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SUITMA 9: URBANIZATION — CHALLENGES AND OPPORTUNITIES FOR SOIL FUNCTIONS AND ECOSYSTEM SERVICES

Consideration of soil in urban planning documents—a French case study

Anne Blanchart[1,2,3] · Jean Noël Consalès[2] · Geoffroy Séré[1] · Christophe Schwartz[1]

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Abstract

Purpose Given their increasing importance, soils should be considered as valuable resources by those involved in urban planning. Indeed, soils are expected to be multifunctional in order both to ensure sustainable development of human societies and to resist major environmental issues. Through the study of planning documents, this article describes the way in which political intentions impact the preservation of soil as an urban resource.

Materials and methods A lexical analysis was conducted of more than 100 French planning documents. Each of them relates to a specific topic (e.g., soil cover, transport, biodiversity) and to a particular application scale. Tropes© software was used to count the number of times the word "soil" occurs in each document. A distinction was made between "soil" written as a surface area (land use, square meters) and a resource (ecosystem, cubic meters). A further statistical analysis was performed by crossing the results with demographic data and the main characteristics of the documents.

Results and discussion The results revealed that soil is a subject which is relatively infrequently addressed in French planning documents. Indeed, its index of occurrence reached 0.06% in comparison to "transport" (0.77%). Moreover, "soil" refers both to a surface area (0.035%) and a resource (0.031%). However, this consideration varies from document to another and depends on the given urban area. Finally, the publication date of the document was correlated with the frequency of the use of the word "soil." These results suggest that the level of consideration of soil, as a complex ecosystem, is moderate and relies mainly on the people who drafted the document.

Conclusions The frequency of the word "soil" is comparable to those of words as "biodiversity" and "air." Moreover, "soil" is considered as a living resource in the planning documents. It also appears that the services provided by agricultural and forest soils are well known to policy makers and planning operators (e.g., food and non-food biomass provisioning). In contrast, urban soils are predominantly seen as surface areas to be converted or as a potential threat due to their level of contamination or geotechnical properties.

Keywords Ecosystem services · Lexical analysis · Soil resource · Urban planning · Urban soils

1 Introduction

The world population is continually on the rise, as 9 billion human beings are expected in 2050 with the number of people living in urban areas rising from 54% today to 66% in 2050 (United Nations 2014). Consequently, cities are continually growing. In 2010, urban areas covered close to 3% of the total land areas and 0.45% of the total surface area of soils in the world were sealed, excluding only Antarctica and Greenland (Liu et al. 2014). If current trends continue, urban land cover will increase by 1.2 million square kilometers in 2030, according to Seto et al. (2012). This urban growth constitutes a major challenge,

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✉ Christophe Schwartz
christophe.schwartz@univ-lorraine.fr

[1] Laboratoire Sols et Environnement, Université de Lorraine, INRA, 54000 Nancy, France

[2] TELEMME, CNRS, UMR 7303, Aix Marseille Univ, 13628 Aix-en-Provence, France

[3] Agence de l'Environnement et de la Maitrise de l'Energie (ADEME), 75015 Paris, France

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as it entails major environmental issues (Vanoudheusden and Blanc 2014). For example, researchers have long identified environmental impacts of urban sprawl (Johnson 2001), such as a loss of fragile environmental lands, higher energy consumption, an increase in storm-water runoff, and an increasing risk of flooding (Adelmann 1998), as well as a reduced species diversity and ecosystem fragmentation (Margules 1992). In recent years, in addition to this phenomenon of urban growth (centrifugal phenomenon), cities are facing a phenomenon of densification (centripetal phenomenon). Cities are being renovated and public policies encourage the population to come and live there. In this context, cities need multifunctional soils. Soil is an ecosystem at the interface between the atmosphere, the biosphere, the hydrosphere, and the lithosphere. Soil is the place where humans develop most of their economic, social, and cultural activities. From an initial vision of soil as exclusively a physical support of human activities, urban soil management has progressively come to focus on the constraints associated with soils, in particular via health approaches. This has been done in response to major health crises induced by soil degradation due to industrial activities in a context of land use pressure. This approach is still conducted in order to detect and to limit the risks of pollutant dissemination, with a view to preserving human health and ecosystems. More recently, a change of outlook on soils has been accompanied by an increased consideration of their multifunctionality in urban projects. Indeed, soils are able to provide some ecosystem services that ensure the development of human societies (e.g., support of infrastructures, food sufficiency) and that participate in the mitigation of the environmental urban issues (e.g., flood mitigation, climate regulation, food sufficiency) (Craul 1992; MEA 2005; Escobedo et al. 2011; Jenerette et al. 2011; TEEB 2011; Gómez-Baggethun and Barton 2013; Adhikari and Hartemink 2016). For example, soils, by storing carbon, are able to regulate climate change. They are also the place where town dwellers can cultivate fruit and vegetables for their food consumption. Furthermore, unsealed urban soils are able to mitigate flooding which is a major environmental issue. For spatial planning, the challenge is then to extend this logic in order to take soil characteristics into account (e.g., level of contamination, geotechnical properties). This would generate a more integrated approach, which includes the agronomic quality of urban soils, by translating soil properties into their ability to provide services (Blanchart et al. 2018).

Our assumption in this paper is that any sustainable land use development must be based on the protection and optimization of soils, by taking benefits from the services they are able to provide (Escobedo et al. 2011; Gómez-Baggethun and Barton 2013; Morel et al. 2015). This implies that urban planners should consider the soil, including urban soil, as a functional resource and not only as a surface area available for urban planning, as currently occurs (Mantziaras and Viganò 2016). Urban planning is hereby defined as a technical and political process dealing with the organization of land use, the design of the urban environment, the welfare of people, and the protection of the natural environment (Taylor 2007). For many years, urban planning has had to reconcile the well-being of citizens and the preservation of ecological resources and landscapes. Some environmental criteria have been integrated into this strategy. For example, the development of green and blue frameworks has made it possible to integrate the preservation of ecological continuity into urban planning and into planning documents in particular (Arrif et al. 2011). Over time, such initiatives have contributed to smoothly integrating the question of soils. Indeed, authorities have come to notice the importance of soil protection, notably by developing measures to limit and control urban growth (European Commission 2015), or through the application of the polluter-pays principle in some countries (Yoshida 2002). On a country scale, soil issues depend on governments and some countries have introduced various instruments to protect their soils, for instance, legal measures in Austria, economic ones in Belgium or Latvia, or incentives as in Finland or the Netherlands. Without minimizing the importance of such national initiatives and policies, it does however appear that land use is mainly locally. In many countries, the rational uses of soils are determined through local planning documents, such as the “Plan Local d’Urbanisme” for France and the “Piano Urbanistico Communal” in Italy (Urban SMS 2008). These documents are drawn up in accordance with the guidelines set out in other regulatory documents set down at a higher level such as the “Schéma de Cohérence Territoriale” for France and the “Piano Regolatore” in Italy. However, the literature provides no information concerning references to soils n in planning documents.

This article sets out to describe the consideration of soils by those involved in urban planning (e.g., policy makers, operators, urban planners) through the study of planning documents. Since planning documents are public documents which determine development and urban planning at the scale of a city, an urban unit, an urban area, or a region, we assume that the semantic field associated with “soil” in these documents may be assimilated to the consideration that various participants in urban development give to the soil. Studying the frequency of the word “soil” in French planning documents therefore provides indirect information about its consideration. These documents also provide further information such as the influence of the urban area itself, the scale considered by the planning document and its date of publication.

2 Materials and methods

2.1 Localization of the study

Although the French decentralization law (Loi de décentralisation, March 2, 1982), giving municipalities and regions and cities greater autonomy in drawing up their planning documents, was applicable as early as 1982, France remains a centralized country. Territorial planning still retains traces of this centralization, where, for example, certain documents on a local planning scale must take into account or be compatible with those on a territorial. For this reason, planning documents are frequently modified or even revised in order to adapt not only to changes in other documents but also to those of public policies. We pre-selected the 20 largest French urban areas, according to the classification of the biggest 60 urban areas (INSEE 2016). This panel presents very different demographic, geographical, and climatic characteristics, clearly reflecting the diversity of French urban areas.

2.2 Selection of the planning documents

The selected planning documents had to be representative of the different scales of the French territorial organization (Fig. 1) and of the different topics addressed by all the French planning documents (Table 1). In addition, only those planning documents that exist for all of the 20 pre-selected urban areas were considered. This latter criterion led to a reduction in the number of the urban areas studied. Finally, the lexical analysis covered 7 different planning documents of 15 urban areas (Paris, Lyon, Marseille, Toulouse, Bordeaux, Nantes, Strasbourg, Rennes, Grenoble, Rouen, Montpellier, Avignon, Saint-Etienne, Tours, and Nancy), that is to say, 105 planning documents.

2.3 Lexical analysis

The quantitative lexical analysis of the selected planning documents was made possible thanks to the use of the Tropes© software (developed by Pierre Molette and Agnès Landré on the basis of the work of Rodolphe Ghiglione (http://www.tropes.fr/)). This software makes it possible to analyze both quantitatively and qualitatively the presence of a semantic field in a document. Each of the planning documents of each of the selected urban areas was therefore analyzed under Tropes©, by searching for keywords. Given the purpose of our study, the word "soil" ("sol") was sought. The lexical field referring to "soil material" ("terre"—corresponding to soil samples) was also part of the analysis, considering that this often refers to a concept close to that of "soil." Next, words such as "water" ("eau") and "air" ("air") were selected in order to compare the use of these natural elements with the use of the word "soil." Finally, the frequency words and topics which are specific to urban planning and development were also analyzed, as a point of comparison with "soil." Similarly, "housing" ("logement"), "transport" ("transport"), and "economy" ("économie") were also included in the analysis.

The quantitative lexical analysis gave the frequency of the selected words in each of the planning documents. Then, these numbers were related to the total number of words in the

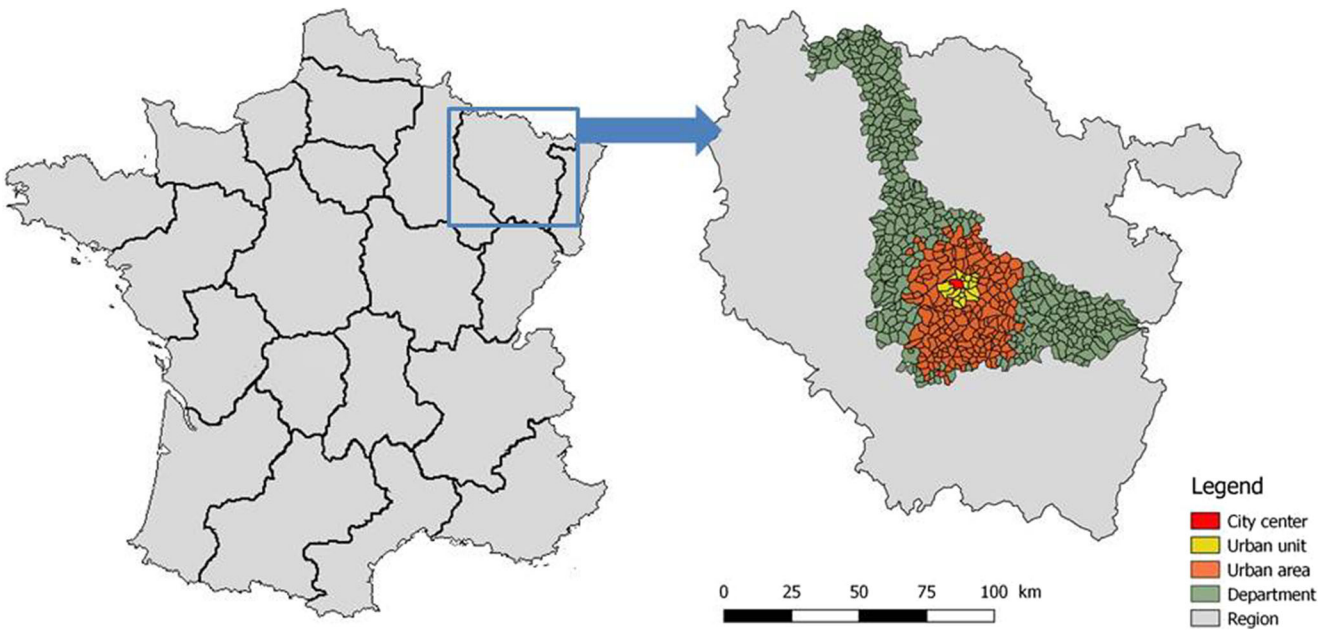

Fig. 1 The different levels of territorial organization in France

Table 1 The French planning documents, their topic, application scale, and legal authority responsible for their elaboration

Planning document	Topic	Application scale	Legal authority
Local planning document *Plan local d'urbanisme*	Soil cover management	City center	Municipal council
Local urban travel document *Plan de déplacement urbain*	Transport	Urban unit	Organizing authority for mobility
Local housing program *Programme local de l'habitat*	Housing	Urban unit	Community council
Intercommunal planning document *Schéma de cohérence territoriale*	Soil cover management	Urban area	Community council
Regional climate, air and energy document *Schéma régional climat, air, énergie*	Climate, air and energy	Region	Regional prefect and regional council
Regional ecological coherence document *Schéma régional de cohérences écologiques*	Biodiversity	region	Regional prefect and regional council
Water management document *Schéma d'aménagement et de gestion des eaux*	Water	Watershed	Basin committee

considered document. This made it possible to provide, *in fine*, an index of occurrences of each word in each planning document of each urban area. This index of occurrences is expressed as a percentage. Then, qualitative lexical analysis using Tropes© software was applied to the lexical field of each use of "soil," indicating "soil-surface" ("sol-surface") for each occurrences referring to land use (square meters) and "soil-resource" ("sol-resource") for each ones referring to ecosystem (cubic meters) (Table 2).

2.4 Statistical analysis

The results of this lexical analysis were then exploited using RStudio© statistical processing software (RStudio Team, 2015, RStudio: Integrated Development for R. RStudio, Inc., Boston). First, their exploitation led to an understanding of the consideration of the analyzed words according to not only the planning documents, their topic, and scale of application but also in terms of urban areas.

Secondly, the results of the lexical analysis of the planning documents relating only to the urban area scale (e.g., local soil cover document, transport document, housing document, inter-communal soil cover document) were compared with intrinsic characteristics of urban areas and planning documents (e.g., population density, surface area of artificial soils, surface area of agricultural soils, date of document publication) through linear regressions in order to understand if these criteria had an impact on their frequency of their use in the planning documents.

3 Results

3.1 Comparison of the occurrence index of "soil" in comparison with those of the other words: quantitative consideration of "soil"

Concerning the quantitative lexical analysis, the first results indicate that "soil" is indeed a subject addressed in French planning documents. Indeed, taking into account all the planning documents analyzed from all the selected urban areas, its index of occurrences reached 0.06% (Fig. 2). Comparatively, words such as "transport" or "economy," intrinsically linked to the topics of planning documents, obtain respectively occurrence indices of 0.77 and 0.39%. These results also indicate that "water" appears significantly more frequently than "soil" (occurrence index of 0.26%). Conversely, words such as "biodiversity" and "air" appear as frequently as "soil," with an occurrence index of 0.08%. Finally, another important result of this lexical analysis is the very low use of the lexical

Table 2 Soil-surface and soil-resource lexical field

Lexical field	Example	Soil-surface/ soil-resource
Land use	Rules of land use, footprint	Soil-surface
Descriptive characteristics	Limestone soil, clay soil	Soil-resource
Degradation and modification	Polluted soils	Soil-resource
Soil functions	Carbon sequestration of agricultural soils	Soil-resource
Soil security	Controlling the soil artificialization	Soil-resource

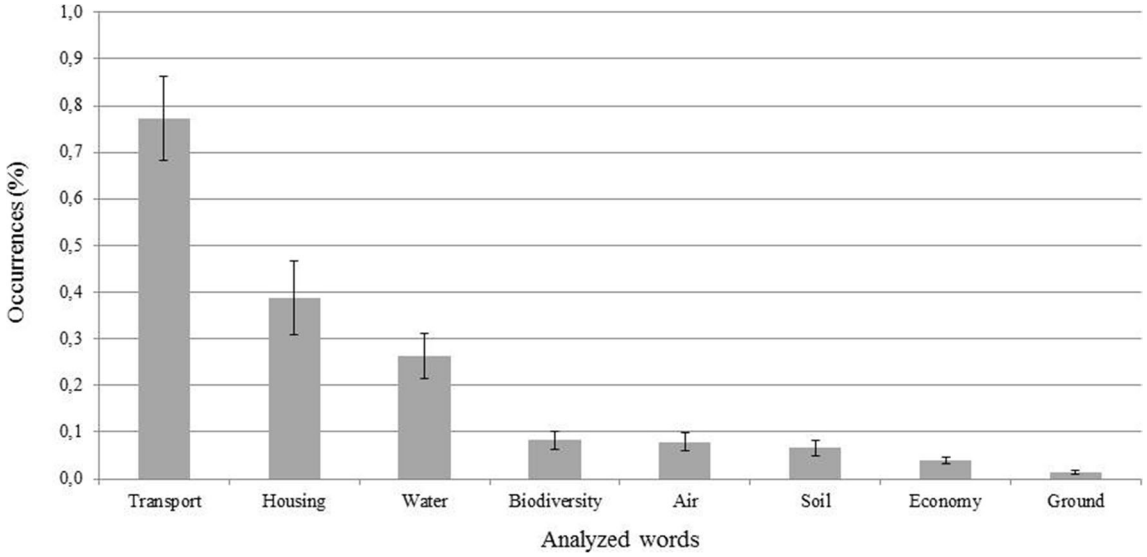

Fig. 2 Occurrences of words analyzed in 105 French planning documents from 15 cities

field referring to "soil material" in planning documents, at merely 0.01%. Consequently, the lexical field referring to "soil material" was omitted from the following results.

The results of the quantitative lexical analysis make it possible to account for the diversity of the occurrences of the words within each document, according to their topic. For example, the occurrence index of "transport" is 2.91% in the planning document dealing with urban mobility, whereas it was only 0.06% in the one concerned with water management. The word "housing" has an occurrence index of 1.87% in the document dealing with habitat, against only 0.007% in the one dealing with water management. In order to put this into context, "biodiversity" had an occurrence index of 0.39% in the document dealing with biodiversity preservation, whereas words such as "soil," "transport," and "water" only had occurrence indices of respectively 0.13%, 0.14, and 0.16%. These differences could be explained, as detailed in Section 2.2., in which many French planning documents are thematic in nature. For example, the document, dealing with the urban mobility, determines the organization of the transport of persons and goods within an urban unit and the one dealing with habitat focuses only on housing policy at the urban unit level. Conversely, some documents are more wide ranging, such as the document defining the local soil cover at the city scale. Thus, the varied scopes of the planning documents explain some of these results.

3.2 Comparison of the index of occurrences of "soil-surface" and "soil-resource": qualitative consideration of "soil"

Concerning the qualitative lexical analysis, results show that in planning documents, "soil" refers both to a surface (land use, square meters) and to a resource (ecosystem, cubic meters) concept. Indeed, taking into account all the planning documents analyzed from all the selected urban areas, the index of occurrences of "soil-surface" reached 0.035%, whereas that of "soil-resource" reached 0.031%. Thus, globally, in planning documents, half of the references to "soil" imply "soil-resource." However, there is only a poor correlation between the occurrence index of the word "soil" in planning documents and that of the concept of soil as a resource. Indeed, the correlation between the index of occurrences of "soil" and that of "soil-resource" is only $R^2 = 0.356$ (Fig. 3).

3.3 Consideration of "soil" by planning document

As far as the qualitative lexical analysis is concerned, the results emphasize that the use of "soil" referring to the concept of "soil-resource" also depends on the planning document in question, and in particular on its application scale (Fig. 4). In fact, some planning documents use "soil" dominantly as "soil-surface." This is notably the case of the document defining the local soil cover at the local scale, in which the occurrence index of "soil-resource" (0.03%) represents almost one fifth of the occurrences of "soil" (0.17%). This is also the case for documents related to transport and habitat. Indeed, in the document dealing with habitat, the occurrence index of "soil-surface" reached 0.003%, when that of "soil-resource" was only 0.001%. Conversely, other planning documents consider "soil" as a resource rather than a surface. This is the case of the biodiversity preservation document, where the occurrence index of "soil-surface" was 0.06% when that of "soil-resource" reached 0.07%. This is even more striking for the planning document dealing with water management, in which the occurrence index of "soil-surface" reached only 0.007% when that of "soil-resource" was 0.035%.

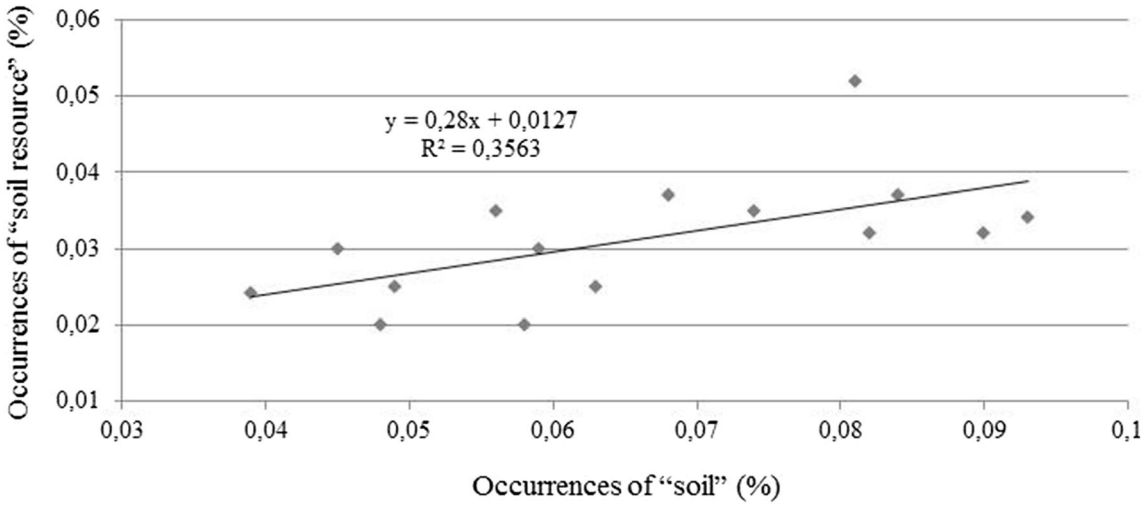

Fig. 3 Correlation between "soil-resource" and "soil" occurrences in planning documents

3.4 Consideration of "soil" by urban area

The difference in the consideration of "soil" by the 15 French urban areas studied was less pronounced than that observed between urban planning documents (Fig. 5). Indeed, it appeared that some urban areas have planning documents in which the word "soil" appears more frequently. This is particularly the case for Rouen, where the use of "soil" in its planning documents amounts to 0.09%. In contrast, Strasbourg's planning documents employed the word "soil," with only a 0.04% occurrence. Globally, for each of the urban areas, about half of the references to "soil" indicate soil as a resource. Only the urban areas of Tours, Paris, Grenoble, and Strasbourg seem to stand out, considering soil more as a resource than a surface. For example, in Tours' planning documents, the occurrence of "soil-resource" was 0.052% but was only 0.029% in the case of "soil-surface." Conversely, in the planning documents of the urban area of Montpellier, "soil-resource" occurred with a frequency of 0.032%, while it reached 0.058% for the "soil-surface" concept.

3.5 Consideration of "soil" according to demographic factors

For the purposes of this analysis, only local and intercommunal planning documents (e.g., local soil cover document, transport document, housing document, and intercommunal soil cover documents) were analyzed. The

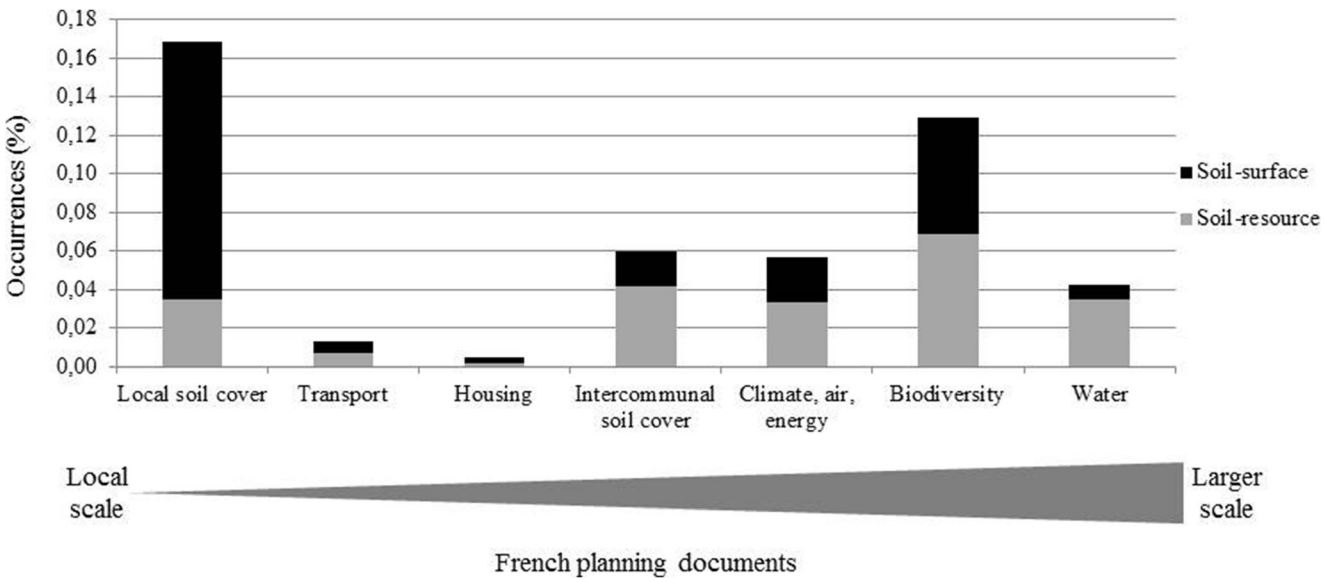

Fig. 4 Consideration of soil by planning document

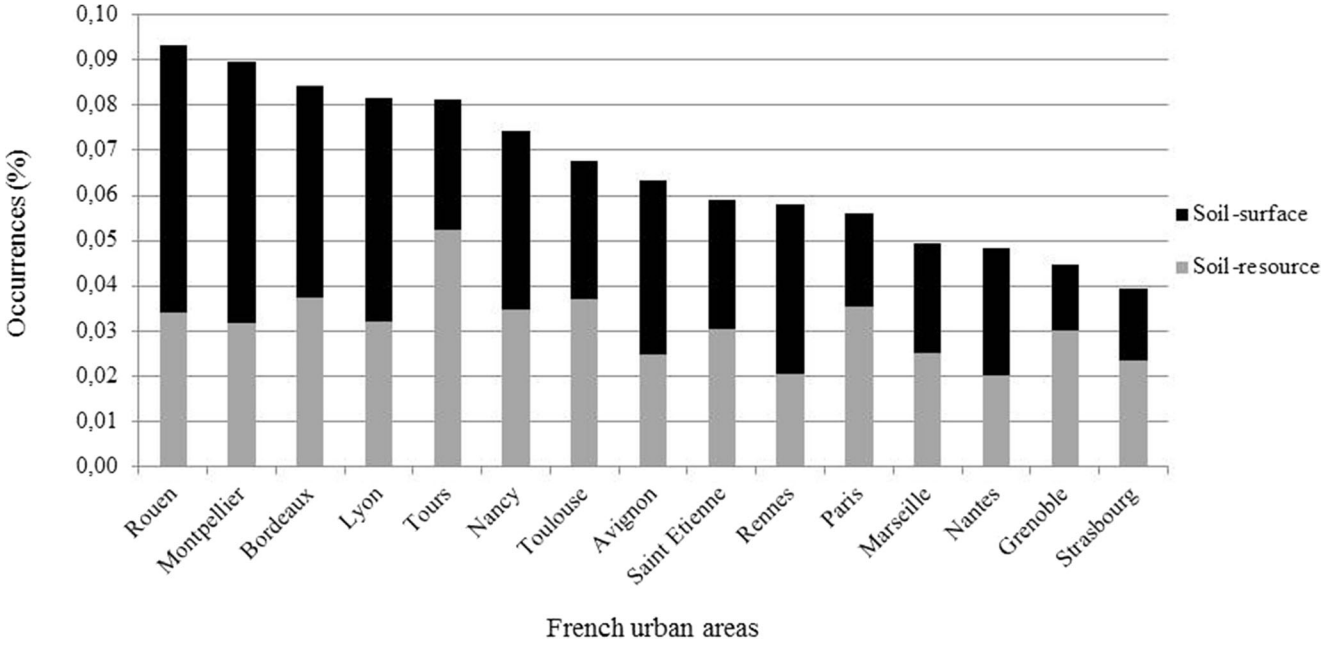

Fig. 5 Consideration of soil by the urban area

results of the linear regressions suggest that, among the criteria selected, few have a real influence on the occurrence of the words analyzed (Table 3). The only criterion that may be detached from the analysis appears to be the date of publication of the document. Indeed, this would seem to have a significant influence on the frequency of words such as "soil-resource" or "biodiversity" (Fig. 6). Indeed, over time, the indices of occurrence of "soil-resource" and "biodiversity" have increased, from 0.001% in 2000 to about 0.04% in 2015. Conversely, this analysis shows that the occurrences of "soil-surface" increased from 2000 (0.001%) to 2008 (0.1%) and then remained stable from 2008 to 2015, with an average occurrence index of 0.02%. In the case of the word "transport," the publication date plays a similar role in its usage frequency, decreasing from 2000 (3%) to 2015 (0.5%).

Table 3 Correlation table of analyzed words and characteristics of urban areas and features of planning documents

		Area	population_density	artificial_area	agricultural_area	forest_area	political_party	publication_date
Soil-surface	R^2	1.9E−03	5.0E−03	4.5E−03	2.7E−03	2.9E−03	5.8E−03	3.0E−03
	p value	7.4E−01	5.9E−01	6.1E−01	6.9E−01	6.8E−01	5.6E−01	6.8E−01
Soil-resource	R^2	1.0E−03	2.9E−04	3.3E−04	1.7E−03	6.7E−04	8.7E−03	6.8E−02
	p value	8.0E−01	8.9E−01	8.9E−01	7.5E−01	8.4E−01	4.8E−01	4.3E−02
Biodiversity	*R*-squared	2.4E−03	1.9E−03	4.1E−04	8.0E−04	7.0E−03	3.0E−02	1.6E−01
	p value	7.1E−01	7.4E−01	8.8E−01	8.3E−01	5.3E−01	1.9E−01	1.5E−03
Water	R^2	1.7E−02	5.4E−05	1.0E−2	7.0E−03	1.7E−02	2.8E−02	9.8E−02
	p value	3.3E−01	9.6E−01	4.4E−01	5.2E−01	3.2E−01	2.0E−01	1.5E−02
Air	R^2	6.3E−03	4.7E−03	2.5E−04	7.0E−04	6.1E−03	7.6E−03	2.7E−02
	p value	5.5E−01	6.0E−01	9.0E−01	8.4E−01	5.5E−01	5.1E−01	2.1E−01
Housing	R^2	1.1E−03	1.2E−05	8.9E−04	2.4E−08	1.3E−03	4.3E−03	5.1E−02
	p value	8.0E−01	9.9E−01	9.8E−01	9.9E−01	7.8E−01	6.2E−01	8.3E−02
Transport	R^2	3.3E−03	3.2E−03	4.5E−05	5.0E−03	2.5E−03	1.0E−03	2.5E−01
	p value	6.6E−01	6.7E−01	9.6E−01	5.9E−01	7.1E−01	8.1E−01	4.1E−05
Economy	R^2	6.0E−03	3.0E−03	1.7E−04	1.1E−02	9.7E−03	2.0E−03	1.4E−01
	p value	5.6E−01	6.8E−01	9.2E−01	4.2E−01	4.5E−01	7.4E−01	3.7E−03

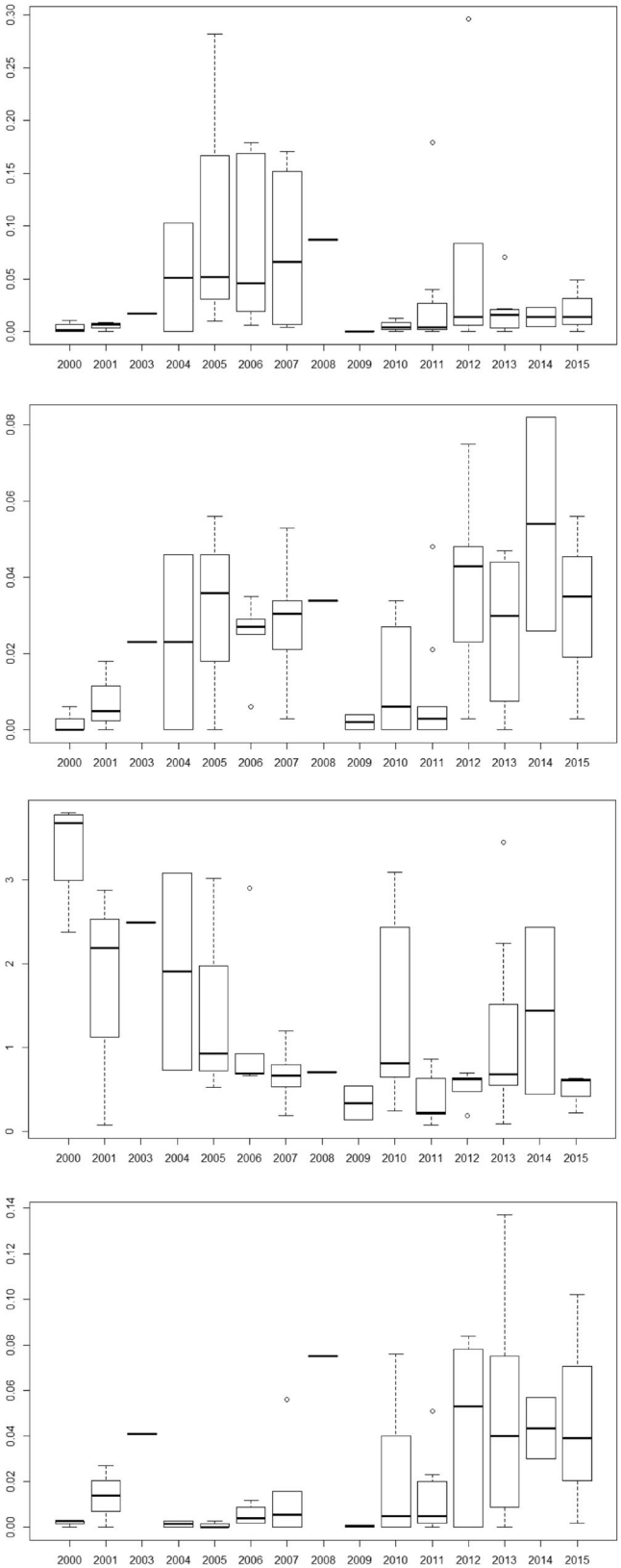

Fig. 6 Occurrences of words analyzed according by publication date of the planning documents

4 Discussion

4.1 A significant consideration of soil as a resource in urban planning documents

In a context of resource protection and of sustainable development of cities, urban planners have gradually integrated environmental criteria into their decision-making. The question of soil preservation can consequently be seen to be progressing importance. Some legal strategies, at both international and national levels, have set out to regulate the forms and dynamics of land use. However, the frequent observation made be made that soil is neglected by urban planning strategies and that when it is considered; it is mainly through a surface approach. Indeed, it would seem that those involved in urban planning mostly ignore the volumetric dimension of soils and therefore their biological, physical, and chemical properties and services they can provide (e.g., climate change regulation, biomass production).

This work, focusing on a lexical analysis of the urban planning documents of the 15 largest French cities, shows that this state of affairs needs to be challenged. Indeed, according to the results, it would appear that the soil is considered in urban planning in the same way as, for example, the air resource. Moreover, the consideration of soil refers both to a surface concept and to a resource concept. That every other occurrence of the word "soil" refers to "soil-resource" indicates that any consideration of the soil as a living compartment of the urban ecosystem is a complex matter. Indeed, since the results indicate that although there is only a weak correlation between the occurrences of the word "soil" and that of "soil-resource," city planning documents do not automatically consider it as a resource. Moreover, any consideration of soil as a resource depends strongly on the main topic of the urban planning document, the urban area concerned, and, to a lesser extent, its date of publication.

These results, acquired in the case of a lexical study of French urban planning documents, reflect the historical evolution of urban planning in France. It would be interesting to compare them with the results of a lexical analysis of planning documents from other countries in the world. Indeed, for example, German or Italian territorial planning does not have the same historical background as that in France. In these countries, the legal protection of soils seems less timid and more highly regulated than the French example, and the main topics considered for territorial planning differ from those in France.

4.2 A non-regulatory value of the consideration of "soil-resource" in urban planning[1]

Most frequently, the consideration of soil as a resource, in urban planning, means only incentive information, without any regulatory constraint. Indeed, some of the French planning documents, such as the local planning and the inter-communal planning documents, are constituted of informative documents (e.g., presentation report, sustainable development, and planning project) and regulatory documents (e.g., regulation for the local planning document, guidance and objectives document for the inter-communal planning document) (French Urban planning code, articles L.110 and L.121-1). In most of the local planning documents analyzed, the consideration of soil as a resource appears predominantly in the presentation report, which contains a description of the environment and a section on the impacts of the urbanization on the environment. In the presentation report, the soil-resource is considered as a dynamic volume, as a potential source of pollution and as a support for food production. Conversely, the compliance of local planning documents must be ensured by local authorities. After referring to general rules and land use easements, soil is then largely considered as a surface.

4.3 The consideration of "soil-resource" in planning documents depends on… the authors

In France, urban planning is governed by a legal relationship, called the normative relationship, between planning documents (French Urban Planning Code). This report expresses the degree of authority of the higher standard documents (e.g., regional ecological coherence document) over the lower standard documents (e.g., local planning document), ranging from (i) "conformity" (the most exact level involving the identical transcription of the rule from the upper norm to the lower standard) to (ii) the simple "take into account" (the least demanding step of not disregarding the rule), passing through (iii) "compatibility" (implying respect for the spirit of the rule). For example, the local planning document, the local urban travel document, and the local housing program must be compatible with the inter-communal planning document, which itself has to take into account the regional ecological coherence document (French Urban Planning Code, article. L.111-1-1). However, consideration of the soil as a resource does not seem to follow this normative relationship. Indeed, those urban areas which most consider the soil as a resource in their local planning document are not those that consider it the most frequent in their inter-communal planning documents. This is also illustrated by the fact that the consideration of soil as a resource varies strongly between both planning documents and urban areas, without any correlation to geographical or demographic contexts. These results suggest that, considering the soil as a resource and therefore any reference to its characteristics (e.g., biological, physical, and chemical) and possible service provision relies mainly on the people in charge of drafting of the planning document. Further investigations will be required to demonstrate that, for example, the awareness of authors of the biophysicochemical characteristics of soils is strongly correlated to their training and their professional background.

[1] Data not shown

5 Conclusions

Over time, those involved in urban planning have gradually integrated environmental criteria into their decision-making. In a context of resource protection, this has led them to question the role and importance of soils. If our first hypothesis is that the soil in urban planning is only considered as a surface (soil as a land reserve, land use), it turns out that the actors of urban planning (e.g., policy makers, operators, urban planners) also consider the soil as a resource, with its own properties. However, the consideration of the soil as a resource in urban planning remains limited and complex. The results of the lexical analysis of French planning documents show that the consideration of soil as a resource is independent of any geographical and demographic contexts. Our new hypothesis is that variations mainly depend on the authors of the planning document. In addition to that, the occurrences of "soil" referring to a resource concept are dominantly considered for its fertility (in relation with its agricultural use) and potential contamination. The occurrences of "soil-resource" also refer to issues of storm water management, geotechnical constraints, and the protection of agricultural soils. Therefore, only a limited number of services provided by soils across the urban area (e.g., agricultural, forest, and urban) are considered in development strategies (e.g., support of infrastructures, regulation of the risk of flooding). Many other services are crucial to the viability of human societies, and the management of many environmental issues (e.g., regulation of the air quality, mitigation of the climate change, production of food and energy, production of fiber and raw materials, regulation of urban heat island, waste recycling, water purification, noise attenuation) is thereby obscured. This is particularly true for urban soils, which are infrequently considered for the services they can provide. Indeed, the urban planners consider soils both as a constraint (e.g., potentially polluted) and as an opportunity (e.g., allowing regulating the cycle of the water in order to avoid risks of flooding). However, any references to opportunities associated with urban soils are scarce in urban planning documents. For example, if the contribution of forest soils to carbon storage is well described, that of urban soils is globally absent in planning documents. All of these results suggest that those involved in urban planning seem to lack sensitivity to, but above all, are largely unaware of (urban) soils and their contributions to cities, where they could provide high-level ecosystem services. One of the ways to overcome this lack is (i) to train urban planners to know the soils, (ii) to make them aware of the importance of considering urban soil properties, and (iii) to develop decision-making tools to evaluate ecosystem services provided by urban soils in order to optimize land use.

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