

# Inventory of scientific publications on urban forestry published between 1800 and 2015: An analysis by period, topic and origin

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## ABSTRACT

Research in urban forestry (UF) is rapidly evolving. In order to better understand this increased interest among the scientific community, a comprehensive inventory of scientific articles published between 1800 and 2015 on the subject was carried out. To do so, 21 keywords were used to query six different databases. Data was gathered and analyzed using the *Endnote x7* reference management software. Some 3100 papers were identified and grouped by period, topic and author origin. The results show that the number of papers published has constantly risen since 1800, more so over the last decades. For example, the number of papers more than doubled between 2000 and 2009 compared to the previous decade (1990–1999). If this trend continues, the number of publications could double again between 2010 and 2019. This observation is valid for all countries, except for Scandinavian and Baltic countries where the number of related articles has decreased in recent years. The most commonly studied topics are human health and sociology, followed by air quality and pollutants. These results show, among other things, that UF research is thriving and that many scientists appear particularly preoccupied by the impacts of global warming.

**Key words:** urban forests, urban forest management, urban forestry, urban parks, health and forests, urban ecology, urban trees, arboriculture, community forestry, urban woodlands, green spaces, urban forest planning, urban green spaces, research review.

## RÉSUMÉ

La recherche en foresterie urbaine (FU) évolue rapidement. Afin de mieux comprendre cet intérêt accru parmi la communauté scientifique, un recensement exhaustif a été réalisé à partir des publications à caractère scientifique parues de 1800 à 2015. Pour ce faire, 21 mots clés ont été utilisés en interrogeant six bases de données. Les données obtenues ont été recueillies et analysées avec le logiciel de gestion de références *Endnote x7*. Les quelque 3100 références recensées ont été regroupées par période, par thème et par provenance des auteurs. Les résultats obtenus montrent que le nombre de publications n'a cessé de progresser depuis 1800, et ce plus particulièrement ces dernières décennies. Par exemple, elles ont plus que doublé de 2000–2009 par rapport à 1990–1999. Si la tendance se maintient, elle pourrait encore doubler de 2010–2019. Ce constat est valable pour tous les pays, sauf les pays scandinaves et les pays baltes où le nombre de publications est en baisse ces dernières années. Les thèmes de recherche les plus souvent abordés sont la santé humaine et la sociologie, suivis par la qualité de l'air et les polluants. Ces résultats indiquent, entre autres, que la FU est un champ de recherche florissant et que plusieurs scientifiques semblent préoccupés par les impacts du réchauffement climatique.

**Mots clés :** Foresterie urbaine, Aménagement des forêts urbaines, Forêts urbaines, Parcs urbaines, Forêt et santé, Écologie urbaine, Arbres urbaines, Arboriculture, Espaces verts

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## Introduction

The world's population is increasingly concentrated in large cities. Regarding populations, Statistics Canada (2017) defines an urban area as "having a population of at least 1000 and a density of 400 or more people per square kilometre." There is no standard definition of an urban area, each country having developed its specific one according to various criteria (World Bank 2015). In 2014, over 50% of the world's population lived in urban areas (World Bank 2016a). As this trend continues, this is expected to reach 66% by 2050 worldwide (FAO 2016). As reported in the last Canadian Urban Forest Strategy (Tree Canada 2019), the 2016 census estimated that 81.1% of Canadians are urbanites.

Rising urban populations inevitably lead to urban sprawl, which entails various issues such as increased pollution related to road transportation and a greater number of heat islands where the temperature can be 6–8°C warmer than in neighbouring green areas (Frumkin 2002). As recognized in the scientific literature for many years, the development and maintenance of urban forests are crucial to countering this issue. For example, healthy urban forests are conducive to sustainable city management (FAO 2016) and contribute to the physical (Donovan *et al.* 2013; Rao *et al.* 2014) and mental (Berman *et al.* 2012) well-being of city populations.

There is a wide consensus regarding the many benefits of urban forests, but the definition of the latter varies greatly (see e.g., Konijnendijk 2003), and generally for our part we like to simply adopt the short one suggested by Bussi eres *et al.* (2009): "all trees found within a city's urban boundaries". Such benefits include, for instance, sequestration of gaseous and particulate air pollutants, energy conservation, and storm-water and noise attenuation (Tree Canada 2019). Furthermore, trees in urban areas often face complex and harsh environments, which can, for instance, restrict their access to the various nutrients in the soil (Mullaney *et al.* 2015). Factors such as contaminated and compacted soils, the presence of de-icing salts, and physical damages caused by snow removal and car activities also undermine their healthy development (Tree Canada 2019). Trees in urban areas are also sensitive to global warming (Ord o ez and Duinker 2014). There must be enough

human and financial resources in place to maintain healthy urban tree populations and to take the necessary measures to increase forest cover in municipalities (Johnston and Rushton 1999). It should be noted that, in order to justify such investments, an increasing number of studies estimate the economic value of the benefits generated by trees in urban areas. For example, Alexander and McDonald (2014) estimated that the trees in Toronto are worth CAD \$7 billion, or \$700 per tree, whereas Rev eret (2017) showed that the positive effects of one hectare of urban forest equates to approximately USD \$32 000 per year.

These aspects, which are all critical to creating a healthy urban environment, also constitute potential research topics. According to European analyses, many studies have been carried out in these UF-related fields over the past few decades (Konijnendijk *et al.* 2000; Ord o ez and Duinker 2014), a number which seems to be still on the rise. This inventory aims to estimate the evolution of research on UF worldwide between 1800 and 2015 with respect to the topics that were studied at various periods. Six bibliographic databases were queried for the purposes of this analysis.

## Methods

### Queried databases

The inventory was carried out between May 4 and June 30, 2015. Six different databases were used: Scopus, Cab Abstracts, Geobase, Urban Studies Abstracts, CAIRN, FRANCIS and the Ariane catalogue from the Universit e Laval's library. Databases were selected following a consultation with a librarian from the Universit e Laval during a master's degree project (Larouche 2016). These databases are described in Table 1.

### Keywords

The following 21 keywords were used for the purposes of the inventory: "Urban forests," "Urban forests management," "Urban forestry," "For esterie urbaine," "Am enagement des for ets urbaines," "For ets urbaines," "Parcs urbains," "Urban parks," "For et et sant e," "Health and forests," "Urban ecology," " cologie urbaine," "Urban trees," "Arbres urbains," "Arboriculture," "Community forestry," "Urban woodlands," "Green spaces," "Espaces verts," "Urban forests plan-

Table 1. Description of the queried databases

Database	Characteristics	Description
Scopus	Social and applied sciences, pure sciences, French	The largest scientific publication database in the world, abstracts are commonly available. <a href="https://www.elsevier.com/solutions/scopus/content">https://www.elsevier.com/solutions/scopus/content</a>
CAB Abstracts	Applied sciences, 1910-2015	Indexes over 10,000 scientific journals, as well as books, reports, conference proceedings and minutes. The topics covered include veterinary sciences, agriculture and affiliated fields (e.g., nutrition and human health), forestry, botany, biotechnology, natural resource management and conservation (source: Ariane catalogue, Université Laval). <a href="http://sites.cabi.org/Uploads/CABI/publishing/promotional-materials/insert/Cab%20Abstracts%204Pp%20Flyer%20French%20Hr.pdf">http://sites.cabi.org/Uploads/CABI/publishing/promotional-materials/insert/Cab%20Abstracts%204Pp%20Flyer%20French%20Hr.pdf</a>
Geobase		Includes thousands of peer-reviewed journals, books and conference proceedings on topics related to the earth sciences, including geology, human and physical geography, environmental sciences, oceanography, geotechnics, alternative energy sources, pollution, waste management and nature conservation. <a href="https://www.elsevier.com/solutions/engineering-village/content/geobase">https://www.elsevier.com/solutions/engineering-village/content/geobase</a>
Urban Studies Abstracts		Includes the research fields associated to urban studies, including economics, community development, urban history and other key topics in the field. Data is drawn from several journals such as the <i>Journal of Urban Affairs</i> , <i>Urban Studies</i> , and the <i>Canadian Journal of Urban Research</i> (Ariane catalogue, Université Laval).
CAIRN		Includes analytical summaries and complete texts from European journals in humanities and social sciences (Ariane catalogue, Université Laval).
FRANCIS		Contains over one million records, covering humanities and social sciences from sources worldwide. The topics covered include archaeology, geography, linguistics, philosophy, religion and sociology, drawn from journal articles, conference minutes, works, reports and doctoral theses (source: Ariane catalogue, Université Laval).
Ariane		The search engine of Université Laval's library, indexing all documents (books, journals, theses, etc.) included in its collections.

ning” and “Urban green spaces.” One of these keywords had to be found at least once in a publication’s abstract or title to be selected for the purposes of the inventory.

#### Data analysis

The articles identified during this study were grouped under various topics, based on a set of criteria. To carry out the analysis, the articles were first entered in the *Endnote x7* reference management software. The search using the 21 keywords in the six databases yielded over 20 000 results. The articles were then sorted to eliminate duplicate entries and irrelevant references. The only publications retained were scientific publications and conference proceedings. Books and theses were excluded since they are usually the product of a collaboration between several authors and have generally involved and/or resulted in the publication of scientific articles. Groups were created, based on research topic, publication period (1800–1969, 1970–1979, 1980–1989, 1990–1999, 2000–2009, and 2010–2015) as well as geographic origin of the authors and articles. Given the small number of articles published between 1800 and 1969 as identified in the databases, and in order to facilitate data analyses, the results in question were included in a group covering a longer period.

Overall, 20 topics were selected in order to limit the number of research groups as much as possible (Table 2). For example, articles on tree health, tree stress and injuries, arboriculture and dangerous trees were grouped under the *tree health and arboriculture* topic. Regardless of the fact that many of our selected topics (e.g., *Ecology*, *Biodiversity* and *Management*) were also used in other studies (Konijnendijk *et al.* 2007; Wolf and Kruger 2009), the grouping process remains naturally subjective and alternative classification methods have been used at times.

*EndNote* shows the location of the publication and the authors’ origins. However, after verification, we discovered that the authors’ origin stated in *EndNote* was more often than not the location of the journal’s publication. After meeting with a librarian from the Université Laval, we determined that the most appropriate tool to identify the origin of the articles’ authors was the *Web of Science* database. To efficiently use this database to retrace the origin of the articles, we created a new database with the data collected in *EndNote x7* and we removed the following single title occurrences: “urban resident”, “urban green space”, “urban tree”, “urban forestry”, “urban woodlands”, “urban tree inventories” and “urban forestry education”. These sin-

**Table 2. Grouped publication topics in the present study**

Category	Description
Management	Urban forest management and development
Trees and climate in urban areas	The role of trees and urban forests in city climates, including their impact on heat islands
Biodiversity, ecology and urban ecosystems	Ecology, ecosystems and biodiversity in urban forests
Biomass and physiology	Biomass of urban forests and tree physiology (exchanges between leaves and air, aero-dynamism and transpiration)
Water and wetlands	Wetlands, runoff management and water supply for trees
Education and conferences	Conference proceedings and worker training sessions
Fauna	Urban forest fauna
Geomatics and remote sensing	Uses of geomatics and remote sensing
History and definition	History and definition of the urban forest
Insects and diseases (indigenous and exotic)	Indigenous and exotic pests
Inventory and composition	Urban tree inventory obtained by a method other than remote sensing and the composition of urban forests
Modelling	Model development in relation to urban forests
Policy and legislation	Regulations, legislation and policies related to green spaces and trees in urban areas
Programs	Community and public plantation programs as well as urban forest development programs
Air quality and pollutants	Air quality, role of trees in pollutant filtration and allergies induced by various tree components
Literature reviews, studies and research needs	Literature reviews on urban forest publications, studies or surveys, and identification of research needs regarding urban forests
Tree health and arboriculture	Tree health, injuries, stress, arboriculture and dangerous trees
Human health and sociology	Trees and human health, and sociological aspects of urban forests
Soils, tree plantation and selection	Plantation, soils and species selection
Tree value	Economic value of forests and value of forest-derived products

gle title occurrences were found in many other long titles. For example, if we found the following title: “Urban trees: a survey of street trees in England” and we kept the single title occurrence “urban tree”, this title would appear twice in the search results of the *Web of Science* (one time with the long title and a second time with just “urban tree” highlighted). By removing these seven single occurrences before doing our research in the *Web of Science*, only seven documents were lost as their title was solely composed of these single occurrence terms, instead of having a lot of multi-occurrences of the same title.

We also removed all French titles (8%), since they were not available in the *Web of Science*. In order to meet the requirements of this database’s search tool and to make the identification of article titles possible, we placed each title in quotes and inserted the boolean operator “OR” after each one. Once the data had been organized, we searched for the titles in the database using the advanced search tool. Afterwards, we opened every identified article to find the first author’s origin.

## Results and discussion

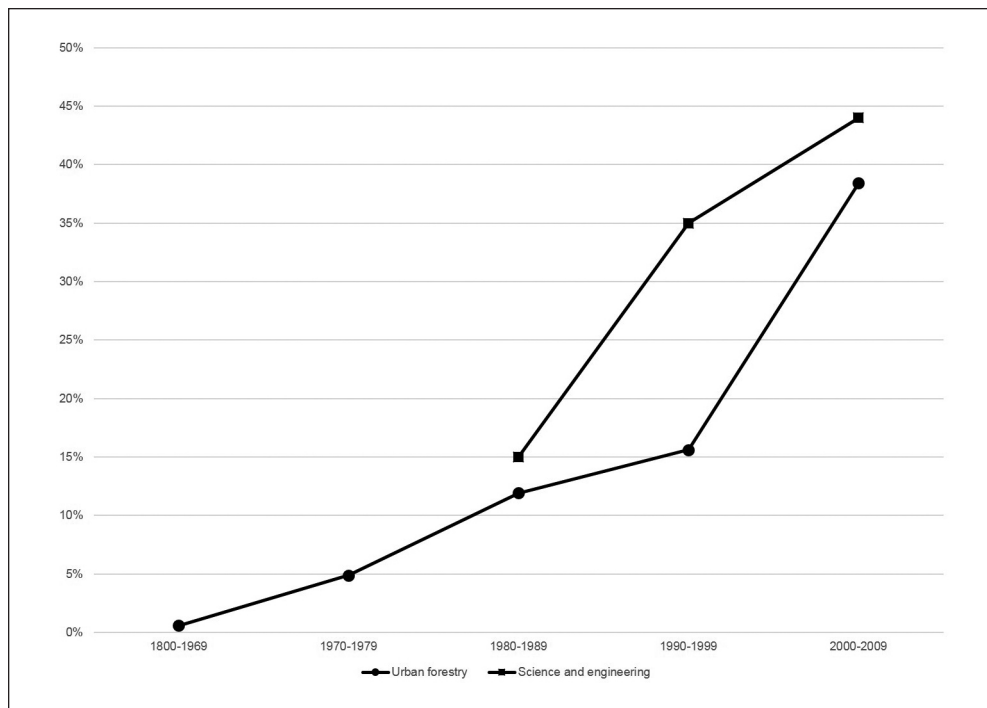
### Distribution of urban forestry (UF) publications by period between 1800 and 2015

Using six different databases and the Ariane catalogue, we were able to cover the period between 1800 and

June 2015. We collected 3,112 documents using our list of selected keywords.

The results indicate a constant increase in the number of UF publications since 1800. This increase is more notable over the last decades where, for instance, the number of publications have more than doubled between 2000 and 2009 compared to 1990 to 1999 (Fig. 1). It is expected to double again between 2010 and 2019 if this trend continues. Nonetheless, this increase is inferior to that reported in a similar study conducted by Ostoić and van den Bosch (2015) which covered the period from 1988 to 2014. These researchers identified 519 articles published in this period by searching for the keywords “urban forest” in the Scopus database, querying only four specialized journals: *Arboriculture and Urban Forestry (AUF)*, under the name *Journal of Arboriculture (JA)* until 2006, *Urban Forestry & Urban Greening (UF&UG)*, *Landscape and Urban Planning (LUP)* and *Forest Policy and Economics (FPE)*. They noted a constant increase in the number of publications over the years, a number that tripled between 1990–1999 and 2000–2009. For the last five years covered by the study, i.e., 2010 to 2014, 210 articles were identified. This number represents 40% of the total. Despite being created only in 2002, *UF&UG* published 31% of the 519 articles. *AUF/JA* published 44.5% of the papers, while *LUP* and *FPE* issued 23% and 1.9%,





**Fig. 1.** Global publications in science and engineering<sup>4</sup> and in the field of urban forestry according to the percentage of publications

<sup>4</sup>Number of science and engineering articles published on physics, biology, chemistry, mathematics, clinical medicine, biomedical research, engineering and technology, and earth and space sciences.

respectively. Another study covering the 159 articles published by *UF&UG* between 2002 and 2009 also showed that the journal published an increasing number of articles over the years (Bentsen *et al.* 2010), this being reflected, for instance, by the fact that the journal went from three to four issues per volume by 2004. The comparison of our study with that of Ostoić and van den Bosch (2015) is not an easy one, partly because we used more keywords and databases. It is interesting to note the increased interest shown by urban forest stakeholders over the past few decades when compared to previous decades.

During a presentation at the 14<sup>th</sup> World Forestry Congress held in September 2015 in Durban, South Africa, Fabio Salbitano from the University of Florence used a query run in Scopus to show the significant rise in the number of articles published between 2000 and 2010 regarding a specific field of UF, i.e., green infrastructure, as compared with the previous decade (Borelli *et al.* 2015). Although there is no doubt among key stakeholders concerning the benefits of urban trees, this study shows that concrete actions had recently been taken to ensure the sustainability of the resource and thereby meet citizens' expectations.

A comparison with the global field of "science and engineering" articles published between 1980 and 2009 (World Bank 2016b) indicates that their number increased as well (data available only for this period) (Fig. 1). The increased rate of scientific publications was greater than that of UF publications between 1980-1989

and 1990-1999, but this trend reversed in favour of UF publications when comparing 1999-2009 and 2000-2009.

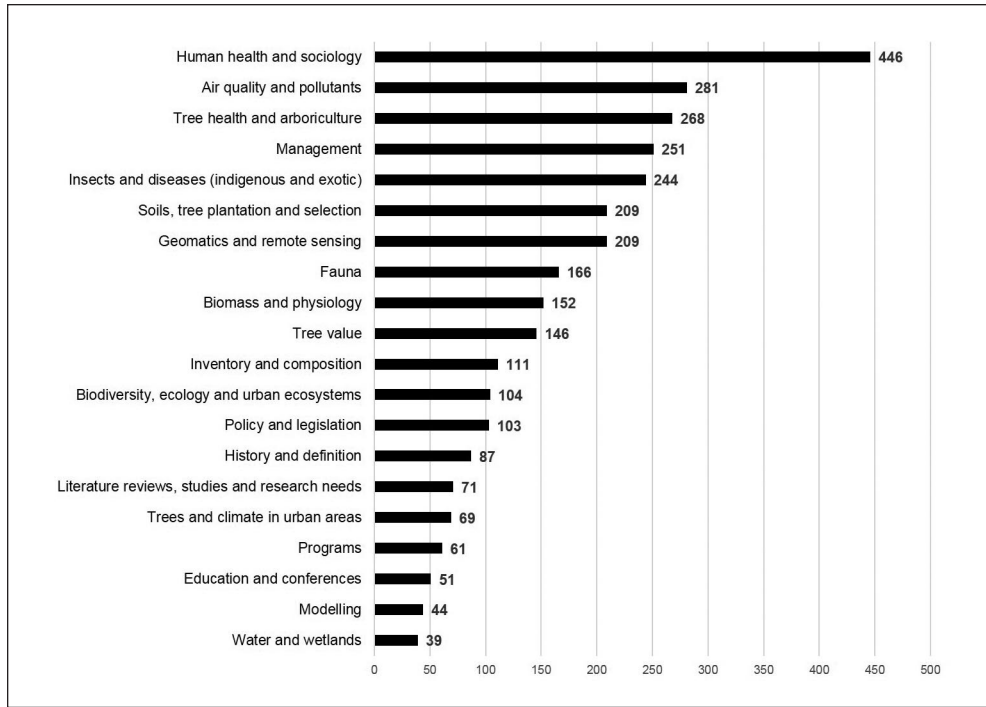
#### Distribution of scientific articles in urban forestry by research topic

The *Human health and sociology* topic (446 publications, 14.3% of the total) includes the most articles, followed by *Air quality and pollutants* (281 publications, 9.0%) and *Tree health and arboriculture* (268 publications, 8.6%) (Fig. 2).

These results are comparable to those of similar studies. Ostoić and van den Bosch (2015) reported that the *Management* topic, which includes all aspects of tree health (e.g., selection, growth, inventory, dangerousness), and therefore

overlaps with the *Tree health and arboriculture* topic in our study, includes 50% of the publications, while *Human health and sociology* ranked in second place with 19% of publications. However, the authors were surprised to note that, over the period covered, very few studies focused on adaptations to climate change and its impact on human health. In another study on UF research projects covering 2005 to 2009 in Denmark, Finland, Norway and Sweden, Molin *et al.* (2010) showed that, of the 67 studies surveyed and divided into 15 topics, only four themes were cited by specialists in over 20% of these studies. The *Nature and health and Social values* topics, which are very similar to *Human health and sociology* (ranked first in our inventory), tied for third place with 20% of responses when these topics were grouped by research topic frequency (Molin *et al.* 2010). Ranking first with a landslide 60% was the *Urban planning* topic, while *Ecology and biodiversity* came in second with 30%. Of the 67 studies, 51 were essentially conducted in universities, 15 in research institutes and one by a governmental department.

The same trend was observed in a study on UF research which was conducted in Europe covering the 1990 to 2000 period and 20 countries (Konijnendijk *et al.* 2000). The studies were grouped into three topics: *Establishment of objectives and functions of urban forests and trees* with 40% of the total, *Establishment and selection of trees for urban uses* with 32%, and *Management of urban forests and urban trees* that included 28%. Of the 404 studies surveyed, only three subtopics grouped more than 50: *Planning* (60, or 14.9% of the



**Fig. 2.** Distribution of urban forestry articles by topic (N = 3112)

total) and *Recreation studies* (54 or 13.3%), being included in the first topic, and *Selection and testing of plant material* (60, 14.9%) that was part of the second topic.

Another study, conducted in 2005 by Konijnendijk *et al.* (2007), focused on UF research carried out in Scandinavian and Baltic countries. This study showed that of the 20 topics selected using 306 keywords, *Planning* (~11%), *Ecology and biodiversity* (~10%) and *Management* (~8%) were standouts. Of the 76 projects described, only six occurred in the Baltic countries (five in Estonia, one in Latvia and none in Lithuania).

The study by Bentsen *et al.* (2010), which focused on the 159 papers published in *Urban Forestry and Urban Greening* between 2002 and 2009, is quite instructive regarding the topics selected and quantified over the course of various inventories. The topics chosen by these authors were drawn directly from the study by James *et al.* (2009) which was published in that same journal in 2009. The topics used in the latter were selected after consulting with 40 UF experts. However, James *et al.* (2009) clearly mentioned that these topics should be considered as emerging or trendy, although it is surprising to find that the “old” *Management* theme is one of them. Bentsen *et al.* (2010) did not mention this aspect in their study. This suggests that certain classic, albeit still current, topics could have been put aside, thereby creating a slight bias in the analysis carried out by Bentsen *et al.* (2010). These authors also created a new category, *Type of science*, which included *Social sciences* (38.4% of articles), *Natural sciences* (37.7%), *Multiple disciplines* (23.8%) and *Humanities* (0%). As the journal usually does not cover human aspects, the

absence of studies in this last field was to be expected. Most specific studies on human health, such as the one carried out in Canada by Crouse *et al.* (2017) which demonstrated, for instance, significant decreased risks of mortality when citizens’ residences were located in areas where greenness was prominent, require considerable investments and are published in journals that are most likely to be read by health-care providers than forestry professionals. Such journals include *Lancet Planetary Health*, which was chosen by these authors to publish their results. It should be noted that we could not have detected this paper with the use of

our keywords, as Crouse *et al.* (2017) used the keyword “urban greenness” in their title and abstract. Finally, although Konijnendijk was a co-author in the Bentsen *et al.* (2010) study, the authors candidly admit that it is difficult to compare their topics to those of more detailed surveys conducted by Konijnendijk *et al.* in 2000 and 2007.

We found certain differences between these studies and our own when it comes to the research topics identified (Tables 2 and 3). However, the beneficial aspects of urban forests for human health, sociology, biodiversity and management are widely present in all these studies, confirming the importance of these research topics. The National Urban and Community Forestry Advisory Council (2006) even includes the aspect of health and well-being in its definition of UF: “Urban forestry is the art, science, and technology of managing trees, forests, and natural systems in and around cities, suburbs and towns for the health and well-being of all people”

Moreover, in a study conducted by Bell *et al.* (2007) on mapping research priorities regarding green spaces and public spaces in England, these authors identified about 1300 research items in all published in this field over a recent period of 10 years, i.e., from 1995 to 2004. The results clearly indicate that there was a significant amount of research conducted on sociology, although some of the subtopics associated to the works by their authors were only addressed in a piecemeal fashion. Much of the work was related to economics, for example, the impact of the presence of trees and other plants on property prices. The authors were surprised to note that the least studied field concerned *Human health and the well-being of citizens*, but this only with regard

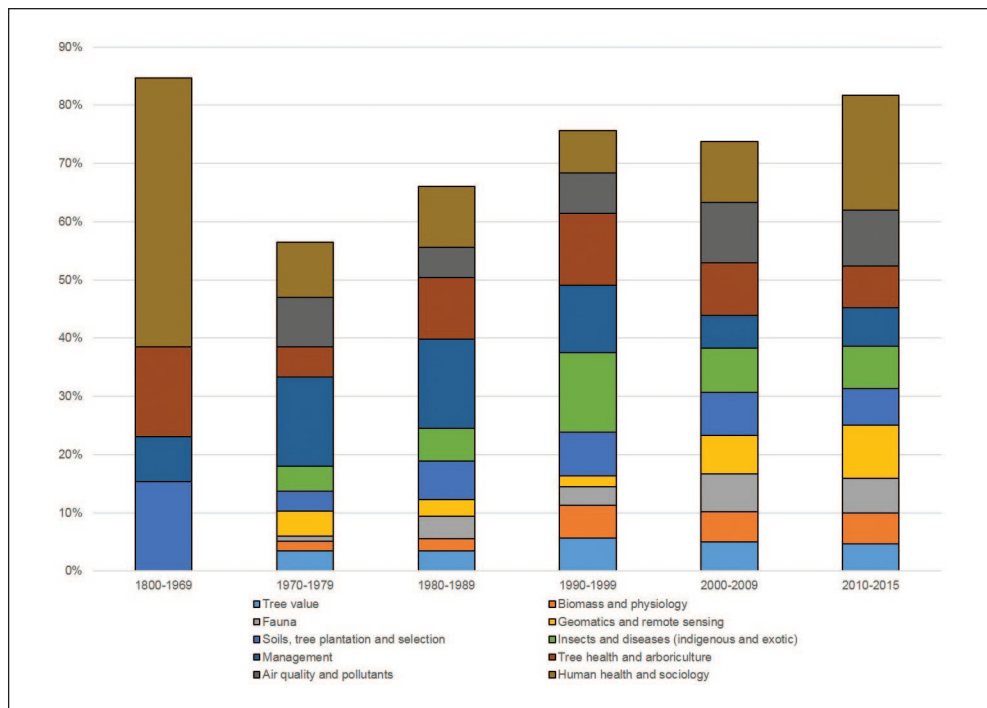
Table 3. Inventory study groups used in the literature

Study	Term	Number of studies considered	Main topics	Number of countries covered
Bell <i>et al.</i> (2007)	1995–2004	≈1000	1. Planning 2. Biodiversity 3. Economic values 4. Social 5. Management	1
Bentsen <i>et al.</i> (2010)	2002–2009	159	1. Management of urban green space 2. Physicality of urban green space 3. Experience of urban green space 4. Governance of urban green space 5. Valuation of urban green space	33
Konijnendijk <i>et al.</i> (2000)	1990–2000	404	1. Urban forestry/urban green structure planning 2. Selection and testing of plant material for urban areas 3. Recreation studies 4. Establishment of street trees and urban woodland 5. Typology and monitoring of ecological values	20
Konijnendijk <i>et al.</i> (2007)	2005	76	1. Urban forest planning 2. Urban forest management 3. Ecology and biodiversity 4. Social and cultural value 5. Recreation and use	6
Molin <i>et al.</i> (2010)	2008–2009	67	1. Urban forest planning 2. Ecology and biodiversity 3. Social values 4. Nature and health 5. Recreation and use	4
Ostoić <i>et al.</i> (2015)	1988–2014	519	1. Management 2. Civic involvement 3. Ecosystem services 4. Biodiversity 5. Urban planning	39

to correctly targeted social groups and the types of green spaces analyzed. They also mentioned that this topic was by far the most common among ongoing and planned research. We also focused on the main research topics per period. For the period spanning from 1800 to 1969, *Human Health and Sociology* was the most studied at 46% (Fig. 3), despite the small amount of data recorded during this period compared with other topics. For the 1970–1979 and 1980–1989 decades, *Urban Forest Management* was the preferred topic with 15%. In 1990–1999, *Insects and diseases (indigenous and exotic)* prevailed with 14% while *Air quality and pollutants* as well as *Human health and sociology* were the most popular subjects in 2000–2009, each covering 10% of the research. The latter was still in the lead in 2010–2015, having around 20% of the total articles identified. It is worth noting that there have been changes in topics over the decades, culminating in recent years with studies primarily focusing on human health and sociology and that most of them essentially reveal that trees provide significant positive benefits for citizens.

In the same sense, in a society that is increasingly concerned with climate change, the effects of pollution on the environment and thereby on human health, the research focusing directly on UF, or indirectly on related fields (Donovan *et al.* 2013; Makar *et al.* 2017), highlights the importance of urban forests on the health and well-being of city populations. We hope that all these studies will influence future research projects to better respond to the numerous challenges facing the maintenance of urban forests and to ensure the well-being of citizens.

We also noted that the *Insects and diseases (indigenous and exotic)* topic was under-represented in our study. We believe that the keywords identified did not adequately represent publications on pests. To verify this hypothesis, we resumed the inventory process using the Scopus database and a single key word, i.e., “emerald ash borer” (*Agrilus planipennis* Fairmaire), an insect which is at the heart of current events causing considerable devastation in forests of North America. We then obtained 441 documents, while only eight concerning this insect had been identified during our



**Fig. 3.** Distribution of urban forestry publications by topic and period (top 10) (N = 3112)

original query using 21 keywords. Thus, to investigate the question of insects and diseases, a specific inventory using the Latin names and even the common names of pests is recommended.

#### Distribution of urban forestry publications by origin

The geographic origin of the authors was only possible using the *Web of Science* database. Of the 3112 documents found, only the 2838 documents published in English were considered for this analysis, since *Web of Science* does not index papers published in French for instance. Using the database with these documents, it was possible to identify the origin of the authors for only 43% (1227) of the studies. The authors hail from 64 different countries which we grouped into 11 regions for the purposes of our analysis (Table 4). This table shows, among other things, that the number of articles published on UF is particularly high in North America (466), followed by Central Europe (214) and Asia (214). Another recent study (Ostoić and van den Bosch 2015) also showed that most of the articles on urban forestry came from North America, followed by Europe. The contribution of other countries was negligible. The authors noted, unsurprisingly, that the first place for North America is likely linked to the fact that the very concept of urban forestry was first expressed in Canada (Jorgensen 1974). Until the early 2000s, the main journal in the field was *JA*, whose name was changed to *Arboriculture and Urban Forestry* in 2006. This journal is published by the Illinois-based International Society of Arboriculture. The United States ranked first with 287 publications and 30 were from Canadian authors, data quite proportional to the respective populations of

these countries (in 2018, around 327 million cf. 37 million, respectively). North America therefore accounted for 61% of the 519 papers identified by these authors, as no studies seemed to originate from Mexico in that inventory, whereas five were identified during our study (Table 4). Although our regional groups and the number of articles analyzed (519 vs. 1265) differ, as well as the queried databases (1 vs. 6) and the keywords used (1 vs. 21), our results are similar in many respects. Moreover, if we were to apply the same groups as those presented in Table 4 to the results of the Ostoić and van den Bosch (2015) study, we would obtain the following in order of importance: North America, Scandinavian countries, Asia, Central Europe, Oceania and the United Kingdom. The same six regions top our list, albeit in a slightly different order, the notable exception being North America which came in first place in both studies.

We also addressed the evolution of the articles over time according to the location of the journal in which the article was published (Fig. 4). The location of publication was identified using *EndNote x7*, with which we were able to find the origin of 1265 articles. Every region published an increasing number of papers in the period 2010–present compared with 2000–2009, including Africa, Great-Britain and the Middle East, with the exception of Scandinavian and Baltic countries, where a drop was observed. Publications sorted by country and by decade generally follow the upward trend observed over time for all urban forestry publications.

#### Conclusion

This inventory, which is the most comprehensive of its kind focusing on urban forestry publications, has demonstrated that research conducted in the field is ever-growing. In fact, the number of research projects is rising considerably in most regions of the world, especially since 2000–2009 when the number of articles more than doubled compared to the previous decade. This trend also reflects the total number of scientific publications rather accurately but is even more pronounced in the field of urban forestry, and this even since 1990. Our analysis also revealed that North America, Central Europe and Asia accounted for the greatest



**Table 4. Number of authors in 11 country groups\***

Group	Country	Number	
Baltic countries Total: 5 (1%)	Latvia	2	
	Lithuania	2	
	Estonia	1	
Africa Total: 17 (1%)	South Africa	9	
	Nigeria	4	
	Algeria	1	
	Ethiopia	1	
	Ghana	1	
	Tunisia	1	
Middle East Total: 18 (1%)	Israel	9	
	Iran	5	
	Pakistan	3	
	Qatar	1	
Eastern Europe Total: 34 (3%)	Turkey	11	
	Greece	11	
	Croatia	3	
	Hungary	3	
	Russia	3	
	Romania	2	
	Ukraine	1	
South America Total: 58 (5%)	Brazil	40	
	Argentina	8	
	Colombia	7	
	Chile	3	
Scandinavian countries Total: 62 (5%)	Sweden	21	
	Denmark	18	
	Finland	18	
	Norway	5	
Oceania Total: 68 (6%)	Australia	51	
	New Zealand	15	
	Fiji	2	
United Kingdom Total: 71 (6%)	England	56	
	Scotland	10	
	Ireland	4	
	Wales	1	
Central Europe Total: 214 (17%)	Italy	39	
	Germany	38	
	Spain	22	
	Netherlands	22	
	Belgium	18	
	France	15	
	Austria	12	
	Poland	11	
	Serbia	9	
	Switzerland	9	
	Portugal	7	
	Czech Republic	5	
	Slovenia	3	
	Bulgaria	2	
	Armenia	1	
	Slovakia	1	
Asia Total: 214 (17%)	China	124	
	Japan	40	
	South Korea	16	
	India	9	
	Taiwan	9	
	Hong Kong	6	
	Malaysia	5	
	Singapore	3	
	Bangladesh	1	
	Nepal	1	
	North America Total: 466 (38%)	United States	385
		Canada	76
Mexico		5	
<b>Total</b>		<b>1227</b>	

\*Distribution of the 1227 authors of the selected urban forestry publications between 1970 and 2015 according to the first author's country of origin

number of studies in urban forestry. We noted that publications on human health, including pollution-related issues, are of increasing interest to specialists in the field. These specialists demonstrate through their studies that managing urban trees more efficiently has a positive and significant effect on the quality of life of city populations. It is expected that the adverse effects of climate change on the urban dweller will only become worse in the coming years, particularly illnesses related to heat islands. Even if gaps have been reported in the number of studies on the topic over the past few years, it is reasonable to assume that they will increase in number in the future and that their impact will lead managers to take the necessary measures to increase the forest cover in cities, especially in strategic areas.

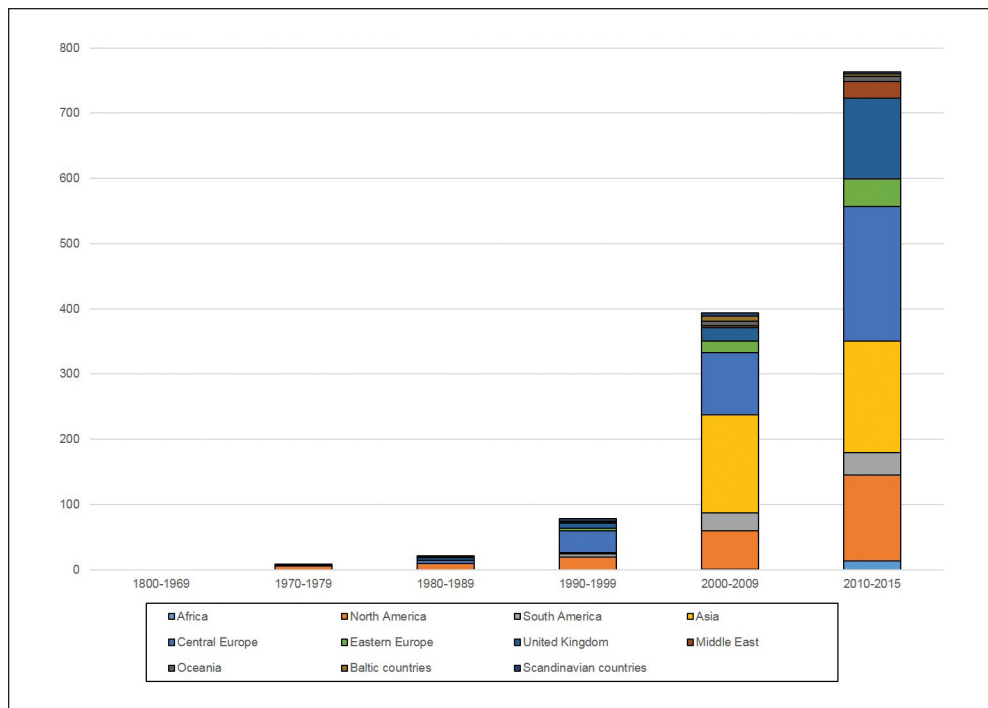
This extensive inventory is the first of two. The next study will focus on identifying the research needs of Canadian cities, based on a widespread consultation of UF authorities throughout Canada conducted in 2015. We will analyze the relationships between these needs and the nature of the articles published to date, namely, in recent years. This will allow us to determine the most relevant research needs and to detect any discrepancies, such as a city need in a particular area while there is already plenty of studies in the literature, apparently unknown to city urban forest specialists consulted during the survey.

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**Fig. 4.** Distribution of publications according to location and period between 1800 and 2015 (N = 1265)

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