

A BIBLIOMETRIC ANALYSIS ON EU AND GLOBAL RESEARCH ON THE ENVIRONMENTAL IMPACT OF CITIES

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Abstract: *Currently, more than half of the world's population is living in urban settlements and by 2030 this proportion will rise to two thirds. The process of urbanization is even more pronounced in developing countries (including in some EU countries). Apart from the cultural, social, economic or political changes that cities foster in their expansion process, urbanization has a major impact on the present and future state of the environment. The complex environmental impact of cities requires a cross-cutting and interdisciplinary research approach and an in-depth assessment. A stepping stone in such an investigative venture is a bibliometric analysis of existing literature on the topic of "environmental impact of cities". This would serve in identifying gaps, understanding the focus and gauging the level of knowledge on the subject. Moreover, the study seeks to raise awareness regarding the limited body of literature originated in the EU member states (most works addressing the topic originate in America and Asia).*

Keywords: bibliometrics; environment; city; urbanization; Scopus

Introduction

According to the Department of Economic and Social Affairs of the United Nations Secretariat (a vital interface between global policies in the economic, social and environmental spheres and national action), more people live nowadays in urban areas (or *cities*) than in rural settlements (the proportion of people living in urban areas exceeding 54 per cent of the world's population in 2014). The same source (United Nations, 2014) states that while in 1950, 30% of the world's population was living in urban settlements, one hundred years later more than two thirds of the world's population is expected to live in cities of various dimensions.

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Meanwhile, important changes regarding the world's population will occur in terms of spatial distribution and size (most of them will take place in Asia and Africa).

The rural-to-urban migration is often associated with significant changes of economic and social nature and is fostered by peoples' beliefs that life in the city brings enhanced opportunities for literacy, education, better jobs or higher incomes as well as cultural and political involvement, high quality healthcare and greater access to social services. Moreover, many consider the city as a vector for development and poverty reduction. Nevertheless, the terms 'city' or 'urban area' are not homogenous, as most of the world's urban population are scattered in settlements that range from small towns and villages to 'mega-cities' whose populations are larger than many countries. Therefore, one can speak of a process of urbanization that can be sometimes rapid and inadequately managed, affecting the overall sustainable development. Apart from the cultural, social, economic or political 'mutations' that a process of chaotic urbanization can foster (and that can nonetheless be addressed through proper policies), the ones of environmental nature can sometimes be immeasurable and irreversible, affecting future generations. Some of the harmful outputs or outcomes where the process of urbanization can have a significant contribution can range from pollution and degradation to unsustainable production and consumption (of water, food, housing, clothing, heat, energy, consumer goods etc.).

The need for sustainable cities was recently stressed in the Rio+20 United Nations Conference on Sustainable Development, where it was considered of 'great urgency' for the United Nations development agenda (United Nations, 2012). The *status-quo* will soon be evaluated with the occasion of the 3rd United Nations Conference on Human Settlements (Habitat III), planned for 2016. Then, it is expected that the participating world leaders will review the global urban agenda proposing a new model of urban development which will better integrate all facets of sustainable development (economic development, social development and environmental protection).

Until then, it is up to the academics to raise awareness on the impact that cities, in their process of expansion, have on the present and future state of the environment (a need that was also identified and addressed by the researchers from the Integrated Centre for Studies in Environmental Science for the Northeast Region – CERNESIM). The complex environmental impact of cities requires a cross-cutting and interdisciplinary research approach and an in-depth assessment. A stepping stone in such an investigative venture is the current bibliometric analysis of the existing body of literature on the topic of "environmental impact of cities". The aim of such an endeavour is to identify the gaps, understand the focus and gauge the level of knowledge on the subject (assessing thus the importance of the subject in the academic environment). We hypothesize that there is a limited body of literature originating in the EU member states as compared to the performance of other countries/regions in the world (most works being produced in America and Asia).

To summarize, in our research, we have performed a bibliometric analysis to explore/estimate the overall level of knowledge that has been produced and



highlight current trends in the research developed on the topic of “environmental impact of cities” over the past two and a half decades. The paper is organized as follows: an overview of some theoretical underpinnings to better grasp the guideline and boundaries of our research, followed by considerations on the data and method employed in this research, the analysis and interpretation of the results and some conclusions as well as suggestions for future investigations.

1. Theoretical underpinnings

Whether they take the form of small towns (having slightly above 1 thousand people) or of ‘mega-metropolises’ (with more than 10 million citizens), cities are thought to be the cradle where the human ‘creative flame’ burns more brightly (well noted by Hall, 1998). It is in cities where drivers of economic, commercial, scientific, political, social, cultural or educational nature push forward the level of development and fuel the rural-to-urban migration.

Table 1. Various definitions of urban areas

Country	Definition of “urban”
Argentina	Populated centers with 2,000 inhabitants or more
Austria	Communes of more than 5,000 inhabitants
Canada	Places of 1,000 or more*
China	Cities designated by the State Council and other places with density of 1,500 or more per sq. km.*
Czech Republic	Localities with 2,000 or more inhabitants
India	Specified towns with governments and places with 5,000 or more and at least three-fourths of the male labor force not in agriculture*
Japan	Cities (shi) with 50,000 or more*
Mexico	Localities of 2,500 or more
New Zealand	Cities, towns, etc. with 1,000 or more
Norway	Localities of 200 or more
Peru	Populated centers with 100 or more dwellings
Romania	Cities, municipalities and other towns (as classified by administrative authorities)
Senegal	Agglomerations of 10,000 or more
United States	Places of 2,500 or more, urbanized areas of 50,000 or more*

Note: * in addition, there are other urban characteristics taken into consideration

Source: United Nations (2007)

Nevertheless, as mentioned earlier and as shown in the literature, the term ‘city’ or ‘urban’ is not a homogenous one. When referring to a city, usually glimpses of New York, Mexico City or London comes into one’s mind but these are merely the giants among urban settlements. In many countries, small towns and villages are home to a significant proportion of urban dwellers. Take, for example, the various interpretations of what ‘urban’ seems to be from different country perspectives (considering population size, population density and other urban



characteristics) and depicted by the United Nations Statistics Division in 2007 (see Table 1).

Urbanization is one of Earth's most powerful and visible anthropogenic forces, according to Dawson *et al.* (2009). This process refers to the general increase in the population of cities through migration from rural settlements, resulting in a tilt of the scale from a rural majority to an urban one. Nevertheless, urbanization is not a homogeneous process. If in the developed countries urbanization was often accompanied by an increase in welfare, this was not the case of developing countries. In the developing world, urbanization has experienced the fastest rate of growth concentrating in their cities 66% of the world's estimated 3 billion urban citizens. In 2007 there were 400 cities in the world with a recorded population of over 1 million; in 2015 the number reached 564, while in the immediate future, virtually all of the world's urban population growth will take place in developing countries (United Nations, 2007).

Although it is undisputed that urbanization has played, at least until now, an important role in the development and modernization of societies (be they developed or less developed), providing opportunities to improve one's quality of life, we cannot ignore the numerous environmental problems it causes, ranging from a local scale to a global one. The paradox is that although cities occupy only 4% of the Earth's land, they are accountable for the majority of environmental issues that we are dealing with today. As valuable and limited inputs go into the cities (in the form of natural resources, energy, water, wood, land etc.), long-lasting harmful outputs come out from them (in the form of wastes in solid, liquid and gaseous forms) jeopardizing the quality of life for future generations. We are aware of the fact that a city's environment cannot be isolated from its surroundings, but when today's decisions affect tomorrow's quality of life, be that ours or of our children, we cannot stand idle. As Martine (1996) argues, the extreme possibility, to 'stifle' urbanization, is not the right solution either: "...Nevertheless, it is fundamental to recognize that curbing urban growth is not the solution to either environmental or urban problems". Therefore, attention must be raised and all must be aware of the consequences of their decisions on sustainable development itself. We must better comprehend the role that our city plays in the surrounding environment. Non-marketable amenities such as green spaces, clean air, fresh water or temperate climate should not be the luxury of wealthier individuals, but a common good available intra- and intergenerationally regardless of one's wealth.

There are some papers that deal with the issue of the environmental effects of cities and/or urbanization but we doubt that these are enough to raise people's attention. Some of these papers deal with: land use patterns and their impact on the environment (Entwistle and Stern, 2005; Cui and Shi, 2012); the role of urbanization in creating air and water pollution (Cincotta and Engelman, 2000; Zheng *et al.*, 2011) and decreasing water supply (Liu and Diamond, 2005; Shao *et al.*, 2006); the dependence on nuclear plants, considered ecologically unsustainable (Saveanu and Ignat, 2014); local climate alteration and increased energy demands (Zhou *et al.*, 2004; González *et al.*, 2005); a major reduction in natural vegetation production and carbon storage/sequestration (Fang *et al.*, 2003; Yuan, 2008); as



well as many other studies that link urbanization and the environment (such as Arizpe *et al.*, 1994; Curran *et al.*, 2002; Dasgupta *et al.*, 2002). Other studies argue that the positive effects of urban expansion exceed any environmental negative outcomes (like White, 1996; Williamson, 1998; Bloom *et al.*, 2008), but their number is limited.

Within this context, we join the other observers that raise concerns about the impact of cities and urban growth on the environment (such as Montgomery, 1988; Foster, 2001; Kante, 2004; Newman, 2006; Chen, 2007; Bloom *et al.*, 2008; Li and Yao, 2009; White *et al.*, 2009; Martínez-Zarzoso and Maruotti, 2011; Zheng and Khan, 2013; Kahn and Walsh, 2014). To raise attention on the limited importance that is given to the topic of “environmental impact of cities”, within Europe, in academic circles we hereby present the results of a bibliometric analysis of the existing body of literature on the subject. To our knowledge, no such study has yet been performed in the form of a bibliometric analysis of EU and global research on the environmental impact of cities. We hope to contribute to the existing literature by providing a milestone on the current status of knowledge on the topic of “environmental impact of cities”.

2. Methodology

The bibliometric analysis (sometimes called ‘scientometrics’) was first introduced by Pritchard in 1969 in a study where he applied mathematical and statistical methods to books and other media of communication (Pritchard, 1969). Essentially, bibliometrics is the application of quantitative analysis and statistics to publications such as journal articles and their accompanying citation counts (Thomson Reuters, 2008, p. 3). According to Novais *et al.* (2012), while scientometrics is regarded as the measurement of both scientific and technical research activities, bibliometrics is considered as its subcategory, directing its attention towards the quantitative study of scientific publications for statistical purposes. Thus bibliometric methods serve the purposes of description, evaluation and scientific monitoring.

Before using the data provided by vast databases, bibliometrics had been the little known domain of librarians, sociologists and historians of science (Russell and Rousseau, 2002, p. 4). Nowadays, bibliometrics has its own journal (‘Scientometrics’) and its own international professional society (International Society for Scientometrics and Informetrics). According to Small (2003), bibliometrics is currently used to assess research performance and trends by investigating various publication characteristics, such as authorship, sources, subjects, geographical origins and number of citations.

We performed our bibliometric analysis by retrieving publication data from the Scopus database (one of the two large academic databases, along with Web of Science). We consider Scopus to best meet the needs of the current paper because, firstly, it considers all the research materials, irrespective of an eventual change of their ISI status (that can be associated with their indexation in Web of Science) and



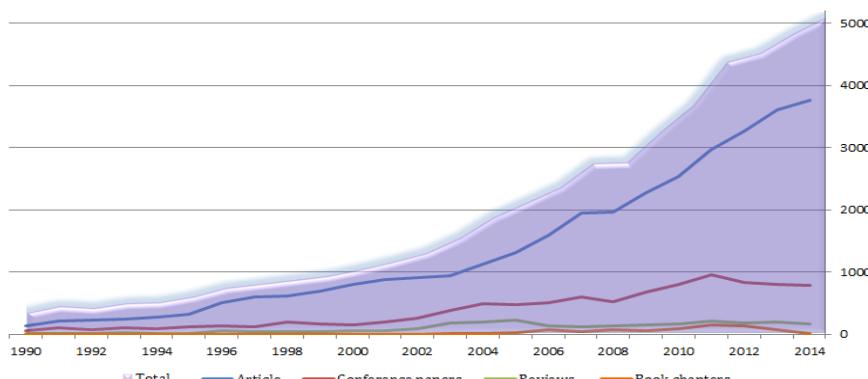
secondly, Scopus tends to be less restrictive regarding the accessibility of the publications, offering a more consistent pool of research materials.

In the academic search engine, we used the field “TITLE-ABS-KEY”, this retrieving the results referring to the publication title, abstract and keyword fields. When interrogating the database, we used the following query: TITLE-ABS-KEY (“urban*” OR “city” OR “cities”) AND TITLE-ABS-KEY (“effect\$” OR “impact\$”) AND TITLE-ABS-KEY (“environment*”) – thus measuring the frequency of appearance of these particular concepts. By using the asterisk (*) we allowed the search engine to look for concepts that contained the root specified plus any group of characters, including no character (for example, with “urban*” the program searched for: urban, urbanisation and urbanization, urbanize, urbanities etc.). Because there were few documents before 1990, we limited our time span from 1990 to 2014 (the most recent completed publication year at the time of writing). We accounted also for the singular as well as for the plural form of the categories (e.g. ‘city’ and ‘cities’, ‘effect’ and ‘effects’, ‘impact’ and ‘impacts’) by using the dollar sign (\$) – this represents zero or one character.

3. Results and discussions

At the time of data collection, the results of the query that meet the selection criteria reveal a total of 48,642 research materials within the 1990-2014 period, suggesting that there is a certain interest in performing research that deals with links between ‘cities’, ‘effect/impact’ and the ‘environment’. Moreover, as the indexation process is an ongoing one, the overall number of research materials for the 1990-2014 period is likely to increase. From the distribution analysis, 16 types of documents were found. The most-frequently used document type was the article (33,709) which comprised 69.3% of the total publications, followed by conference papers (with a number of 9,542 papers; a share of 19.6% of the total publications), reviews (2,504 reviews; 5.1%) and book chapters (760 chapters; 1.6%). The remaining type of publications show less significance and refer to conference reviews, press articles, books, notes, surveys, letters, reports and others (see Figure 1).

Figure 1. Evolution of the type of research outcome



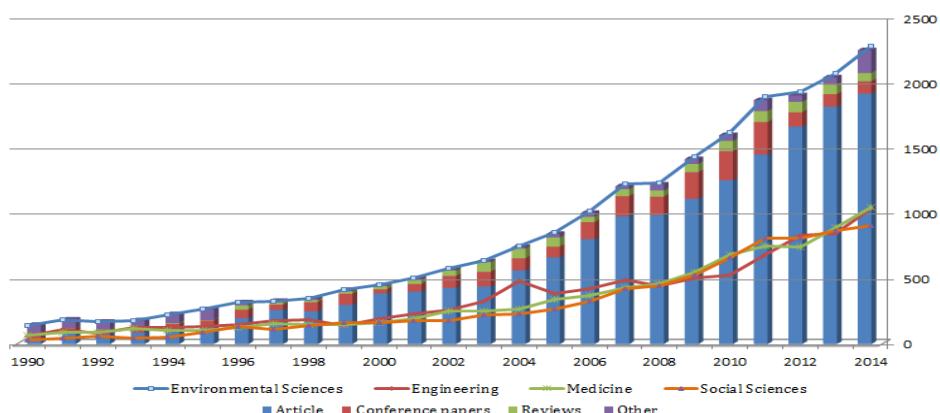
Source: Analysis based on data from Elsevier B.V. (2015)



Regarding the language of the research materials, English was by far the dominant language in the research performed (with 45,001 results), followed by Chinese (1,380), Spanish (546), French (517) and Portuguese (370).

As expected, Environmental Sciences was the most popular subject area with a total of 21,252 research materials (and a share of the total publications of 43.7%) followed by Engineering (9,113 research materials; 18.7%), Medicine (8,702 research materials; 17.9%) and Social Sciences (8,033 research materials; 16.5%). From a total of 148 research materials produced in 1990 to 2,295 research materials in 2014, Environmental Sciences has held primacy all throughout the study period, and was not exceeded by other study fields (see Figure 2). Within the results referring to the Environmental Sciences subject area, articles are by far the dominant type of research outcome (researchers find more convenient to publicize their research results in articles) – the majority of them being written in English.

Figure 2. Evolution of the research outcomes on the top four subject categories



Source: Analysis based on data from Elsevier B.V. (2015)

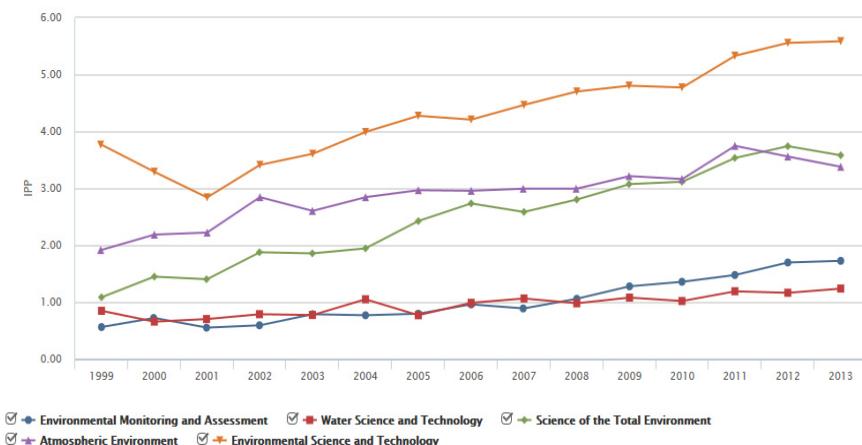
Scopus also revealed the most active journals producing research materials on the topic of “environmental impact of cities”. The most productive ten journals based on the total number of publications were: Science of the Total Environment (with 967 publications; representing 1.99% of the total publications), Atmospheric Environment (831; 1.71%), Environmental Monitoring and Assessment (722; 1.48%), Water Science and Technology (566; 1.16%), Environmental Science and Technology (473; 0.97%), Landscape and Urban Planning (393; 0.81%), Environmental Health Perspectives (386; 0.79%), Advanced Materials Research (375; 0.77%), Environmental Pollution (348; 0.72%) and Wit Transactions on Ecology and the Environment (299; 0.61%). Among these, only three journals revealed an IPP (Impact per Publication by year) greater than 1.00 over the entire analysed period (see Figure 3): Environmental Science and Technology (with an average IPP in 2013 of 5.596), Atmospheric Environment (IPP of 3.380) and Science of the Total Environment (IPP of 3.582). As for the total number of citations received by a journal in each year, Environmental Science and Technology was by far the dominant one (with a total of 113,370 citations in 2014), compared



to Atmospheric Environment (with 40,175 citations) and Science of the Total Environment (with 39,166 citations) in 2nd and 3rd place respectively. The same journals occupy the top three positions in the ranking based on normalized impact per paper by year (NIP): Environmental Science and Technology with an average NIP for 2013 of 2.049, Science of the Total Environment with a NIP of 1.730 and Atmospheric Environment with a NIP of 1.599.

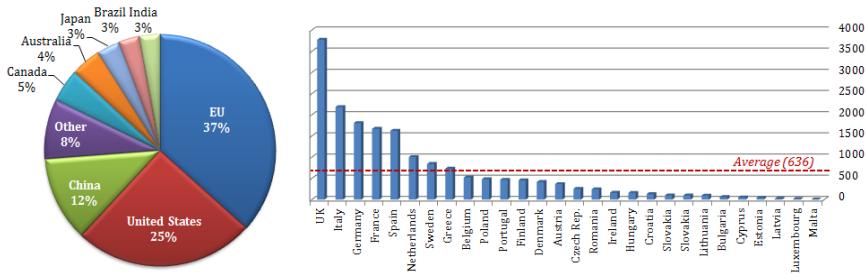
The total number of 48,642 research materials published from 1990 to 2014, covered 160 countries, of which 12,316 (25.32%) were published in USA, 5,768 (11.86%) were published in China, 3,774 (7.76%) in the United Kingdom, 2,226 (4.58%) in Canada and the remaining 31,333 research materials (totalling 64.4%) were published in other countries. With only 246 research materials on the topic (0.51%), Romania ranked 37th in the total number of publications. If we were to compare EU's total productivity in terms of research materials produced during 1990 and 2014, it ranks 1st, surpassing the United States, China, Canada, Australia, Japan, Brazil or India (see Figure 4). Nevertheless, with an average of 636 research materials per country, the EU falls far behind. Only eight states (UK, Italy, Germany, France, Spain, Netherlands, Sweden and Greece) are above the average productivity of the EU, compared to the remaining twenty bellow it. Thus, we can notice a lack of research productivity within EU on the analysed topic.

Figure 3. IPP for the most performant five journals



Source: Analysis based on data from Elsevier B.V. (2015)



Figure 4. The most productive countries in the world and within EU

Source: Analysis based on data from Elsevier B.V. (2015)

The United States lead the rankings based on the most productive authors – referring here to the first authored and corresponding authored research materials – (the most productive authors being Schwartz, J. with 91 research materials and Perera, F.P. with a number of 68 research materials) followed by the Netherlands (Brunekreef, B. – 49, Hoek, G. – 49) and Spain (Querol, X. – 48, Sunyer, J. – 47). Italy and UK followed behind these countries and ranked the 4th and 5th position in terms of all indicators (Forastiere, F. – 56 and Katsouyanni, K. – 49 respectively). China and Germany closed the ranking of top 7 places (with Yang, Z. – 46 and Heinrich, J. – 44 respectively). As for the affiliation of the research materials, the top five most productive institutions include the following: Chinese Academy of Sciences (with 510 research materials), United States Environmental Protection Agency (371), Harvard School of Public Health (309), Universidade de Sao Paulo – USP (305) and Peking University (289). Only 99 institutions produced at least 100 research materials on the topic.

4. Conclusions and future directions

Within this study we presented the results of a bibliometric analysis as a picture of the existing body of literature on the topic of “environmental impact of cities”. Thus we tried to grasp the level of knowledge that has been produced in the research developed on the above mentioned topic over the past two and a half decades. Some significant points on the worldwide research trends were obtained covering the period from 1990 to 2014. In total, 16 document types were found (articles dominated the portfolio with a share of 69.3% of the total publications) totalling 48,642 research materials. English was the dominant language on environmental impact of cities research (leaving far behind Chinese or some European languages such as Spanish or French). The results also showed that Environmental Sciences was the most popular subject area and kept its supremacy, over the other fields, all through the study period. Another interesting fact was that three main journals were identified as being the most productive, differentiating themselves from the other publications in terms of total number of publications, IPP, NIP and total number of citations received: Environmental Science and Technology, Science of the Total Environment and Atmospheric Environment.



USA was the most productive country in terms of research materials obtained over the analysed period. EU exceeded USA's productivity, but only after considering the research materials obtained by all 28 countries. Individually, the first EU country in the productivity hierarchy is the United Kingdom and it ranks in 3rd place after the United States and China followed shortly after by Italy. Romania ranked only 37th by the total number of publications. Professors and researchers from the United States, Netherlands and Spain are in front of the ranking while the first five most productive institutions are located in USA, China and Brazil.

As one can see from the remarks made above, the topic of "environmental impact of cities" is beginning to be more attractive for the academic circles as it appears in increasingly more materials. The results confirm our hypothesis that there is a limited body of literature originating in the EU member states as compared to the performance of other countries/regions in the world. Although no one can deny the leading positioning of USA and China research on the topic, EU comes strong from behind (more as a whole, then individually). When surveying the literature, we noticed that the topic regarding the quality of the environment and its development is becoming increasingly debated (in EU and worldwide). We believe that more focus is needed on researching the less explored problem of the impact that cities have on it, so we could adopt a more proactive/preventive approach rather than a corrective one *vis-à-vis* environmental damages that urbanization produces.

The result of this research opens for us new directions to investigate. Given the importance of the articles as vectors for disseminating the research results, we intend to fine-tune our bibliometric analysis by considering exclusively this document type. Also, as English was the dominant language within the research results and Environmental Sciences the most popular subject area, we intend to focus in our next study on articles that have these attributes. Subsequently, in the future, we intend to direct our research towards an in-depth assessment of the environment in its relation with the city (by employing a cross-cutting and interdisciplinary research approach). Specifically, our focus will gear towards the 'smart environment', as a component of the 'smart city'.

Acknowledgement: This study was realized using the research infrastructure of the Integrated Centre for Studies in Environmental Science for Northeast Region, CERNESIM, a project financed through the POS-CCE programme number 257/28.09.2010.

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