the anthropogenically formed loose lithosols of the glacial spillway.

Most areas are of only minor significance as habitats for near-natural and rare plant communities. These are primarily inner city areas with anthropogenic aggradations, such as construction debris.

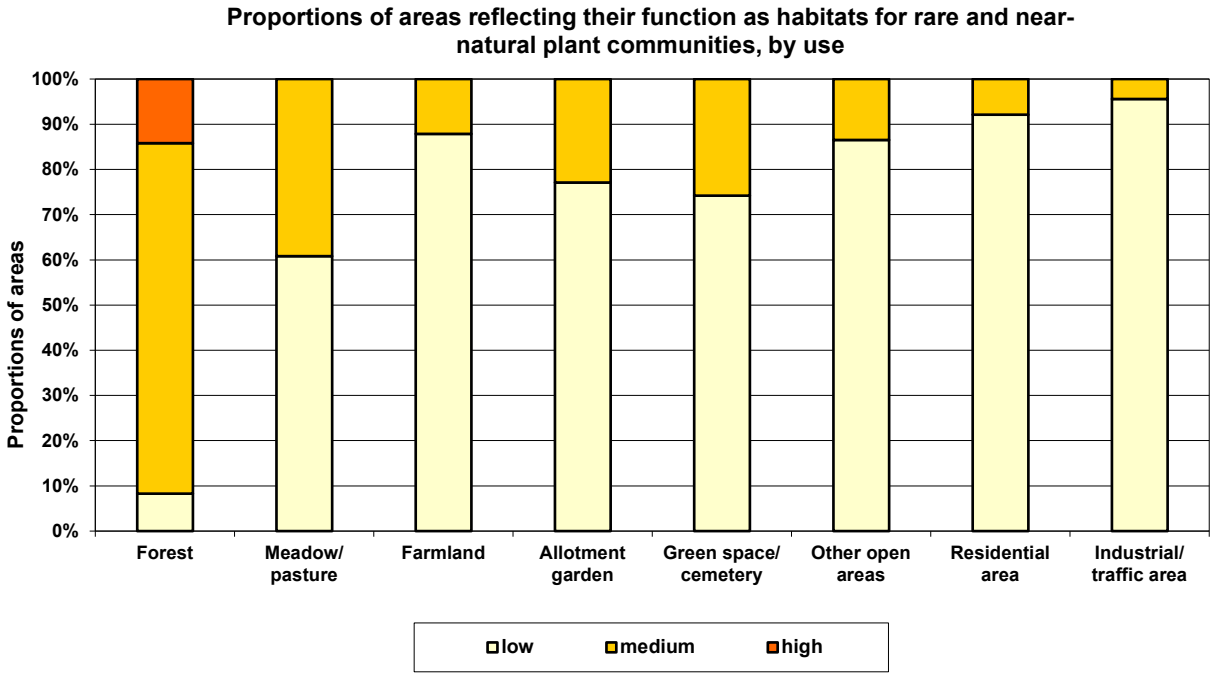

Fig. 2: Proportions of areas reflecting their function as habitats for rare and near-natural plant communities by use (incl. impervious sections, excl. streets and bodies of water (not all uses are shown)

01.12.2 Yield Function for Cultivated Plants

Description

The yield function and efficacy of soils regarding cultivated plants describe how suitable soils potentially are for agricultural and/or horticultural use and production. The suitability of soils for forest use is not assessed here.

The yield function depends on the conditions of a soil dictated by its location. These are essentially determined by the soil properties, especially by the local water and nutrient balance. The water supply is determined by the storage capacity of the soils and any additional water supply available to the plants from the groundwater, due to capillary rise. Loamy and/or sites near groundwater therefore have a considerably higher water supply than sandy sites and/or sites remote from groundwater. The nutrient supply is closely connected to the thickness of the humus layer, the content of organic substance and the soil texture. A well-developed humus cover constitutes a substantial reservoir of nutrients, both of alkaline nutrients, including calcium, potassium and magnesium, and of nitrogen and phosphorus. Loamy soils have a better supply of minerals than sandy soils, and can hold and store them better, too. In the assessment, this quality is included by considering the effective cation exchange capacity (KAK_{eff}) of the soils. This, however, reflects only the supply of base cations. The rooting capacity is not restricted by hardened horizons and the presence of solid rock in the Berlin area. A differentiation according to different reliefs is also not required, since the Berlin area is largely characterized by minimal differences is relief.

Methodology

To obtain a rating as a habitat for cultivated plants, the ratings for the water and nutrient supply, which have been determined for the site (cf. Map 01.11.7 and Map 01.11.8) are added. As demonstrated in Tab. 1, each location is assessed according to a three-point scale ("low", "medium" and "high").

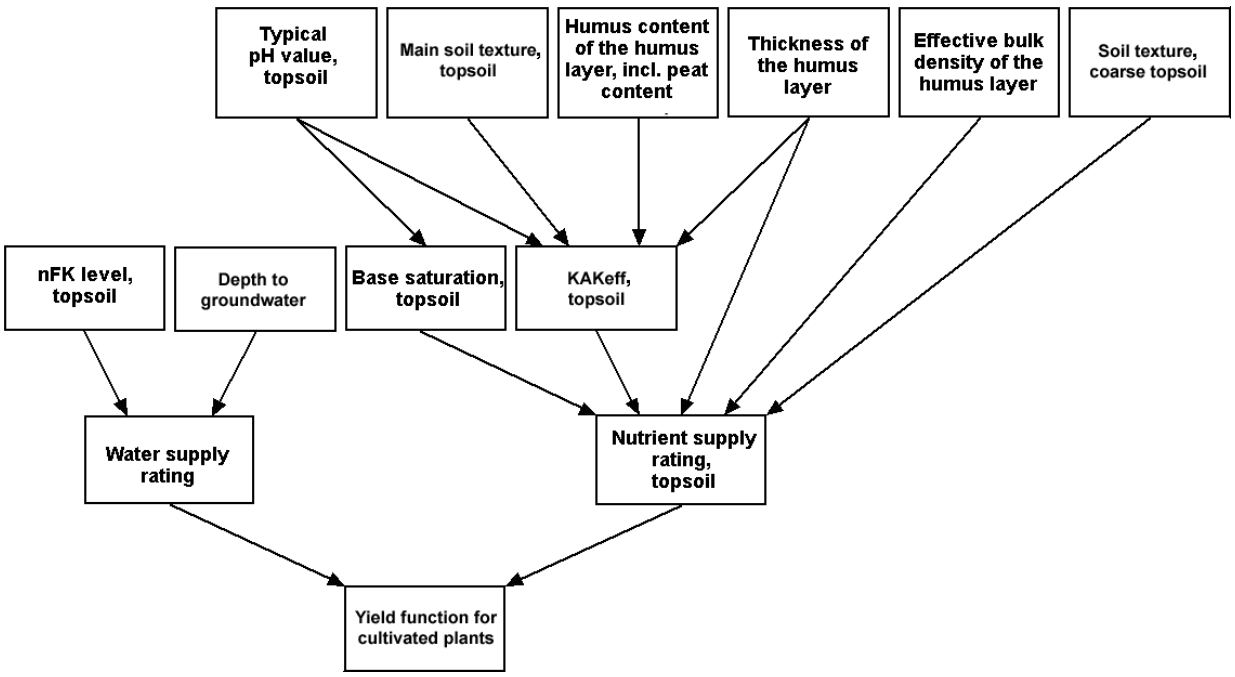

Fig. 1: Diagram to evaluate the yield function for cultivated plants

Added ratings for water and nutrient supply	Yield function for cultivated plants	
	Level	Designation
2	1	low
3		
4	2	medium
5	3	high
6		

Tab. 1: Evaluating the yield function for cultivated plants, based on the added ratings of water and nutrient supply (Gerstenberg 2017)

Map Description

The yield function of Berlin soils receives a "high" rating only in a few cases. These are primarily sites in close proximity to groundwater with gleyic bog associations and a high content of organic substance as well as a good water and nutrient supply. In addition, there are lime-mud soils and, on the plateaus, luvisol and arenic cambisols from boulder marl with interbedded sand, provided that they show high organic matter content. Since the organic matter contents vary depending on use, the yield function for cultivated plants is also greatly dependent on use (cf. Fig. 2). Larger contiguous areas do not occur.

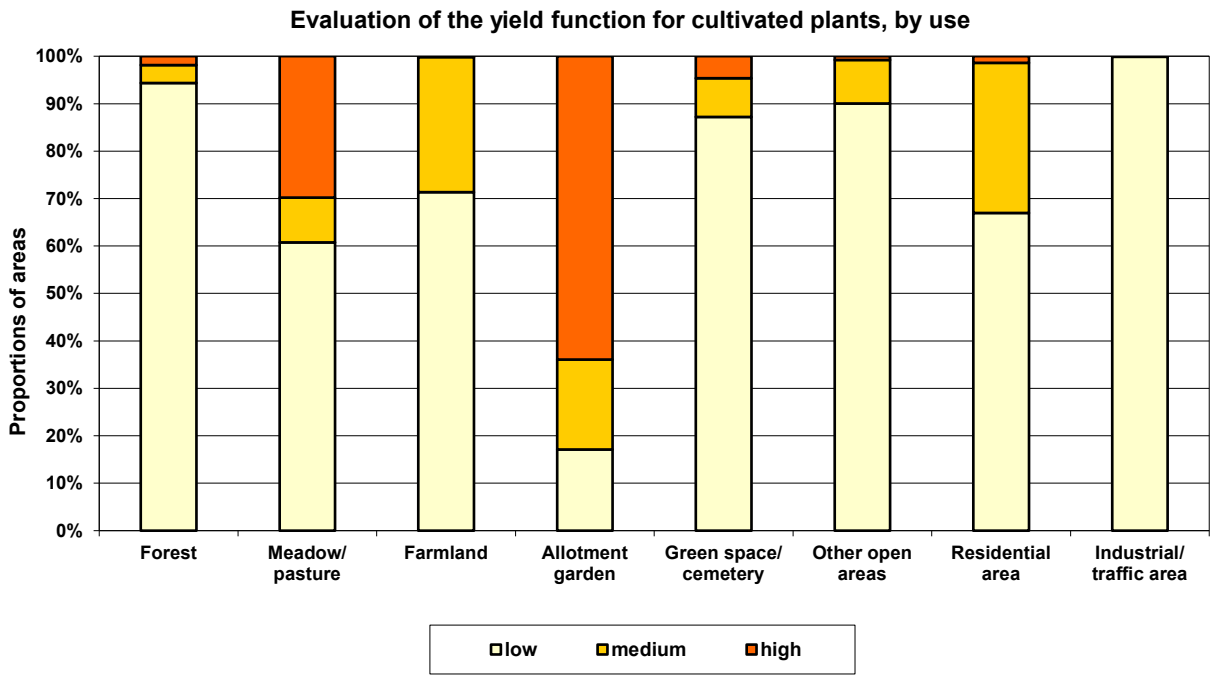

Fig. 2: Evaluation of the yield function for cultivated plants by use (incl. impervious areas, excl. streets and bodies of water, not all uses are shown)

Small-scale nutrient-rich fluvi-eutric histosols in meltwater channels and a few calcareous and nutrient-rich gley associations in valley-sand areas receive a medium rating. On the boulder marl plateaus with near-natural uses, this evaluation class is dominated by luvisols and podzoluvisols, associated with arenic cambisol, dystric cambisol and cambisol.

Nutrient deficiencies, sandy soils with a predominantly poor water supply and loamy plateau soils remote from groundwater with a restricted water supply result in low yield functions in many areas. For example, areas with forestry use are thus frequently characterized by sandy and low-nutrient sites. These are large contiguous areas mainly located in the outskirts of the city.

The inner city soil associations are usually characterized by anthropogenic aggradations and a low yield potential.

01.12.3 Buffering and Filtration Function

Description

The buffering and filtration function describes the ability of the different soils to slow substances down in their ecosystematic material flow (buffering function), or to withdraw them permanently from this cycle (filtration function). It is based on the ability of the soils to capture or neutralize substances by physicochemical adsorption and reaction, and by metabolism in the soil.

An essential aspect of this is the ability to capture immitted pollutants on their way through the soil into the groundwater. The evaluation is based on the respective water permeability of the soil, its binding power for heavy metals, its binding capacity for nutrients and pollutants, and its filtering distance to the adjoining groundwater. Buffering counteracts the acidification of the soil by means of the reaction of alkaline cations. Filtration mechanically filters solid substances out of percolated water. These dissolved substances are then bound primarily through sorption by humus and clay. This ability is determined by various physical, chemical and biological soil qualities. The soil has different filtration and buffering capacities for different substances and substance groups, such as plant nutrients, organic compounds, acidifiers or heavy metals.

Soils with a high filtration and buffering capacity can accumulate pollutants to a high degree. The pollutants taken up are generally not broken down, but remain in the soil until its buffering and filtration capacity is exhausted, at which point they are released into the groundwater. With continual immission, the danger therefore exists that these soils will function as pollutant sinks, and that soil pollution will arise which can, for example, inhibit agricultural or horticultural uses in these areas.

An additional aspect is the capacity of the soil to store carbon in the form of humus or peat. Disturbances and destruction of the soil, including decreased levels of groundwater, lead to the loss of humus as part of soil respiration and decomposition. As a consequence, it leads to carbon dioxide (CO_2) or methane (CH_4) being released from the soil into the atmosphere. Bog soils are particularly rich in carbon, and hence fulfill the buffering and filtration function in the organic carbon cycle with great efficacy.

Methodology

To assess the filtration and buffering function, the ratings for the following criteria are taken into account for each area: buffering capacity in the organic carbon balance (cf. Map 01.11.11), nutrient storage capacity / pollutant binding capacity (cf. Map 01.11.6), binding strength for heavy metals (cf. Map 01.11.10), filtration capacity (cf. Map 01.11.9) and depth to groundwater (cf. Map 02.07).

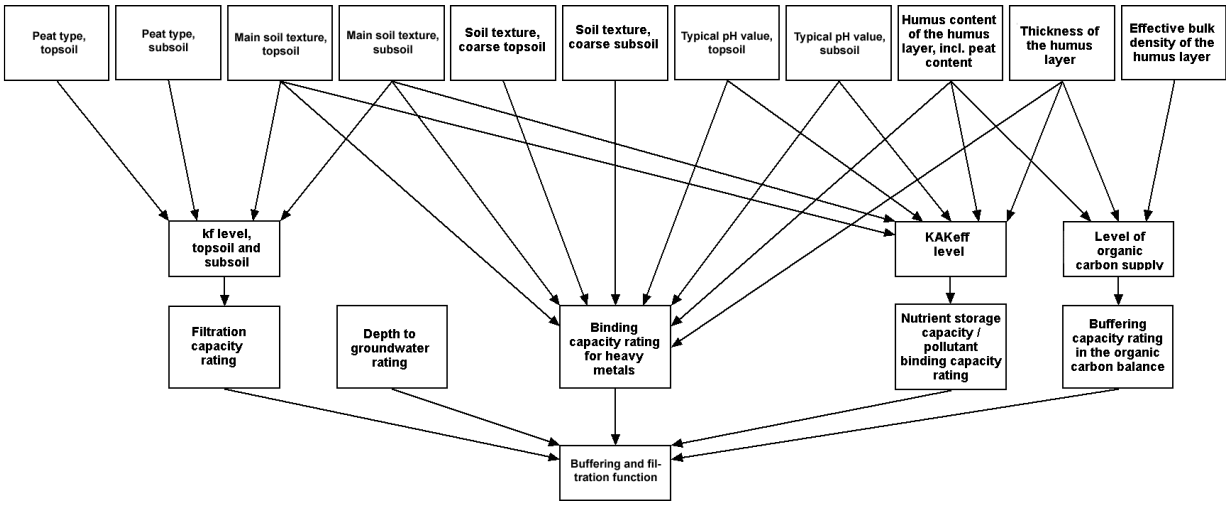

Fig. 1: Diagram to evaluate the buffering and filtration function (Gerstenberg 2017)

The buffering and filtration function of the soils is evaluated according to Tab. 1. The ratings for nutrient storage capacity/ pollutant binding capacity, binding strength for heavy metals and filtration capacity of 1 (= low), 2 (= medium) and 3 (= high) are added and corrected by the rating for depth to groundwater. In addition to the soil's ability to bind substances, the filtration distance is also taken into account, as pollutants are introduced into the groundwater more quickly the closer a site is to groundwater.

Regardless of nutrient-storage/ pollutant-binding capacity, binding strength for heavy metals or depth to groundwater, the soil associations with the highest buffering capacity in the organic carbon balance (3) are rated as high. The lower levels do not affect the evaluation.

The total score for the buffering and filtration function is based on a three-point scale, consisting of "low" (1), "medium" (2) and "high" (3).

Added ratings of the criteria filtration capacity + nutrient storage capacity/ pollutant binding capacity + binding strength for heavy metals	Depth to groundwater	Buffering capacity in the organic carbon balance	Evaluation of the buffering and filtration function	
			Level	Designation
3 - 5	< 2 m		1	low
	2 – 5 m		1	low
	> 5 m		2	medium
6 - 7	< 2 m		1	low
	2 – 5 m		2	medium
	> 5 m		3	high

8 - 9	< 2 m		2	medium
	2 – 5 m		3	high
	> 5 m		3	high
-	-	high	3	high

Tab. 1: Evaluation of the buffering and filtration function (Gerstenberg 2017)

Map Description

Loamy soils have a high buffering and filtration function with low water permeability and a neutral-to-basic pH value which reduces the mobility of heavy metals. These soils are also characterized by great depths to groundwater and a high effective cation exchange capacity, based on their high clay and humus contents. These requirements are met primarily by the soils on the Teltow and Barnim boulder marl plateaus. As a rule, these are luvisol – arenic cambisol – podzoluvisol soil associations, with near-natural uses, undisturbed by anthropogenic aggradation, and frequently used for agriculture or allotment gardens (cf. Fig. 2).

The sandy soils of the end and push moraines and dune sands reflected by the soil association cambisol – dystric cambisol – spodo-dystric cambisol with near-natural use, or with sandy-soil aggradations caused by residential construction receive a medium rating. Although the sands have a relatively high water permeability, their greater distance to the groundwater increases their filtration distance.

The sandy soils of the glacial spillway, the channels and sinks, which are characterized by short filtration distances that pollutants have to travel to reach the groundwater, only have a low ability to filter and buffer pollutants. These are soils whose development is determined by the groundwater, such as gleyic and bog associations with near-natural use, or soils with sandy aggradations in the inner city area with loose lithosol, regosol, and calcaric regosol soil associations.

Soil associations with boggy soils under woods, or grasslands, have a high buffering and filtration capacity with respect to organic carbon; they are primarily found in the glacial spillway and in the meltwater channels.

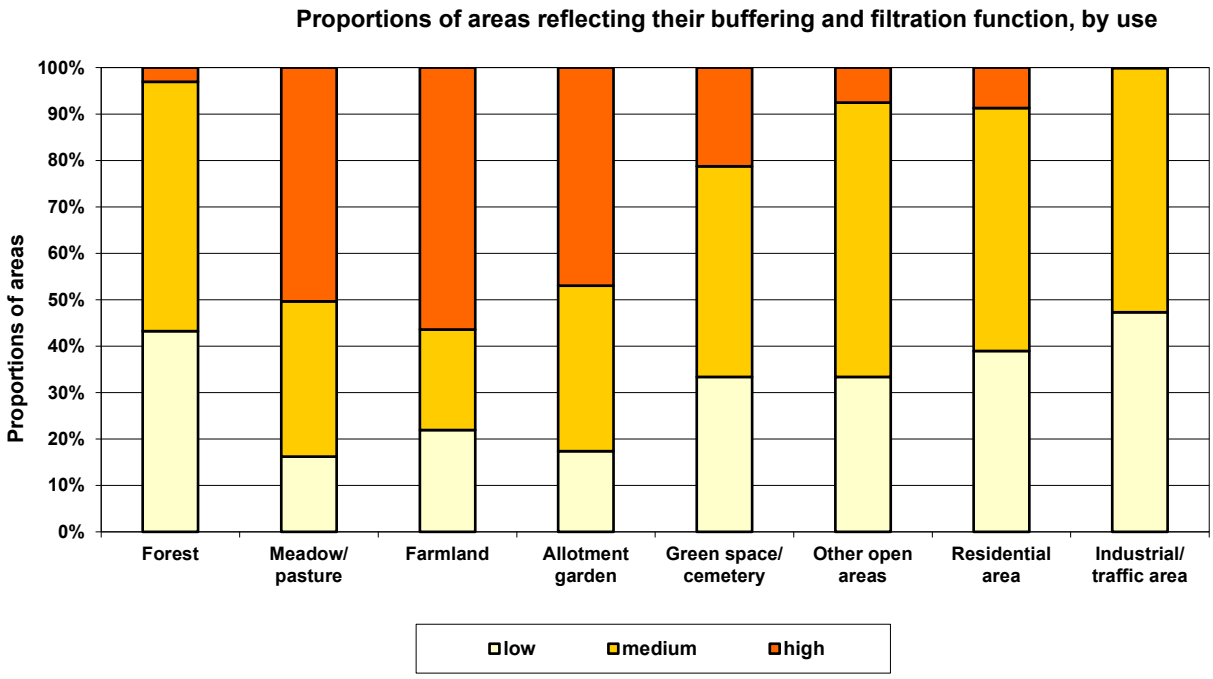

Fig. 2: Proportions of areas reflecting their buffering and filtration function, by use (incl. impervious areas, excl. streets and bodies of water, not all uses are shown)

01.12.4 Regulatory Function for the Water Balance

Description

The regulatory function for the water balance is determined by the storage or retention capacity of the soils, which influences the groundwater and surface-water runoff. The groundwater exchange rate is used to assess this soil function (cf. Map 01.11.4). A low exchange rate means that the dwell time of the water is long and the water quantity retained in the soil is high. A low exchange rate is therefore positive for the water balance of the landscape. Furthermore, longer dwell times increase the decomposition of immitted substances, and therefore have a positive effect on the percolation water quality. The formation of new groundwater is slow, however, in connection with a high storage capacity and a low exchange rate, as precipitation water largely remains in the soil where it is absorbed by the plants.

Methodology

The regulatory function for the water balance is derived directly from the groundwater exchange rate (cf. Map 01.11.4). It is assessed based on a three-point scale, "low" (1), "medium" (2) and "high" (3). In accordance with Tab. 1, a very low exchange rate is considered "high", a low to medium exchange rate is considered "medium", and a high to very high exchange rate is considered "low. "

Groundwater exchange rate per year	Regulatory function for the water balance	
	Level	Designation
< 1	3	high
1 -3	2	medium
> 3	1	low

Tab. 1: Evaluation of the regulatory function for the water balance, depending on the groundwater exchange rate

Percolation (disregarding impervious coverage) (cf. Map 02.13.4) was used to calculate the groundwater exchange rate. The level of percolation is influenced not only by precipitation and soil conditions, but also largely by the level of evaporation. Evaporation in turn depends on vegetation and use. When studying the map, it should therefore be noted that areas of the same soil associations may be evaluated differently, depending on the vegetation, which also influences percolation.

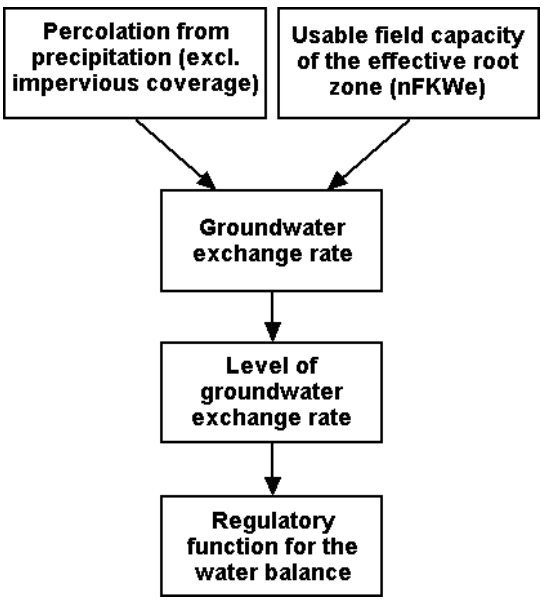

Fig. 1: Diagram to evaluate the regulatory function for the water balance

Map Description

The regulatory function of many near-natural soil associations with a groundwater exchange rate of less than a year is rated as high. This includes all groundwater-influenced soil associations with lower bogs and gleys which are consistently supplied with sufficient water in the topmost metre of soil throughout the year. Due to the high evaporation levels of the vegetation, the percolation from precipitation is very low here (cf. Map 2.13.2). In some cases, groundwater depletion even occurs, resulting in very low exchange rates. The soils of the plateaus of boulder clay/ boulder marl constitute another group. Due to their low permeability, they have a large storage capacity and can retain precipitation water well. Like clay soils, dune sites with fine sand as their main soil textures are also characterized by great storage capacities, and should be assigned to this class. Dune sites with fine sand as their main soil texture have large storage capacities, just like clay soils, and fall into the same class.

Near-natural soils remote from groundwater with a groundwater exchange rate of once to twice per year receive a medium rating. These are primarily dystric cambisols of end and push moraines, arenic cambisols on the boulder marl plateaus with interbedded sand, and dystric cambisol – eutro-gleyic cambisol associations in the valley-sand areas. In addition, there are soils of aggraded and translocated natural substrate, such as sands and loams, from which regosol – calcaric regosol – hortisol soil associations have developed. Soils with a low rating, i.e., a groundwater exchange rate of three to four times a year, are concentrated in the inner city, industrial areas and track facilities (cf. Fig. 2). Coarse aggraded material, such as construction debris and track gravel, ensures a high permeability of the soil, so that precipitation water percolates quickly.

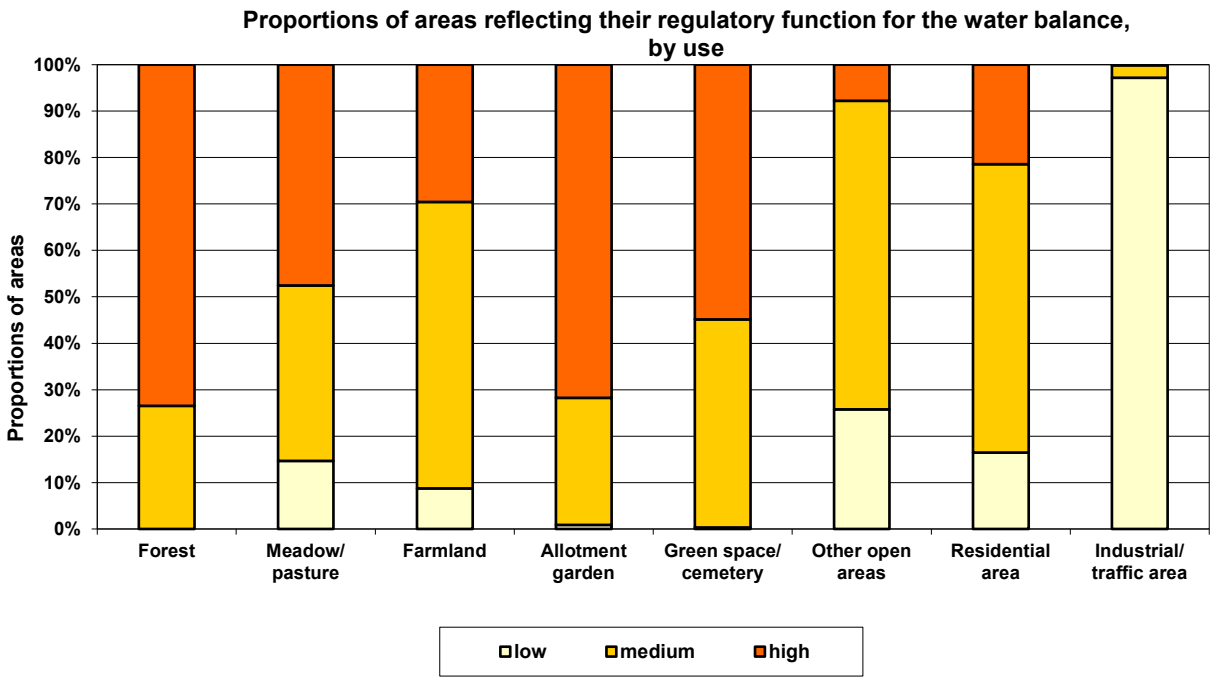

Fig. 2: Proportions of areas reflecting their regulatory function for the water balance, by use (incl. impervious areas, excl. streets and bodies of water, not all uses are shown)

01.12.5 Archival Function for Natural History

Description

Soil types develop depending on the respective environmental conditions (rock, climate, time). Soils can therefore reflect the landscape-historical conditions of their time of origin in their profile features, if their structure has not been anthropogenically destroyed. These soils are therefore a valuable archive or source of information on landscape history. For the Berlin area, the soils serve as an archive for the glacial conditions during formation and the postglacial bog formations. .The natural characteristics of the area, such as dead-ice sinks, push moraines and the regional rarity of soil associations define the archive function. Very rare and geomorphologically unique soils are rated the highest.

The aim is to highlight soil associations and soil properties which characterize the natural environment of Berlin in a special and unique way or soil associations and properties which are rare and therefore exceptional. These soils are particularly worth preserving and protecting.

Methodology

On the one hand, the regional rarity of the soil association was used to assess the archival function for natural history. The soil associations amounting to less than 0.4 % of the area shares (of the urban area excl. streets and bodies of water) were classified as level 2 (very rare to rare). The remaining soil associations were classified as level 1 (moderate to very common) (cf. Map 01.11.1). Additionally, soil associations with a distinct natural character (level 1), based on their geomorphological conditions were included in the assessment (cf. Map 01.11.2). Both ratings were added to evaluate the archival function. The rating of the archival function is based on the sum of the individual ratings; a sum of 3 indicates a ”high” rating, 2 a ”medium” rating and 1 a ”low” rating (Gerstenberg 2017).

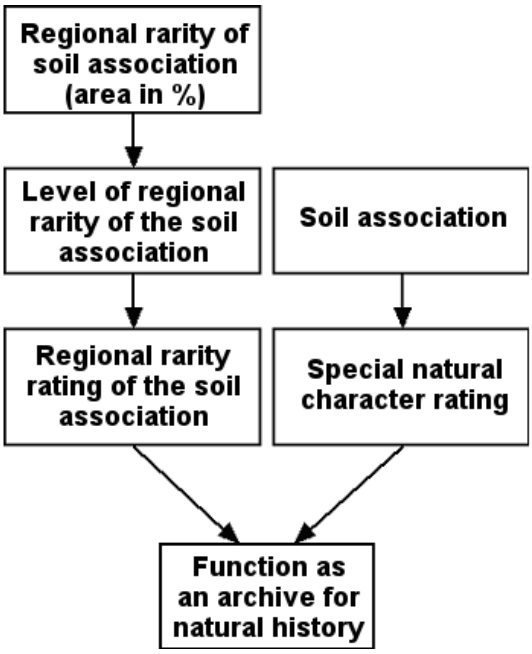

Fig. 1: Diagram to evaluate the archival function for natural history

Map Description

There are only few areas in the Berlin region that stand out in their archival function for natural history. They are restricted to near-natural soils, which are often located in the outskirts of the city.

Lime-mud areas, bog associations and histo-humic gleysols in river leas and dead ice kettles as well as calcic gleysols, dystric gleysols and calcaro-dystric histosols on the push and end-moraines are of particular importance. In addition, there are preserved arenic dystric cambisols and gley arenic dystric cambisols on the boulder marl plateaus in Gatow and Frohnau.

The other lower bog and groundwater soils of meltwater channels, sinks, and some valley-sand areas receive a medium rating. Furthermore, there are podzolized soils of dune landscapes, dystric-cambisol associations on moraine hills and on end and push moraines. On the plateaus, arenic dystric cambisols and gley arenic dystric cambisols of boulder marl should be highlighted.

The remaining soil associations, that often have been strongly anthropogenically changed, or soils formed by aggradation, only play a minor role in their function as an archive for natural history.

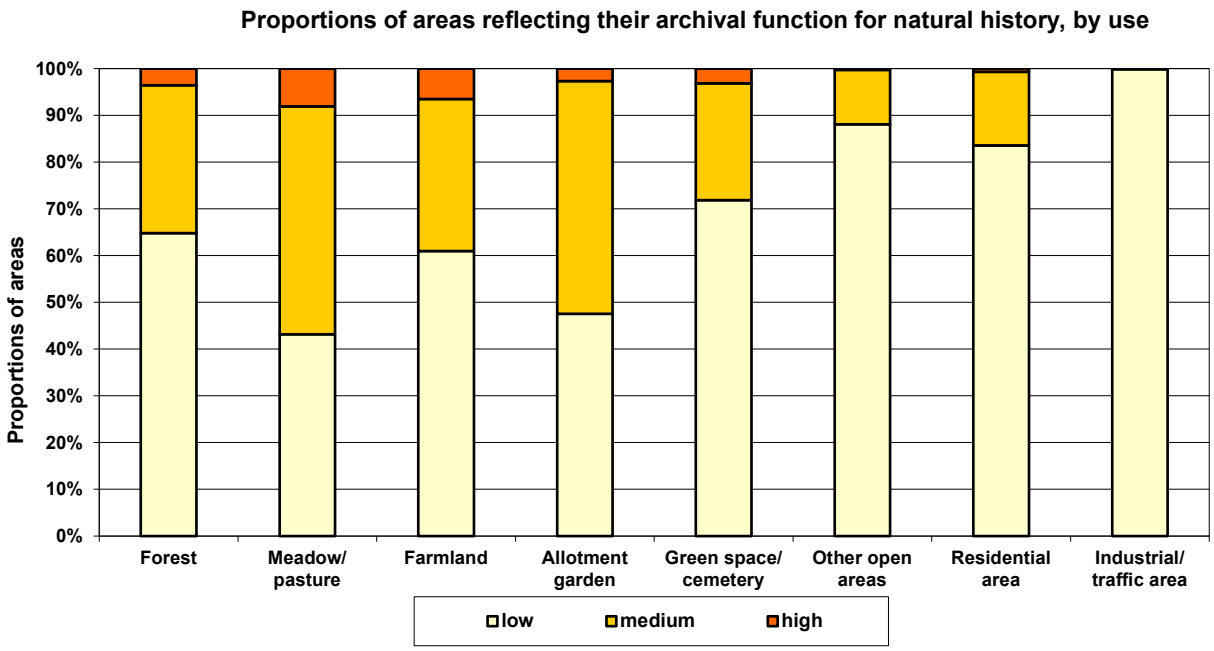

Fig. 2: Proportions of areas reflecting their archival function for natural history, by use (incl. impervious areas, excl. streets and bodies of water, not all uses are shown)

01.12.6 Capacity of Soils to Fulfil the Natural Soil Functions and the Archival Function

Description

Maps 01.12.1 through 01.12.5 provide an evaluation of the capacity of soils to fulfil their individual natural soil functions and their archival function. Based on this, after an initial assessment onsite, interventions in their capacity can therefore be prevented or compensated. It makes sense to combine these evaluations for the purpose of integrating aspects of soil protection into the overarching spatial planning process. The goal of the present map is thus to evaluate the efficacy of the soils not only with regard to these individual functions, but also as a whole. Areas which are generally considered highly important in terms of their performance and efficacy, and which are thus crucial for soil protection, are highlighted in particular.

Methodology

The evaluation of individual soil properties not only varies across the five soil functions, but is also juxtaposed at times, causing problems in the combination of the latter. Thus, for example, the habitat function for natural vegetation rates damp/ wet, near-natural and rare sites as “high”, i.e. it favours extreme sites. Their yield function for cultivated plants, however, is rated as “low”. The sites rated high with regard to the archival function for natural history include very dry dune sites. The same sites, however, receive a very low rating regarding their filtration and buffering function, the regulatory function for the water balance, as well as their yield function.

Another problem is that due to the evaluation methodology chosen for the individual functions, areas that differ greatly in size received the same rating “medium” or “high” for a particular function (cf. Fig. 1). Thus, for example, large parts of the city area were evaluated "high" with regard to their buffering and filtration function, while only very few areas displayed a “high” capacity to fulfil their function as an archive. As a result, although the five soil functions equally contribute to the final evaluation on paper, some soil functions, in particular the regulatory function for the water balance and the buffering and filtration function, influence the final result more strongly than other functions in reality.

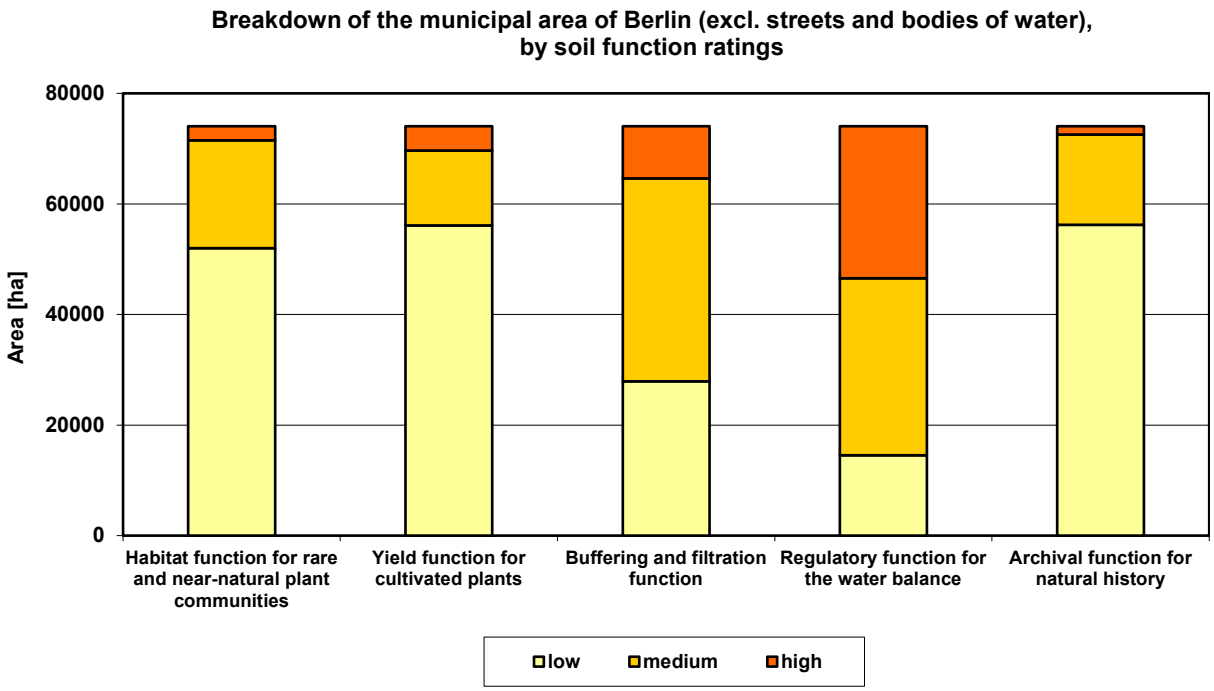

Fig. 1: Breakdown of the municipal area of Berlin (excl. streets and bodies of water), by soil function ratings

The final assessment is based on the evaluation of each function according to a three-point scale. An evaluation of "ow" (1), "medium" (2), or "high"" (3) thus exists for each soil function and each area in the city. For an overall assessment, two potential criteria were formed, consisting of the sum of the individual evaluations for each area and the number of times a soil function was rated "high" for each area.

Following an alternative approach, a variety of potential methods were tested to assess the soils' capacity to fulfil their natural soil functions.

In the end, it was decided that the overall evaluation process include both the frequency of the highest evaluation (level 3) and the sum of the evaluations (cf. Tab. 1). All soil functions have an equal influence on the overall evaluation; no weighting was carried out.

Criteria	Efficacy of the soils	
	Level	Designation
Low mean efficacy for the 5 soil functions (sum of individual ratings < 9, and no function rated "high")	1	low
Medium mean efficacy for the 5 soil functions (sum of individual ratings 9 – 10, or only one function rated "high")	2	medium
Above-average mean efficacy for the 5 soil functions (sum of individual ratings > 10, or more than one function rated "high")	3	high

Tab. 1: Evaluation of efficacy, based on the number of "high" ratings, and the sum of individual ratings

This method is designed to reduce the disadvantages and defects of the other potential methods. The regulatory function for the water balance and the buffering and filtration function are therefore less dominant. Areas for which only one soil function was rated "high " (3) but which have a high combined rating, can still attain the highest evaluation level.

Map Description

Areas with an overall high efficacy predominate on the plateaus in the north and south, the Spandauer Forst and the Gosener Wiesen. On the other hand, heavily populated areas far from being near-

natural are characterized by a low to medium efficacy. The dominance of the regulatory function for the water balance and for the buffering and filtration function is particularly evident on the plateaus.

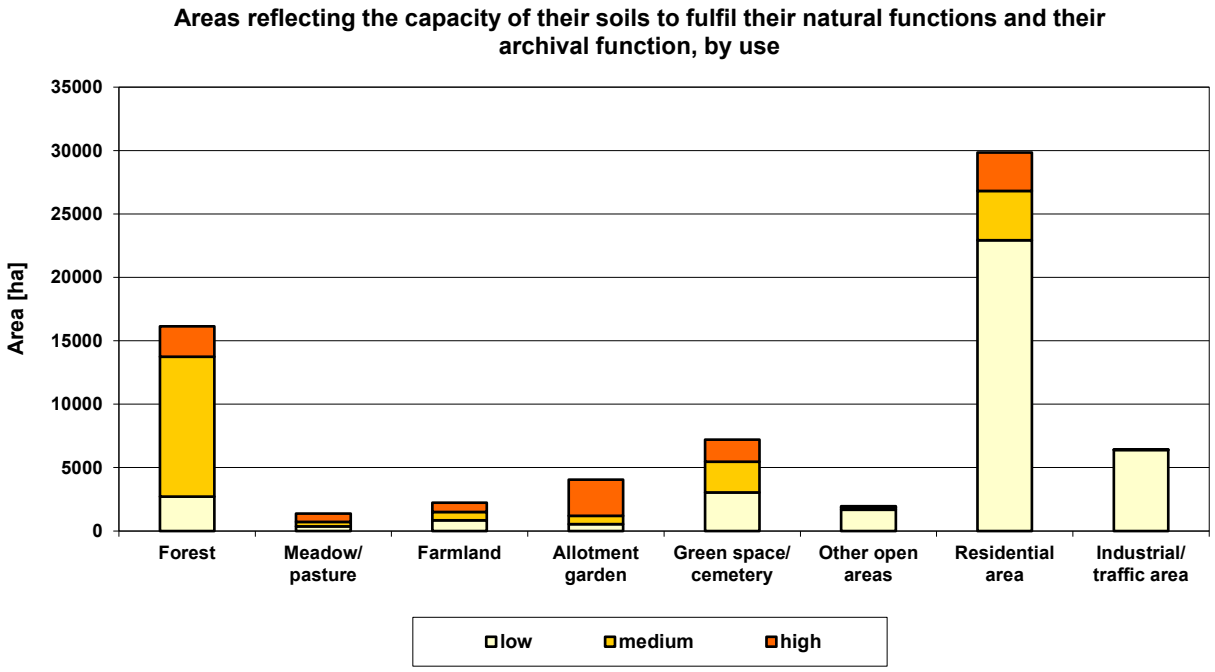

Fig. 2: Areas and the capacity of their soils to fulfil their natural functions and their archival function, by use (incl. impervious areas, excl. streets and bodies of water, not all uses are shown)

Soils that stand out with regard to their efficacy rating are primarily located in forests, allotment gardens and agricultural areas. There are also residential areas with an open structure, however, for which it can be assumed that near-natural soils have remained unchanged. These sometimes display high efficacies (cf. Fig. 2). Due to their uses, however, some of these areas are impervious.

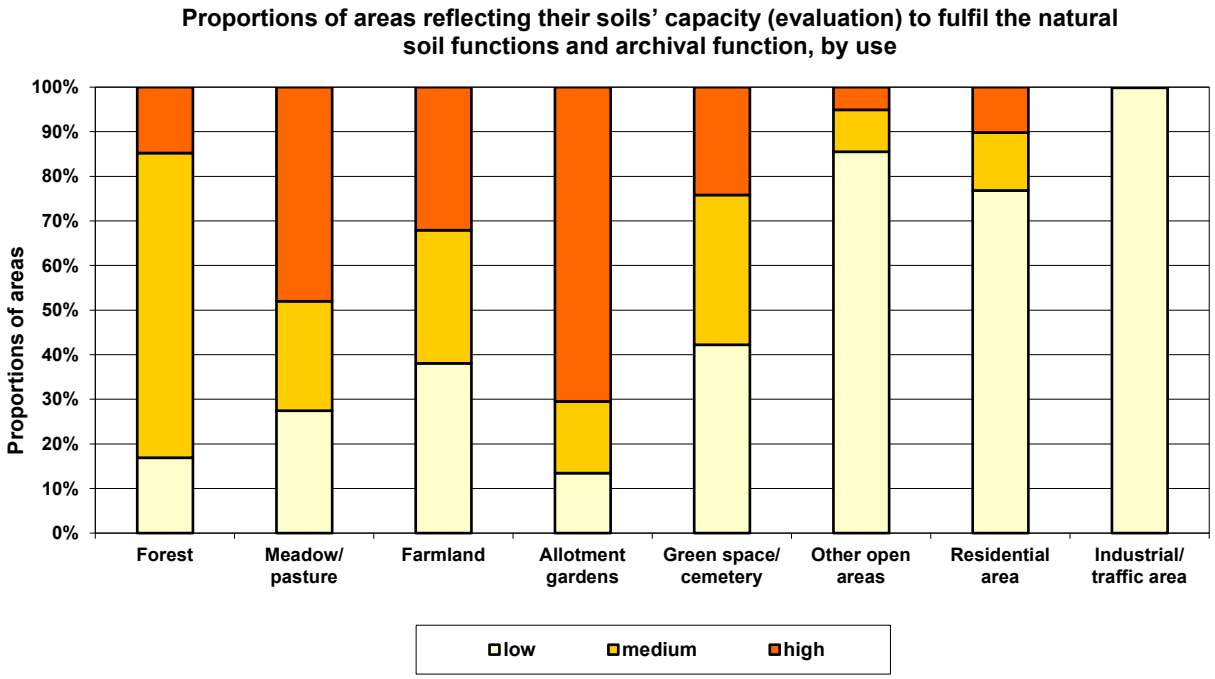

Fig. 3: Proportions of areas reflecting their soils' capacity (evaluation) to fulfil their natural soil functions and their archival function, by use (incl. impervious areas, excl. streets and bodies of water, not all uses are shown)

In relation to their total area, though, many areas in the allotment garden, meadow/ pasture, farmland and green space/ cemetery are rated "high " in terms of their efficacy (cf. Fig. 3).

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