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How Does Regional Science Address Environmental Issues? A Bibliometric Analysis of Two Decades of Publications

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Abstract (231 words):

Using bibliometric methods, this paper is aimed at providing an overview of Regional Science publications that address environmental issues. The analysis covers a corpus of 1,145 articles that refer to the environment in their title, abstract or keywords and published in 18 journals between 1999 and 2020. Although these publications account for only 6% of the articles published in these journals over that period, their number gradually increased. To gain a clearer picture of the environmental issues addressed, we characterise them according to whether an integrative or topical approach is adopted and by their spatial dimensions. This analytical framework is first applied by searching for specific terms in their title, keywords and abstract. The results show that both approaches are equally effective; further, these articles address intraregional or interregional environmental issues more than global environmental issues. Second, we conduct a keyword co-occurrence analysis revealing four coherent thematic article groups treating environmental issues from the perspectives of amenities and migration, governance and policy, innovation and clusters, and land use and urban sprawl. More detailed analyses of each group allowed us to refine our understanding of how environmental issues were addressed. Finally, a cross-cutting view of the four thematic groups suggests that Regional Science approaches environmental issues through spatial disparities and inequalities, spatial interactions and interdependencies, and the spatial dimension of public action. The research perspectives in each of these areas are highlighted.

Keywords: Regional Science; Environmental issues; Bibliometric analysis; Literature review; Keyword co-occurrence analysis.

JEL: R10; R11; Q56

Introduction

Since its origin and since the seminal work of Walter Isard, Regional Science has addressed regional changes from an interdisciplinary perspective (Rose, Folmer, and Nijkamp 2014). At present, humanity is facing major environmental issues (e.g., climate change, increased risk of natural disasters, mega fires, drought, and biodiversity loss) with clear effects on regional growth and development. Moreover, as they are directly linked to human activities, the rise of these natural phenomena is increasingly calling for a profound transformation of production, consumption and flow patterns.

While these environmental issues are obviously global, they also call for changes in terms of regional development and raise specific questions at more local levels for several reasons. First, both natural resources and the abovementioned phenomena are inherently spatial. Second, cities and regions support growth based on the strong consumption of natural resources, the production of waste and negative externalities such as pollution. Third, environmental changes have economic and social consequences (e.g., inequalities in the exposure to pollution or environmental risks, fuel poverty), which are spatially inscribed. Finally, to use the expression that Donald and Gray (2019) borrowed from Massey (1979), if cities and regions are “part of the problem”, then they are also “part of the solution”. The regional and urban scales are relevant for both setting up responses to reduce impacts and for adapting to associated environmental issues (Gibbs and O’Neill 2017).

The environment can be understood, in a broad sense, as all neighbourhood features or, in a sense, as limited to the natural environment. Despite the high stakes and the relevance of a spatial and regional approach, issues related to the natural environment seem to be insufficiently addressed in Regional Science publications (Donald and Gray 2019). The Regional Science community is particularly attentive to this well-identified problem. Several Regional Science journals have published articles seeking to identify the reasons for this lack of consideration

and to consider the research perspectives on this topic. Among them, Bailey et al. (2020) question, in a constructive way, the capacity of Regional Science to respond to environmental crises. The above authors wonder whether the existing theories and concepts are adequate for explaining new realities or if new analytical frameworks are needed. They also wonder if Regional Science scholars are asking the right questions and looking in the right places to find innovative solutions for fostering more sustainable economic development.

The present article aims to contribute to hindsight on the evolution of papers in Regional Science and to better understand how they consider environmental issues. In the literature, several authors have presented fruitful narrative reviews to identify key issues in the Regional Science literature regarding the environment (Batabyal and Nijkamp 2004) and to identify the limits of this field (Bailey et al. 2020 ; Donald and Gray 2019). Following a complementary approach, our aim is to provide a systematic overview of the main environmental issues that are addressed, as well as the ways that they are addressed, by articles in Regional Science journals published over a period of 20 years. We propose the application of an analytical framework that categorises environmental issues according to both the adopted approach and the considered spatial dimension. Using bibliometric methods, we analysed 1,145 articles that had been published in 18 leading Regional Science journals over the period of 1999 to 2019, covering the period before the COVID-19 crisis. First, a general overview of the entire corpus of articles is constructed. We describe our sample of articles using current bibliometric indicators. In line with our analytical framework, we identify the importance of the different approaches and types of environmental themes on the basis of specific terms or expressions searches in the titles, keywords and abstracts. The results show that both approaches are commonly taken in the articles, and that the sustainability theme is predominant. We also observe that the articles deal much more with intraregional or interregional environmental issues than with regional environmental issues that are directly linked to global issues. Second,

we conduct an analysis of keyword co-occurrences, revealing four coherent thematic groups. The first two groups address environmental issues, where the first group deals primarily with the themes of natural amenities and migration and the second group deals primarily with governance and policy. The third group focuses on innovation, clusters and districts, and the final group deals mainly with those environmental issues linked to land use and urban sprawl. In the third step, within each group, a specific bibliometric analysis based on a more detailed reading of the top 25% of references and on cocitations was conducted to refine our focus of the core literature streams and of the research fields.

This article is divided into four sections in addition to this section. Section 2 provides a brief literature review on the consideration of environmental issues in Regional Science and presents our analytical framework. Section 3 describes the methods used. Section 4 presents the results of the analysis performed on the whole sample of articles, describes the content of the four thematic groups identified and discusses the results. Based on a transversal reading of these four groups, Section 5 identifies three specific ways in which Regional Science approaches environmental issues and suggests possible directions for future research.

Brief Literature Review and the Analytical Framework

The Natural Environment in Regional Science

The natural environment has been addressed in Regional Science from an early stage, as evidenced by the extensions of the regional economy models proposed by Isard (1972) to include the relationship between economics and ecology. Beyond their interest in the fields of Regional Science, for many, these seminal works constitute major contributions to both environmental and ecological economics (Cumberland 1995; Rose, Folmer, and Nijkamp 2014). In the late 1970s, Richardson (1978) considered the natural environment, viewed primarily in terms of amenities and natural resources or in terms of pollution as a factor limiting regional growth, to be at the heart of the avenues to be explored in Regional Science. Since

then, the environment, taken in a broad sense, has been the subject of numerous works in Regional Science. Many of the environmental topics identified by Richardson (1978) have been addressed in Regional Science publications, both theoretically and empirically (Batabyal and Nijkamp 2004). Among them, two types of work can be distinguished based on literature reviews.

On the one hand, some related research has been focused on specific environmental topics related to Regional Science questions. Thus, some studies have examined, among other factors, the influence of natural environmental features (e.g., landscape, amenities, disamenities) on location choice, land use and property values (Batabyal and Nijkamp 2004). Others have dealt with environmental externalities. These studies are focused on the environmental impacts of regional human activities (Goodchild et al. 2000 ; Macleod 2014) or on the industrial location and composition of regions (Batabyal and Nijkamp 2004). Adopting such a local or regional perspective, other works consider both natural resources (e.g., water, forest) and waste from the perspectives of type of use (e.g., productive use of natural resources, waste recycling), location or optimal management on one hand, and from the perspective of the most appropriate scale of intervention on the other (Batabyal and Nijkamp 2004). A wide range of related research has been conducted on environmental policies and their effects on regional economic activities, the most efficient tools (or combinations of tools) for achieving this and the relevant scale (Batabyal and Nijkamp 2004). Climate change has also been the subject of some Regional Science studies that focus on the regional differences in GHG emissions and their determinants and on regional mitigation policies (Batabyal and Nijkamp 2004).

On the other hand, other research has adopted a more holistic and integrating approach, placing emphasis on regional and urban dynamics, to the study of environmental issues. First, this includes a wide range of work on sustainable development. Indeed, this notion has given rise to numerous studies on the measurement and state of regional sustainable development, the

interdependence between sustainable development and natural resources, the transformations occurring in certain sectors (e.g., food, forest, tourism) and the design and effects of regional sustainable development policies (Batabyal and Nijkamp 2004; Truffer and Coenen 2012). Second, numerous insights in Regional Science are related to the notion of sustainability transitions. With little study prior to the 2010s, the spatial dimensions of this process have increasingly come under consideration in works on sustainability transitions (Truffer and Coenen 2012), which primarily attempt to explain how and why such transitions are similar or different in different places (Hansen and Coenen 2015; Köhler et al. 2019).

Constraints on the Integration of Environmental Issues in Regional Science

Despite the extent of this growing body of literature, several authors have claimed that the spatial dimension of transitions is largely ignored (Truffer and Coenen 2012; Hansen and Coenen 2015) and, more broadly, that the integration of environmental issues in Regional Science remains insufficient given the current stakes (Isserman 1995; Donald and Gray 2019; Goodchild et al. 2000). The reasons can be found in the fundamental questions raised by Bailey et al. (2020): is Regional Science asking the right questions and looking in the right places? Do the existing theories and concepts in Regional Science adequately explain new realities? Do existing policies and frameworks help (or hinder) cities and regions?

For Donald and Gray (2019), the difficulty faced by regional scientists in responding to the current environmental crisis mainly lies in the excessive prominence that is given to economic growth, in research questions, theories and resulting policy recommendations. Thus, these authors believe that Regional Science too often prioritizes the pursuit of regional growth at the expense of sustainable, equitable and just development. These authors also point out that Regional Science does not necessarily look in the right places, as it overly focuses on regional “success stories” (e.g., Silicon Valley), particularly those in the innovation domain, or develops a biased vision of regional growth, thus highlighting the more positive aspects of these stories

and obscuring the less praiseworthy aspects (e.g., environmental damage). Finally, Donald and Gray (2019) argue that by assuming unlimited growth and increasing consumer needs, regional growth theories fail to address the finite dimension of environmental resources. By challenging the prevailing paradigm of economic growth, the current environmental crisis is disrupting. Such a challenge calls the nature of the future economic vision of these regions into question and advances a range of options that represent the breadth of interpretations of what a “green economy” can be, from a clean-tech economy to the economic notion of “degrowth” (Gibbs and O'Neill, 2017).

In particular, Regional Science could be more effective at addressing climate change issues and especially at addressing mitigation strategies. The debate in Regional Science seems to have shifted from whether the environment is being degraded by resource exploitation to a discussion about the best ways to adapt to an already degraded environment. Environmental science scholars, on the other hand, have been exploring ways to rearrange both society and the economy to better foster sustainability (Donald and Gray 2019).

The Potential of Regional Science for Tackling Environmental Issues

Although major authors have pointed out the lack of research in Regional Science on current environmental issues, they also stress the relevance of this field in addressing such issues. This stems first from the fact that cities and regions are not only part of the problem but rather are also part of the solution. On the one hand, the increase in population, production and consumption within cities and certain regions can contribute to climate change and thus constitute a threat to the future natural resource base of our planet (Batabyal and Nijkamp 2004). Thus, environmental issues originate at a regional or local level. They may also have extremely significant local economic and social consequences, even in the case of global climate change. On the other hand, solutions to these environmental problems, even when they are global, partly

call for concerted action on the part of regional and local authorities (Batabyal and Nijkamp 2004). In terms of environmental policies, the regional scale is often particularly relevant due to local knowledge and the ability to fine-tune policies (Hansen and Coenen 2015). Research in transition geography clearly shows that local and regional areas can serve as experimental targets. This shows that environmental issues are closely linked to both the development of cities and regions and to their policies and strategies. Such research also raises specific questions at the local or regional level that echo those at the heart of Regional Science (in particular, disparities, interactions and governance).

Regional Science is also well positioned for addressing environmental issues because of its concepts, intellectual tradition, skills and tools, which can assist in the consideration of the complex spatial relationship between human activity and the environment (Isserman 1995; Donald and Gray 2019). Interdisciplinary by nature, Regional Science belongs to an open-minded intellectual tradition. Historically shaped by both geography and economics, it has been extended to include more institution-based approaches (Batabyal and Nijkamp 2004). Goodchild et al. (2000) called for a new step in which Regional Science can more closely collaborate with environmental science to better account for the regional differences in human-induced climate change or, more broadly, to document and explore new institutions, policies and processes that are related to environmental issues. Furthermore, Regional Science provides a multiscale perspective through which regional scholars can apprehend both bottom-up and top-down solutions. Such scholars can discuss localisms within a broader framework (regional, national or global). These skills are highly valuable for tackling multilevel environmental and transition issues. Finally, with an emphasis on practical action and a focus on the questions posed by public stakeholders, Regional Science relies on the skills needed to conduct large-scale empirical studies supported by georeferenced data, advanced statistical and econometric methods, and grounded community work. The combination of these different skills provides

both a refined, contextualized understanding and a more generalized knowledge of the relevant processes. Therefore, the Regional Science research field and methodology appear to be particularly adaptable for addressing complex and cross-cutting environmental issues such as climate change (Goodchild et al. 2000).

A Spatial Characterization of Environmental Issues

To better identify the way in which Regional Science publications address environmental issues, we propose a categorization that is based on both the approach adopted and on the spatial dimension of the environmental issues under consideration. The above literature review highlights two main approaches to environmental issues that are commonly taken in Regional Science: a holistic and integrative approach and a topical approach. Specifically supported by the notion of sustainability, the former addresses environmental issues mainly through the lens of regional development and transition strategies and policies. The latter places greater focus on specific environmental topics, with particular attention given to the environmental effects of human activities and human-induced change.

In the topical approach, environmental issues can be distinguished according to their spatial dimension, the fixed or mobile nature of the environmental resource concerned, or the correspondence between the spatial dimensions of the cause and the impact of the environmental or human effect. Following Turner et al. (1990), we distinguish among three types of human-induced environmental change according to their regional dimensions. The first category is intraregional environmental change, which is produced in a region by human activities occurring in that region. It is related primarily to fixed environmental components (e.g., a loss of plant species or a lowering of the groundwater table). The second category is inter- or transregional environmental change, which is produced in one or more regions by human activities or dynamics occurring in another region or other regions and constitutes

regional externalities. This type of change is based on moving and circulating environmental components (e.g., river contamination by upstream activities and air pollution diffusion). The distinction between intra- and interregional is, of course, relative. The assignment of an environmental issue to one or more of these two categories depends on the location and spatial scale of the change produced and the source of the change. However, this also depends on the dimension of the region under analysis. The higher the level of spatial analysis (e.g., continental or national scale) is, the more that the phenomena are internal to the region. For these two categories, environmental change occurs on regional scales. However, cumulative global change can also occur when either it is duplicated in many other areas (e.g., local losses of plant species contributing to global biodiversity loss) or when it affects a high proportion of a global resource beyond a certain threshold (e.g., deforestation).

Following Turner et al. (1990), the third category refers to regional-global change, where human activities located within a region or a set of regions directly contribute to systemic global change (e.g., greenhouse gas emissions). The Turner et al. (19990) classification is focused on the pathways associated with human-induced environmental change. As the analysis of environmental issues in Regional Science also concerns the influence of the natural environment on human activities, these three categories must be sufficiently enlarged for integrating the interactions between human activities and the environment that occur in both directions. For instance, intraregional environmental issues also cover the effect of regional natural amenity endowments on the location of human activities. Thus, a fourth spatial category of environmental issues can be added as a counterpart of the third. Global-regional environmental issues concern those situations in which global change can, via local phenomena, impact regional human activities (e.g., natural disasters) and they vary by regional characteristics.

Methodology

By analysing articles published in Regional Science journals over the 20 years prior to the COVID-19 crisis, our aim was to provide an overview of the main environmental issues addressed and to identify the way in which they were dealt with (i.e., main themes, core literature strains, disciplinary approaches). To this end, we opted to apply the bibliometric analysis method.

Selection of the Bibliometric Approach

Before the 1990s, the synthesis of the existing work on a specific subject and of the results obtained was most often achieved through a narrative literature review. Based on a detailed analysis of the content of the related publications, this method allows for the specification of the concepts used, the mechanisms and processes identified and the results obtained. This method remains largely predominant. Nevertheless, this approach can only cover a relatively small number of selected publications. As a response to the strong increase in the number of publications and the volume of information available, two other bibliographic approaches, namely, meta-analysis and bibliometrics, have appeared. Based on statistics and econometrics, these methods enable the processing of a larger amount of information than does a narrative literature review (Stanley 2001). Meta-analysis is used mainly to compare the results obtained by different studies on a specific question for which there is no consensus, enabling the analysis of the effect of different parameters (e.g., study context, methodology, and publication characteristics) on the results obtained. By construction, this method compares empirical works that utilize quantitative analyses.

Bibliometrics emerged at the beginning of the 20th century but has developed exponentially since the 1960s, first driven by research evaluation dynamics and then by the broader use of science analysis favoured by the dissemination of bibliometric techniques and tools (Rostaing 1996 ; Hertz 2003). Based on the application of statistical or mathematical methods to bibliographic data, bibliometric analysis enables a summary of the bibliometric and intellectual

structure of a research field through an analysis of the relationships among bibliographic constituents (e.g., authors, countries, institutions, and topics) (Donthu et al. 2021). Few works in Regional Science have applied bibliometric methods. Among them, Rey and Anselin (2000) and Suriñach et al. (2003) provide in-depth overviews of the research published in Regional Science journals between 1990 and 2000. Other authors use bibliometric methods to review works on a particular approach, such as evolutionary economic geography (Zhu, Jin, and He 2019), or on a specific notion, such as regional innovation systems (Fernandes et al. 2021). At the same time, some papers present bibliometric analyses considering the environment through concepts such as the green economy (Loiseau et al. 2016) or the circular economy (Goyal, Chauhan, and Mishra 2021), but without limiting themselves to the fields of Regional Science. Similarly, based on a bibliometric approach, our work lies at the interface between these two entries and combines Regional Science and environmental issues.

Methodological Steps

Selection of journals and papers. The first methodological step consisted of the selection of articles for bibliometric analysis. Following Suriñach et al. (2003), we first established a list of Regional Science journals. We selected those journals included in both the Econlit database and one or more of the following Web of Science categories: geography, regional and urban planning, and urban studies. This step allows us to identify multidisciplinary journals integrating the main disciplines in Regional Science. Within the resulting list, we restricted our selection to those journals whose titles or *Aim and Scopes* explicitly referred to the notions of region, regional growth or regional development. Ultimately, we selected a list of 18 journals (Table 1). Among all their publications, our analysis focused on articles¹ published over the period 1999–2019 that addressed both environmental and regional development issues. These articles were drawn from the Web of Science database and selected by applying search equation

¹ We limited our research to original articles and excluded "reviews" to avoid biasing the cocitation analyses.

crossing terms in the titles, keywords or abstracts that were close to “environment” (“ecology*,” “environmental,” “sustainab*,” “natural,” and “nature”) on the one hand and to “regional development” (“region*,” “growth,” “development,” and “location”) on the other hand.

The choice of the terms used in the search equation is one of the difficult tasks of a bibliometric approach, as these terms must capture the intended idea as well as possible. In our case, being polysemous, the terms “environment” and “nature” generate considerable noise. Following a back-and-forth process between the results obtained and the query design, we progressively rectified the search equation to reduce the presence of inconsistent references². To test the relevance of our sample of articles, we also verified its robustness to inclusion of some particularly important environmental topics, such as pollution, biodiversity, climate change, energy, water, and waste. This test revealed that our base search equation captured the vast majority of articles that could have been retrieved using an equation containing a longer list of environmental terms. Insofar as the inclusion of each of the specific terms are open to discussion, we opted for a simpler search equation based on generic environmental terms. In the end, we retained a corpus of 1,145 references whose bibliographic data were imported into Cortext Manager³ and treated with this platform.

Table 1. Distribution of selected articles across 18 journals (1999–2019)

[Table 1]

² In the final search equation, we kept the terms “environment” and “nature” unchanged only in the keyword search and replaced them with the terms “environmental” and “natural”, respectively, in the title and abstract search. We also excluded some terms, such as "natural experiment" or "built environment," from the research equation.

³ Cortext Manager is a data analysis platform developed by LISIS Unit (Marne-la-Vallée, France) that proposes a set of modelling and exploratory tools for analysing text corpora: <https://www.cortext.net/projects/cortext-manager/>.

Overall analysis and positioning of specific environmental themes To provide an overall picture of the corpus, we first analysed all the selected articles using current bibliometric indicators (e.g., annual evolution in the number of articles and citations and distribution of journal titles over the period). In line with the spatial classification of environmental issues that is presented in the analytical framework section, we also sought to identify the place of integrative and thematic approaches and, in the latter case, the spatial types of environmental issues addressed (intraregional, interregional, regional-global, or global-regional). To this end, we identified sixteen specific environmental themes from our first literature review.

As noted in the analytical framework section, the boundary between the intraregional and interregional categories is relative insofar as it is partially dependent on the spatial scale used for the analysis. Distinguishing between regional-global and global-regional categories solely on the basis of theme identification can be difficult, as some of these categories can encompass both directions of causality (e.g., climate change). Therefore, the intraregional and interregional categories and the regional-global and global-regional categories are treated together.

Among the sixteen environmental themes, thirteen fall under a topical approach. Nine relate to intraregional or interregional environmental issues, which can contribute to cumulative global change. These include natural and extractive resources; amenities and disamenities; forest; land; biodiversity; waste; energy; air pollution and quality; and water (including both water pollution and water quality). The other four topics are directly linked to global environmental issues and fall within the regional-global or global-regional environmental issue categories. They are ecological footprint, climate change, greenhouse gas emissions, natural hazard and disasters. Finally, we sought to identify where more integrative approaches to environmental issues had been taken through the appearance of three themes: green growth (or the green economy), sustainability and transition.

For each of these themes, we searched for the presence of one or more associated terms (Appendix 1) in the abstracts, titles, keywords provided by the authors and Keywords Plus⁴ of the articles, and we thereby identified related articles. The categorisation presented in this article is neither complete nor exclusive. Indeed, some articles may not include any of the searched environmental themes. Conversely, some articles may cover several environmental themes simultaneously.

Identification of thematic groups. In the second step, to complete this initial approach to the environmental issues covered, we carried out a keyword co-occurrence analysis to distinguish among thematic subsamples within our large corpus of articles. Taking a bibliometric approach, co-occurrence analysis enables us to identify the links between bibliographic data from the association (or co-occurrence) of the different items of a categorical variable (i.e., keywords, authors or cited references). When based on keywords, co-occurrence analysis aims to identify the main concepts addressed, characterize the links between them and highlight groups of keywords used together (Donthu et al. 2021).

In our case, we based our co-occurrence analysis on both the keywords provided by the authors and Keywords Plus. After a phase of keyword harmonization and reindexing, 3,883 keywords were identified, more than 71% of which appeared only once in all the articles in our sample (e.g., soil), while the most commonly used keyword (e.g., cities) appeared 200 times. Thus, we restricted our analysis to the 339 keywords that occurred at least five times⁵. Keyword co-occurrence analysis classified these keywords into four different thematic groups that are

⁴ We have considered both the keywords provided by the authors and the “Keywords Plus”. These are generated automatically by a Web of Science algorithm and correspond to words or phrases that appear frequently in the titles of the cited references. While the author keywords are more comprehensive in representing the content of an article, “Keywords Plus” are particularly suitable for bibliometric analysis to study the knowledge structure of scientific fields (Zhang et al. 2016).

⁵ To determine the threshold for the number of keyword occurrences, we carried out several sensitivity tests and compared the number of references classified, the number of groups obtained and their sizes according to the threshold. The choice of a 5-occurrence threshold results from a trade-off between having as many classified references as possible and having a relevant number of thematic groups (and in particular not very small groups).

relevant from a Regional Science perspective. Afterwards, we used one of the Cortext Manager features, based on comparisons among the keywords of each paper in our sample and the keyword composition of each of these groups, to assign each paper to the group whose keywords were most similar to its own. In the end, we were able to match 1,085 of the 1,145 articles in our sample to one of the thematic groups. However, sixty of these articles, corresponding to 5% of the total number of articles, remained unattributed⁶.

Analysis of thematic groups. In the third step, we analysed and compared each of the four thematic groups. To gain a better understanding of the environmental issues addressed in the different thematic groups, we first analysed the distribution of the articles containing the sixteen environmental themes according to the four thematic groups, and we then identified those that were significantly overrepresented in each group. Next, to refine our understanding of the way in which environmental issues were addressed in these articles, we conducted specific analyses on each of the thematic groups. Dividing our initial sample of 1,145 articles into four thematic groups led to smaller, coherent sets of articles. Therefore, we were able to combine automatic analyses with qualitative analysis. We first examined in greater detail the top one-fourth of publications in each thematic group. Our selection criterion was the number of citations of the articles. To prevent older publications from being overrated, we ranked the articles according to the average number of citations per year rather than according to the total number of citations over the period. This more in-depth reading of 25% of the articles within each thematic group gave us a clearer picture of disciplinary fields, research questions, and analytical methods. To identify the research traditions to which each group belonged, using Cortext Manager, we completed a qualitative analysis through a cocitation analysis that was conducted on every

⁶ The results of the keyword co-occurrence analysis are very sensitive to the parameterization of Cortext Manager. Indeed, the parameters can modify the number of groups identified within the network and their content in terms of keywords and references. Therefore, we performed a series of parameterization tests to check the robustness of the groups.

article in the group. This type of bibliometric analysis relies on articles' bibliographic sections and aims to identify groups of cocited works. The underlying idea is that the groups of cocited documents constitute the core literature strains or “founders” of the research field (Lazzeretti, Capone, and Innocenti 2017). Once these groups of seminal works have been identified, it is possible to also identify the articles in the thematic group that refer to them the most.

Results

Overview of Environmental Issues in Regional Science Publications

Evolution of the number of articles and citations. A total of 1,145 articles out of the 18,500 articles published between 1999 and 2019 in the selected Regional Science journals referred to the environment in their title, abstract or keywords, representing 6% of the total number of articles and an average of 55 published articles per year across all journals in our sample. This number of articles fluctuates from year to year (Figure 1). Nevertheless, this number tended to increase over the sample period, from approximately 25 articles per year in the first 5 years to approximately 81 articles per year in the last 5 years. Moreover, the average number of citations per article already published increased strongly over the sample period (with a clear inflection in 2016), reflecting the expansion of this field of research.

[Figure 1]

Figure 1. Evolution of the number of articles and citations (1999–2019)

Distribution across journals. Over the 1999–2019 period, the selected Regional Science journals published an average of 64 articles on the environment. However, these publications are unevenly distributed among journals. *Environment and Planning A*, *Urban Studies* and *Regional Studies* are the three main journals in this field, publishing 243, 190 and 142 articles,

respectively, from our sample and accounting for half of the articles (Table 1). These variations across journals are partly due to differences in publication volume. Indeed, these three journals published more articles in general than did the other journals over the period 1999–2019. Considering the relative contributions of these journals, articles dealing with the environment are overrepresented, not only in the *Environment and Planning A* and *Growth and Change* but also in the *Economic Geography*, *International Regional Science Review* and *Cambridge Journal of Regions, Economy and Society*.

Positioning of specific environmental topics. The search of the titles, keywords and abstracts for the terms or expressions associated with each of the sixteen specific environmental themes enabled us to identify one or more environmental themes addressed by 864 of the 1,145 articles in the sample (75.5%). The analysis of these articles showed that they cover a wide range of environmental themes. Both integrative and topical approaches were taken, and they were used in 42.4% and 47.8% of articles, respectively. Regarding the first approach, sustainability is a particularly important theme and appears in the abstract, title or keywords of 454 of the articles, i.e., 39.6% of the overall corpus (Figure 2). Transition and green growth/green economy are much less common, accounting for 7.7% and 1.0%, respectively, of the articles in the corpus. Regarding the topical approach, in their title, abstract or keywords, the articles refer more to intraregional or interregional environmental issues (547 references) than they do to regional environmental issues that are directly linked to global issues (123 references). Among the identified intraregional or interregional categories, the most frequently cited topics are land (19.6%), amenities and disamenities (15.7%), energy (9.2%) and water (6.1%) (which includes 1.1% of the corpus articles dealing with water pollution and quality issues). Regarding regional environmental issues that are more directly linked to global issues, climate change (6.6%) and natural hazards and disasters (3.1%) are more frequently mentioned

in the title, keywords and abstract than are GHG emissions (2.1%) or the ecological footprint (0.3%).

[Figure 2]

Figure 2. Frequency of the main environmental themes in the sample

Keyword Co-occurrence Analysis Results

Identification of thematic groups. A relational map⁷ enables us to visualize the keyword network structure given by the keyword co-occurrence analysis (Figure 3). Based on their most prominent keywords, the four thematic groups identified are “Amenities and Migration”, “Cluster and Innovation”, “Politics and Governance”, and “Sprawl and Land Use”. The map shows that the four thematic groups are well identified but also intertwined, reflecting the porous nature of the boundaries between them.

[Figure 3]

Figure 3. Keyword co-occurrence map and thematic groups

“Politics and Governance” and “Amenities and Migration” are the two most important thematic groups, accounting for 31% and 30%, respectively, of the classified keywords and 41% and 28%, respectively, of the assigned references (Table 2). The group “Politics and

⁷ The more occurrences there are of the keyword in all articles, the larger it is on the map. Moreover, the more strongly that two keywords are associated, the shorter the line linking them. Keywords close to each other are gathered in a group. The resulting keyword networks are symbolized by different colours.

Governance” is based mainly on keywords related to both cities, politics (i.e., policy, politics, and governance) and environmental issues (i.e., environment, sustainability, and climate change). The terms associated with the environment are less prominent for the “Amenities and Migration” group, whose main keywords are growth, model, market, agglomeration, urbanization, migration and location. As its name suggests, the thematic group “Cluster and Innovation” is structured around those keywords related not only to innovation, networks, knowledge and clusters but also to geography, performance and regional development. The thematic group “Sprawl and Land Use” is based mainly on keywords related to land use (i.e., sprawl, density, and patterns) and to mobility (i.e., transport and health).

Table 2. Thematic group features

[Table 2]

The relative position of the groups changed little over time (Appendix 2). Nevertheless, the predominance of “Politics and Governance” has gradually increased since 2008. Conversely, the predominance of “Amenities and Migration” has decreased since 2008, bringing it closer to the third position of “Clusters and Innovation”.

Distribution of specific environmental themes according to the four thematic groups. The importance of the thematic groups varies greatly by whether an integrative or thematic approach is adopted or from one environmental theme to another (Figure 4). The integrative approach is present in all of the groups, but the “Politics and Governance” group is strongly overrepresented. To be more precise, the shares of this thematic group in the articles referring to sustainability, transition or green economy and green growth are 55.9%, 65.2% and 63.6% respectively, and that share is 38.7% of the entire corpus. The relative importance of the four groups in the environmental themes considered to fall under the topical approach varies

depending on whether these themes concern intraregional or interregional environmental issues or regional environmental issues that are directly linked to global issues. The “Politics and Governance” thematic group is overrepresented in the works referring to global issues. This is particularly true for articles relating to climate change, 92.0% of which are classified in the “Politics and Governance” group. Among all the articles that refer to intraregional or interregional environmental issues, “Sprawl and Land Use” thematic group was overrepresented (with a share of 14.3%, compared to 11.0% for the corpus as a whole). However, within this category, the distribution of thematic groups varies according to the environmental topic. More precisely, the “Amenities and Migration” thematic group, which accounts for 26.9% of the articles in the corpus, is overrepresented in the articles that refer to air pollution and quality (72.4%), water pollution and quality (46.2%), amenities and disamenities (42.8%), or natural and extractive resources (38.3%). The “Politics and Governance” and “Sprawl and Land Use” groups are overrepresented in articles that relate to energy and land, respectively, with shares of 53.3% for the former (compared with 38.7% for the whole corpus) and 24.6% for the latter (compared with 11.0% for the whole corpus).

[Figure 4]

Figure 4. Distribution of the environmental themes by thematic group

Description of the Content of Each Thematic Group

A qualitative analysis was conducted on the top one-fourth most cited articles, and the cocitation analysis involved all the articles, thus enabling us to move beyond this first comparison and refine our vision of the content of each thematic group.

Amenities and Migration. The qualitative analysis confirmed that this thematic group specifically deals with intraregional or interregional environmental issues and specifically considers amenities and disamenities and natural and extractive resources. Taking a disciplinary focus in economics and using mainly quantitative methods of analysis, most of the articles in this group account for the environment as a factor in the location of economic agents on a regional scale. Thus, the main theme focuses on the analysis of natural amenities as a determinant of households' residential location choices. The typical article seeks to evaluate the link between a natural amenity, used as a proxy for environmental quality (climate, lakes or wetlands, open spaces, etc.), and quality of life, attractiveness and, at the end, population growth in a given regional or local area (Winters and Li 2017), sometimes using spatial econometric tools to grasp the specific effect of this variable. The dependent variable is most often demographic; it can also be an indirect measure of the valuation of natural amenities through land or real estate prices. Amenities are considered a key determinant of household location choices, sometimes against traditional factors, such as employment, prices and wages, public goods and services, transport infrastructures or social interactions (Partridge 2010). Some environmental disamenities (waste, mines, environmental risks, etc.) are the subject of specific papers.

Some articles reflect the fact that the location of firms is, in practice, less directly sensitive to amenities and environmental variables than is that of households. In most cases, these variables play a role only in the medium or long term through factor prices, depending on the structural transformation of the labour and land markets. However, some activity sectors are directly sensitive to environmental quality, either as a professional environments (green employment) or as settings for temporary populations (tourism). In most articles, the importance of historical and factorial features is to be put into perspective with the effects of market potential and interactions that produce agglomeration or urbanization economies.

Nevertheless, economic activities are not dissociated from the environment, and their impact is assessed through, in particular, air pollution and, more generally, the link between growth and the environmental state formalized by the environmental Kuznets curve (Rupasingha et al. 2004).

Finally, in this group, the land market is rarely analysed on its own but often underpins analyses on local natural or urban amenities, the effects of public policies or, more broadly, the effects of quality of life on location. Moreover, some papers address the labour market. However, such papers are mostly disconnected from environmental amenity issues and rather focus on regional differences in unemployment and productivity. However, amenities are taken into account to explain the location choices of highly skilled workers or the elasticity of the wage rate (Schmidt and Courant 2006).

Cocitation analysis reveals that the articles in this thematic group mainly reference three bodies (Appendix 3a): one is devoted to mobility and migration issues (Tiebout 1956 ; Graves 1980 ; Roback 1982), a second is devoted to the more general analysis of the geography of growth and a third is devoted to methodological issues (Lucas Jr 1988 ; Krugman 1991), containing more technical references related to the hedonic pricing method (Rosen 1974) or to spatial econometric tools (McMillen 2010).

Politics and Governance. This second thematic group differs greatly from the others in terms of both disciplinary and methodological approaches. Maintaining a perspective on political science, sociology, geography or urban planning and using mainly qualitative methods, these articles adopt an integrative approach to environmental issues (e.g., sustainability, transition and green growth) or deal with global environmental issues (e.g., climate change). In particular, three major research themes stand out.

The first theme addresses with governance in relation to environmental issues, focusing on the interactions between stakeholders. Among these studies, Adger (2003) shows the role of social capital and communities' ability to act collectively in their adaptation to climate change. Local initiatives, stakeholder interplay and civic participation take a central position in these works and are often carried out in an urban context. These case studies sometimes highlight real urban laboratories, experimenting with new forms of governance that promote, amongst other issues, low-carbon economies (Evans and Karvonen 2014). Stakeholder interplay is considered not only from the positive angle of collective action but also through the role of stakeholders in conflicts of use (Lombard and Rakodi 2016).

The second theme addresses with public policies and their links with environmental issues, including the study of climate policy implementation by local and regional authorities. For instance, Sharp, Daley, and Lynch (2011) show that interest group pressure, political institutions and problem severity play a role in a city's decision of whether to develop climate protection programmes. The effects of policies are considered from more of a qualitative perspective, and few studies in our sample offer quantitative evaluation of the impact of public policies.

The third theme offers a critical examination of urban planning and development. In these articles, an in-depth examination of the sustainability conditions for urban development is conducted. The objects studied are diverse, ranging from urban projects as a whole to transport infrastructure, energy or sewage networks, or urban parks. Moreover, some articles contribute to the debate on smart cities (Vanolo 2014). Other articles address urban form in relation to energy consumption (Holden and Norland 2005) or stress the potential implications of low-carbon urbanism and urban densification in terms of social segregation (Rousseau 2015). In general terms, such articles suggest ways in which to renew urban planning in response to ecological imperatives.

Cocitation analysis reveals that the articles in this group refer mainly to three sets of seminal works (Appendix 3b). The first deals with urban governance and the role of public participation, specifically drawing on the founding work of Molotch (1976). The second body of work addresses urban development with particular attention given to the processes of the segregation and privatization of public space (Graham and Marvin 2001). Finally, the third body of work addresses political ecology and ecological modernization (Hajer 1995).

Cluster and Innovation. Mainly based on economics or geography, this thematic group addresses environmental issues and the green economy specifically through the innovation dynamics of firms, the relationships between firms (regardless of geographic proximity) and regional development. Concerning firms' environmental innovation dynamics, some articles address this issue at the individual level. Thus, O'Neill and Gibbs (2016) seek to analyse the motivations of "green" entrepreneurs and the tensions that may arise between their activities and their environmental aspirations. However, the main focus is on the influence of regional factors, regional innovation systems and institutional context on innovation dynamics in general and on environmental innovation in particular. The latter is often seen as a key element in transitions towards more sustainable regional development (Truffer and Coenen 2012).

A substantial body of articles on interfirm relations that addresses this question at both the intraregional and interregional levels is also contained in this group. In the first case, the notions of clusters or industrial districts are central. These works describe the organization of clusters or analyse the influence of certain characteristics (e.g., the environmental sensitivity of its members) on the functioning of the network (Panzer-Krause 2019). One work focused on the performance of clusters and their effect on system sustainability. Industrial ecology or industrial symbiosis approaches renew the analysis of these local relationships and are considered complementary to the cluster and industrial district concepts. Following Gibbs, Deutz, and Proctor (2005), the industrial ecology approach enables us to better address sustainable

development issues. Other works analyse interfirm relationships on a larger scale, focusing on global production networks (e.g., oil and gas), their organization and governance, their impact on global markets such as energy, or their effect on socioeconomic development (Bridge 2008).

Finally, this thematic group also treats environmental issues through an integrative approach and, in particular, through the issue of sustainable regional development. Some articles provide food for thought on the very notion of sustainable development, notably by adopting an interdisciplinary approach (Adger et al. 2003). These articles focus on certain determinants of sustainable development, such as the progression of sharing economies favoured by new technologies, the evolution of individual behaviour or the evolution of some sectors of activity, the latter of which may involve the evolution of traditional sectors (e.g., tourism) towards greater sustainability or the emergence of new industrial pathways, often related to the bioeconomy (e.g., water recycling/desalination) (Binz and Truffer 2016). By adopting a more dynamic approach, works on development trajectories often consider regional diversification as a necessary condition for the transition to a more sustainable form of development (Boschma et al. 2017). Finally, some works consider that the relatively recent emergence of the notion of territorial resilience has opened up new research perspectives in Regional Science and on regional dynamics (Martin and Sunley 2015).

The results of the cocitation analysis are consistent with these themes and effectively distinguish four subsets of seminal works (Appendix 3c). The first addresses the effect of the socioeconomic environment on regional and urban development through the notions of agglomeration and urbanization economies (Jacobs 1969 ; Krugman 1991) and that of resilience (Martin 2012). The second subset of related work focuses on the notion of clusters and the analysis of interfirm relationships (Porter 1990). The third subset addresses the influence of the environment and interfirm relations through the notion of industrial ecology (Grabher 2002).

Finally, the fourth subset of related work addresses the issue of interfirm relationships from the perspective of global production networks (Henderson et al. 2002).

Sprawl and Land Use. Taking approaches mainly based on geography or economics and using mostly quantitative analysis, the studies in this thematic group are focused on intraregional or interregional environmental issues, particularly in regard to land use. The most cited one-fourth of the “Sprawl and Land Use” articles address three main themes. The first theme focuses on urban growth and city forms and includes works aiming to better characterize urban sprawl and different resulting urban configurations using comparative approaches (Schneider and Woodcock 2008). The methodological objective is to provide spatial metrics that better capture urban morphology, to better qualify the influence of cities on land use and to analyse their effects on the natural environment, greenhouse gas emissions (Zhao, Lu, and de Roo 2010) or flood risks. This situation raises the question of the sustainability of compact cities compared to that of sprawling cities. Bramley et al. (2009) showed that compact forms do not systematically win on all dimensions of sustainability and that greater environmental sustainability can be achieved at the expense of social sustainability.

Household mobility and transport are the second component of this thematic group. Environmental sustainability is then indirectly addressed via household mobility behaviours. These behaviours depend not only on household characteristics but also largely rely on the geographical context. For instance, Hasanzadeh, Laatikainen, and Kytta (2018) propose a methodology for identifying the local spaces in which individuals’ activities are located. At the interface of this theme and the previous theme, many articles analyse the effect of urban forms, the degree of urbanization, and the built environment on the choice of alternative transport modes and household mobility. This influence is inscribed in the relatively long term of planning policy. Mobility behaviour largely relies on household alternatives regarding transportation modes and the spatial configuration of transit infrastructure (Houston et al. 2015).

Among geographic characteristics, environmental attributes play an important role in determining mobility and residential location choices. The link between amenities and residential location is at the heart of the third major body of work. Some articles aim to measure and map access to different types of amenities, such as urban parks. The influence of green amenities on residential location choices depends partly on the level of household sensitivity to environmental issues. Considering household socioeconomic differentiation also reveals that natural amenities are one of the factors explaining the return of the most favoured social categories to urban centres (Florida and Adler 2018). Differences in residential location according to social or ethnic categories are drivers of environmental inequalities, which may be related not only to access to natural amenities but also to unequal exposure to pollution or industrial risks (Downey 2007).

Cocitation analysis reveals that the articles in this thematic group rely mainly on four different groups of seminal works (Appendix 3d). The first group is focused on accessibility and its measures (Handy and Niemeier 1997) as well as mobility and the determinants of household travel (Ewing and Cervero 2001) on the other hand. Following Alonso (1964), the second group addresses urban sprawl and discusses its determinants, policy tools and the measures that can be taken to manage it. The third group, which is more focused on urban forms and the opposition between compact and sprawling cities, differs from the two previous groups in that it has a more normative dimension (Gordon and Richardson 1997). Finally, the fourth group addresses inequality, segregation and environmental justice (Pastor, Sadd, and Hipp 2001).

Discussion

This work provides an overview of the way in which the research in Regional Science accounts for environmental issues. This study has several limitations. First, we focus on research in Regional Science. Following Suriñach et al. (2003), we choose to approach this domain through

the publication of articles and to exclude other types of publications to achieve a certain degree of homogeneity. We also identified these articles from a list of journals considered in the field of Regional Science. Although rigorous, this journal selection has the potential to introduce publication bias into our analysis by giving more weight to journals with a greater focus on environmental issues than to others (e.g., *Environment and Planning A*). Moreover, this journal-based approach does not allow us to detect articles belonging to Regional Science that may have been published in other fields, such as ecological economics, development economics, transportation or public policy. Another difficulty stems from the polysemous character of the notion of the environment. We choose to establish a query for the selection of articles based on a small number of terms and then test the robustness of the clustering in thematic groups to the integration or deletion of certain terms in the query⁸. We could have built a more complex selection query and introduced other terms to capture the natural environment (e.g., climate). Nevertheless, the choice of relevant terms is far from trivial and would require the establishment of an ontology of the notion of the environment oriented towards the social sciences, which is a work in and of itself. Finally, bibliometric analysis makes it possible to establish a general map of the themes addressed and of the core literature strains in the publications analysed. However, such an approach cannot provide a detailed analysis of the definitions used, the research questions, the results, etc. Therefore, we could pursue this work with a more refined analysis of a subsample of publications on, for instance, economic growth or transition and climate change. Despite these limitations, our analysis provides insights into the role of environmental issues in Regional Science publications and suggests directions for future research.

Avenues for Regional Science Research on Environmental Issues

⁸ Robustness tests were carried out to analyse the influence of the introduction of specific environmental terms in the search equation on the number of references identified, on the one hand, and on the thematic groups resulting from the keyword co-occurrence analysis, on the other.

In light of our analysis, articles in Regional Science integrate environmental issues in extremely variable ways and to a greater or lesser degree. In many cases, the concepts relating to the environment are used in a very broad sense. In these cases, concepts of the environment or sustainability are sometimes addressed in their socioeconomic (i.e., institutional context and neighbourhood features) but not ecological dimensions. Likewise, the adoption of specific terms from the environmental sciences, such as ecology or symbiosis, can help approach certain aspects of regional development from an original angle while failing to systematically address environmental issues. Nevertheless, the articles in which environmental issues take a more central position show that Regional Science publications approach these concerns from a particular angle and through the use of specific questions designed to open up new avenues of research.

Spatial Disparities and Inequalities

The spatial disparities and inequalities resulting from economic and political changes are central to Regional Science. Our analysis highlights the fact that Regional Science has also largely considered how the natural environment influences regional disparities (and vice versa).

Following a topical approach and maintaining alignment with the historical literature on comparative advantages, natural factors have traditionally been part of the explanation of the differences in regional specialization and growth. The articles in our sample place particular emphasis on the role of these factors in location choices in terms of both amenities (e.g., quality of the proximate natural environment) for households and natural resources (e.g., extractive resources, forests) for firms. Mostly fixed, these amenities and natural resources lead to intraregional environmental issues. However, they may also involve interregional relations via location choice and mobility. The effects of environmental factors are addressed in terms of not only natural advantages but also disadvantages when the presence of people or firms affects the integrity of natural endowments (i.e., pollution, stock depletion, and waste). In the current

context of climate change, the consequences of the degradation of natural resources and the increase in natural hazards constitute major issues. These issues raise numerous questions that can be better addressed by Regional Science, both concerning their influence on regional dynamics and disparities and the influence of regional differences on their adaptive capacity.

Regional economic and social disparities are largely dependent on land use patterns and especially on urban forms. Considering environmental factors in the field of urban planning has been progressive but steady, as the impact of these factors on property values and the evolution of the real estate market were identified early on. The advantages in terms of the size and functional specialization of large monocentric cities are still largely stressed because of the strength of agglomeration economies. However, these advantages are being increasingly questioned by the introduction of negative environmental externalities in the analysis. These advantages remain under discussion, particularly in terms of social optimums and sustainability, by certain studies with a focus on the analysis of urban forms, insofar as they condition the organization of transport, greenhouse gas emissions and quality of life linked to the environment. The link between agglomeration and the environment is far from obvious. The impact of compact versus sprawling urban forms on sustainability remains unclear and requires further work. This question can be extended to a wider scale to account for the influence of agglomeration on the environment (e.g., GHG emissions) at a regional scale, which is in line with issues of interurban mobility and regional planning.

Some Regional Science articles take more integrative and dynamic approaches. These studies focus on endogenous forms of innovation that promote green growth, sustainable development and transition mechanisms and involve the whole regional system and its future. The main question addressed is whether there are differences in innovation, sustainability and transition across regions, especially due to location-based factors. More broadly, sustainable development issues addressed at the regional level use traditional analytical tools dealing with

regional differences in terms of conditions of production, exchange and consumption. Although Regional Science is increasingly addressing sustainable transition, additional research (especially empirical research) could enable us to better characterize transition dynamics and understand how spatial and regional features affect these dynamics. Additional works, particularly by means of multicriteria analyses, would also help us evaluate the transition results and sustainability.

Regional Science works have always paid particular attention to socioeconomic inequalities. In our corpus, a growing body of empirical work addresses the issue of exposure to climate change and natural disasters, as well as to hazardous emissions from human activities, particularly in an urban context and in relation to social segregation processes. However, environmental inequalities within and between regions as well as how they combine with other forms of inequalities are still marginally addressed in Regional Science and mainly in an urban context. However, these issues are becoming increasingly diverse and important (e.g., energy poverty). As they are linked to key spatial aspects, these issues would benefit from further study within the scope of Regional Science, particularly in the dimension of environmental justice.

Spatial Interactions and Interdependence

Our analysis shows that Regional Science research also addresses environmental issues through the examination of spatial and regional interactions, with a particular emphasis placed on intraregional interactions.

In works on regional internal interactions, three levels of consideration of the environment can be distinguished, characterized by increasing degrees of integration and originality. At the first level, in the tradition of the industrial district and cluster literature, the analyses focus on market and nonmarket interactions between firms. Integrating the environment, these works examine the way in which interactions between companies can promote the environmental sustainability of the productive system, sometimes emphasizing the decisive influence of the

personality and high degree of environmental sensitivity of certain key entrepreneurs. In a vision that is also fairly classic in Regional Science, the notion of clustering allows us to understand the interactions within a system that is larger than that with just the companies alone (e.g., companies, universities, and institutions). Through analytical methods and a framework at the nexus of relational and institutional analysis, this work highlights how local interactions and the constitution of regional innovation systems foster the development of green technologies. These traditional approaches focus mainly on the economic efficiency of interactions and the logic of “coopetition” between firms. At the second level, some works in Regional Science aim to better understand the interactions between human activities and natural ecosystems. In the tradition of Leontief input–output analyses, extended to environmental resources in particular by Isard et al. (1968), these works seek, for example, to determine the direct appropriation of ecosystems by industries and households, as well as its indirect effects. At the last level, the integration of environmental issues in Regional Science is coupled with the appropriation of certain concepts derived from life sciences. Thus, some works in industrial ecology treat improvement capacities in industry through a systemic approach in which the processes of waste production and the companies themselves are linked. From the perspective of the circular economy, the aim of the analysed system is to minimize material and energy losses in the whole system (and not by each company individually).

Unfortunately, the contributions advanced by the relatively recent notions of industrial ecology or symbiosis remain primarily conceptual. However, their application through empirical analysis poses two difficulties: a lack of data and a small number of cases. Although these concepts contribute to an increasing integration in Regional Science of the complexity of interactions and interdependencies within regions, developing empirical studies, for instance, on the regional determinants of industrial ecology and the circular economy (e.g.,

agglomeration effects), represents a major challenge given the need to preserve limited natural resources and reduce waste.

Current environmental issues also lead to an increasing reconsideration of highly globalized exchanges and may contribute to the development of relocalization movements. Several analyses in Regional Science have been developed to better understand the process of relocating of activities. However, these works focus mainly on governance issues and the coordination of local actors and deals, more specifically, with food systems and the development of short food supply chains. As in a circular economy, the relocalization of industrial activities raises specific questions about internal flows within regions and interactions and even interdependencies between regions and calls for the development of new research in Regional Science.

Spatial Dimension of Public Action

As far as public action is concerned, the contributions to Regional Science that are identified in our analysis take both integrative and topical approaches and cover intraregional, interregional and globally linked environmental issues. They are shown to cluster around two main points.

The first point concerns the scale of intervention. Public action can address environmental issues at different scales of intervention, depending on the extent of local public goods or localized externalities. The main difficulties addressed are those of choosing the right scale, depending on the extent of local public goods, and ensuring consistency between scales of action and links between local authorities. Here, the contributions of local public economics can better account for both horizontal (i.e., between jurisdictions of the same level) and vertical (i.e., among hierarchical levels of jurisdiction) externalities in environmental public action.

The second point concerns the trade-off between top-down and bottom-up public intervention. For a long time, public policies considering environmental issues and applied at

the regional or local level were mainly designed at the national level and conceived in a top-down manner. In line with the increase in the number of place-based policies since the 1990s (e.g., European Union cohesion policy, development zone programmes in China), Regional Science's view of how public policies should take environmental issues into account has been partially reversed and now follows mainly a bottom-up approach. Given the spatial dimension of natural goods and phenomena, the integration of environmental issues has historically posed the problem of adapting public policies to the local context and now further raises the challenge of designing and implementing local strategies (tailor-made policies). Promoted in part by an increase in the responsibilities of local authorities, the development of local skills and knowledge and the improvement of observation tools, this evolution concerns both intraregional and interregional environmental issues (e.g., water quality management at the catchment basin level) and global issues (e.g., regional greenhouse gas emissions reduction strategies). It also reinforces the need for regional policies to integrate spatial externalities into their objectives, mechanisms and implementation. However, the corpus of articles analysed points to the difficulties faced by public policies in adapting to the changes underway and the need for new insights, particularly in a multidimensional urban context.

In addition, we are currently experiencing a profound renewal of public action, particularly in terms of environmental issues. Over the past decade, an increasing number of publications have highlighted diverse and mixed forms of public action, combining local citizen action or policies based on local experiments. This shift calls for new research to gain a new perspective on these novel practices to further understand their conditions of emergence and their social, economic and environmental effects and to improve their evaluation.

Concluding Remarks

In the end, the number of articles published on environmental issues is relatively modest (6%) compared to the overall number of publications in the field of Regional Science. Most of these publications remain fairly standard in terms of their scope and methods. Nevertheless, the number of Regional Science articles that address environmental issues increased over the study period and then continued to grow, as confirmed by articles published between 2020 and 2023, after the COVID-19 crisis. Moreover, these articles cover a broad range of environmental issues and show that Regional Science approaches these concerns from a particular angle and through specific questions. The breadth of these works also reinforces the idea that given not only its interdisciplinary, multiscalar and applied approach but also the analytical skills on which it relies (i.e., a combination of quantitative and qualitative tools and methods), Regional Science seems particularly relevant for tackling environmental issues. Beyond the work already achieved, the greater consideration of environmental issues (particularly those directly linked to global change) opens up numerous avenues for research in Regional Science. These avenues could contribute to a renewed analysis of spatial disparities and inequalities, spatial interactions and interdependence, and the spatial dimension of public action. Ultimately, the integration of environmental issues into Regional Science works may elucidate the possible regional transition paths and lead to the rethinking of the very notion of region by simultaneously integrating biotic and anthropic factors.

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Tables

Table 1. Distribution of the selected articles across 18 journals (1999–2019)

| Journals | Number of published articles | Number of articles in the sample (%) | Ratio |
|---|-------------------------------------|---|--------------|
| <i>Annals of Regional Science</i> | 1,113 | 62 (5.4%) | 5.6% |
| <i>Cambridge Journal of Regions, Economy and Society</i> | 328 | 26 (2.3%) | 7.9% |
| <i>Economic Geography</i> | 345 | 28 (2.5%) | 8.1% |
| <i>Environment and Planning A</i> | 2,737 | 243 (21.2%) | 8.9% |
| <i>Growth and Change</i> | 609 | 53 (4.6%) | 8.7% |
| <i>International Journal of Urban and Regional Research</i> | 1,284 | 83 (7.3%) | 6.5% |
| <i>International Regional Science Review</i> | 371 | 30 (2.6%) | 8.1% |
| <i>Journal of Economic Geography</i> | 643 | 32 (2.8%) | 5.0% |
| <i>Journal of Geographical Systems</i> | 272 | 20 (1.8%) | 7.4% |
| <i>Journal of Regional Science</i> | 734 | 45 (3.9%) | 6.1% |
| <i>Journal of Urban Affairs</i> | 715 | 43 (3.8%) | 6.0% |
| <i>Journal of Urban Economics</i> | 1,071 | 25 (2.2%) | 2.3% |
| <i>Papers in Regional Science</i> | 881 | 41 (5.4%) | 4.7% |
| <i>Real Estate Economics</i> | 579 | 6 (0.5%) | 1.0% |
| <i>Regional Science and Urban Economics</i> | 1,135 | 38 (3.3%) | 3.3% |
| <i>Regional Studies</i> | 1,904 | 142 (12.4%) | 7.5% |
| <i>Urban Affairs Review</i> | 706 | 38 (3.3%) | 5.4% |
| <i>Urban Studies</i> | 3,075 | 190 (16.6%) | 6.2% |
| TOTAL | 18,502 | 1,145 (100.0%) | 6.2% |

Table 2. Thematic group features

| | Politics and Governance | Amenities and Migration | Clusters and Innovation | Sprawl and Land Use | All |
|---|---|---|--|--|--------------|
| Number of Keywords | 104 | 101 | 79 | 55 | 339 |
| Top 10 Keywords (Number of occurrences) | Cities (1,041) Policy (701) Politics (615) Governance (600) Sustainability (466) Environment (396) State (313) Space (258) Economic development (251) Climate change (234) | Growth (679) Model (379) Impact (320) Agglomeration (264) Migration (209) Market (186) Location (176) Urbanization (165) Trade (154) Quality (152) | Geography (482) Innovation (419) Networks (357) Knowledge (319) Dynamics (269) Ecology (254) Economic geography (227) Regional development (185) Clusters (180) Performance (162) | Land use (251) Sprawl (142) Mobility (107) Density (104) Health (97) Neighbourhood (95) Behaviour (93) Transport (88) Inequality (86) Patterns (83) | |
| Main Journals (Number of articles) | <i>Environ. Plann. A</i> (136) <i>Urban Stud.</i> (98) <i>Int. J Urban Reg Sci</i> (71) <i>Reg Stud</i> (41) <i>Urban Aff. Rev</i> (27) | <i>Ann. Reg. Sci.</i> (37) <i>J Reg. Sci</i> (33) <i>Reg. Stud.</i> (33) <i>Growth & Change</i> (32) <i>Reg. Sci. Urban Ec.</i> (30) | <i>Reg. Stud.</i> (51) <i>Environ. Plann. A</i> (46) <i>Econ. Geogr.</i> (17) <i>Urban Stud.</i> (15) <i>J Econ. Geogr/Camb. J Reg. Econ. Soc</i> (14) | <i>Urban Stud</i> (39) <i>Environ. Plann. A</i> (24) <i>J Reg. Sci.</i> (9) <i>J Urban Aff.</i> (8) <i>Int. Reg. Sci. Rev.</i> (7) | |
| Proportions of classified articles | 443 (41%) | 308 (28%) | 208 (19%) | 126 (12%) | 1,085 (100%) |

Figures

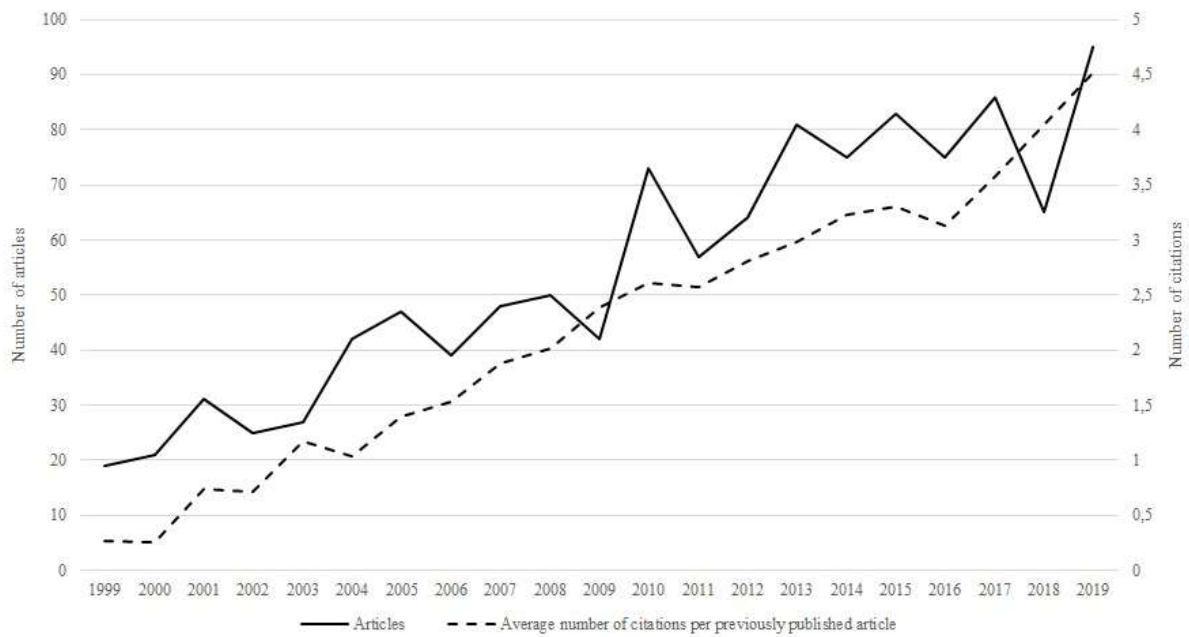
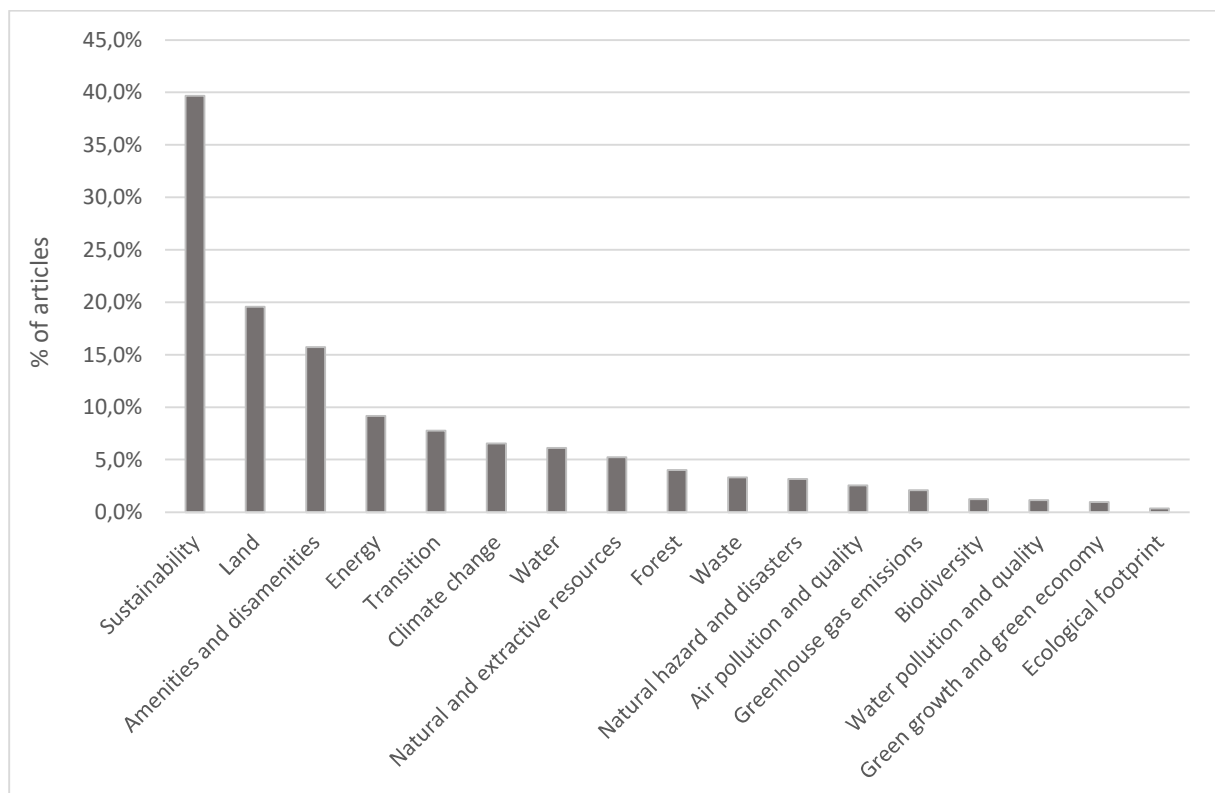
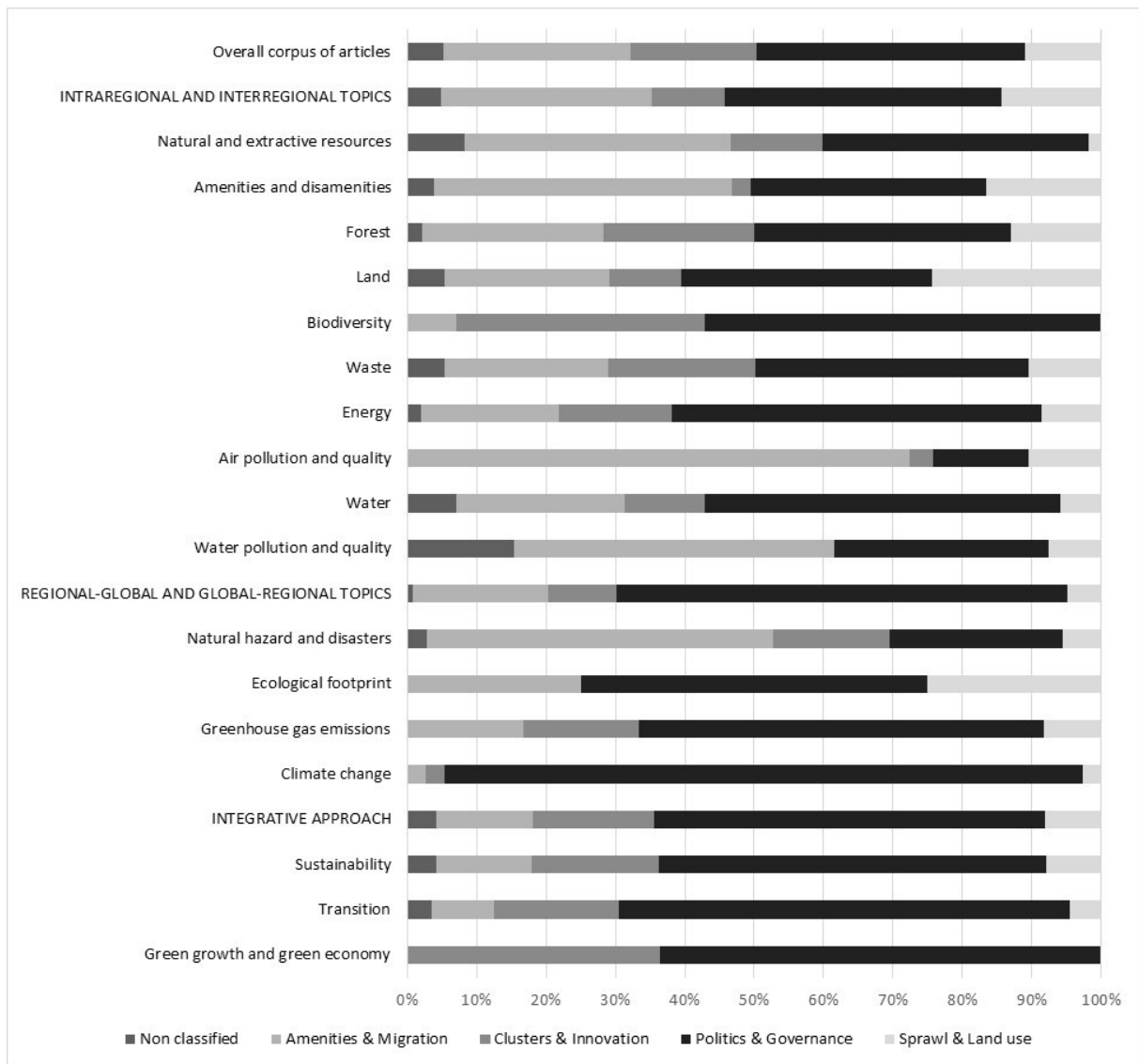


Figure 1. Evolution of the number of articles and citations (1999–2019)



Reading note: Terms related to natural and extractive resources are mentioned in the title, abstract or keywords of 4.5% of the articles in the corpus.

Figure 2. Appearance frequency of the main environmental themes in the sample



Reading note: Among the articles that mention sustainability in their title, abstract or keywords, 5% are nonclassified, 13% are classified in the “Amenities and Migration” group, 19% in the “Clusters and Innovation” group, 54% in the “Politics and Governance” group and 9% in the “Sprawl and Land Use” group.

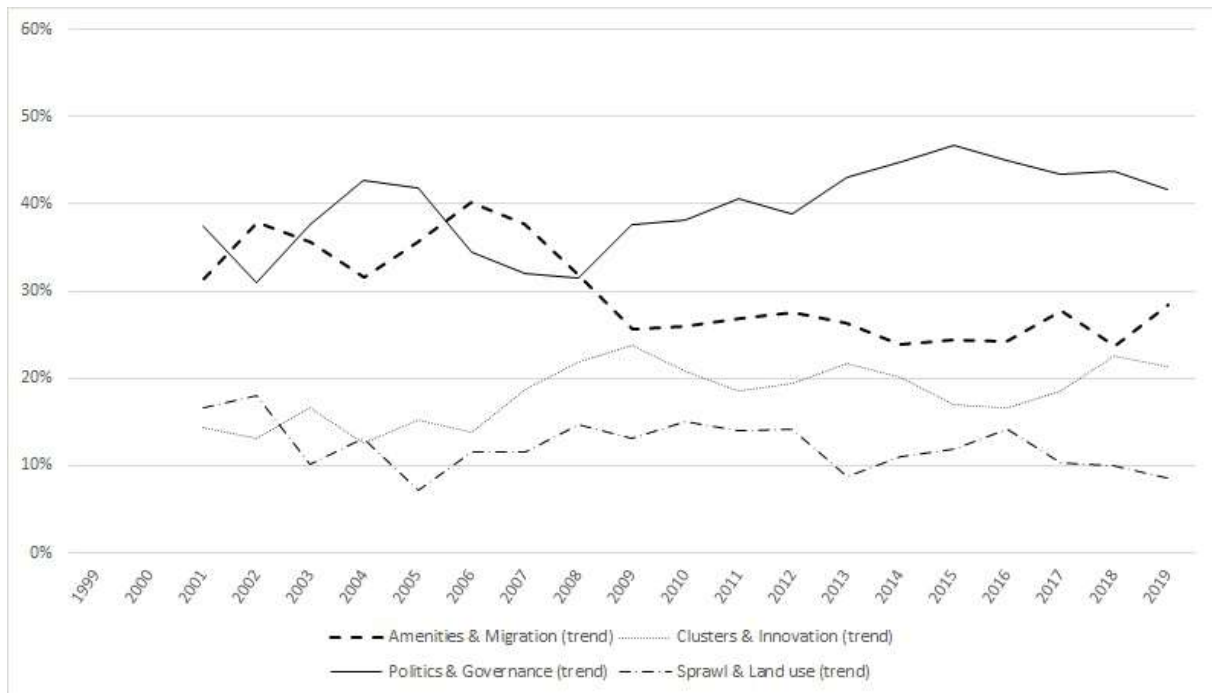
Figure 4. Distribution of the environmental themes by thematic group

Appendices

Appendix 1. Environmental topics search terms

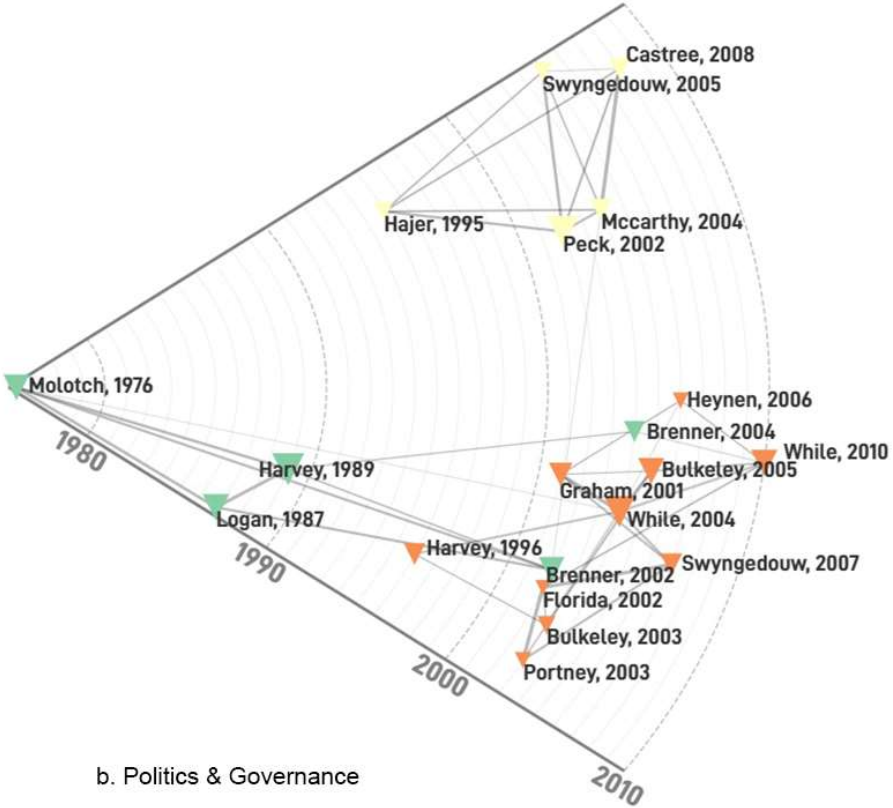
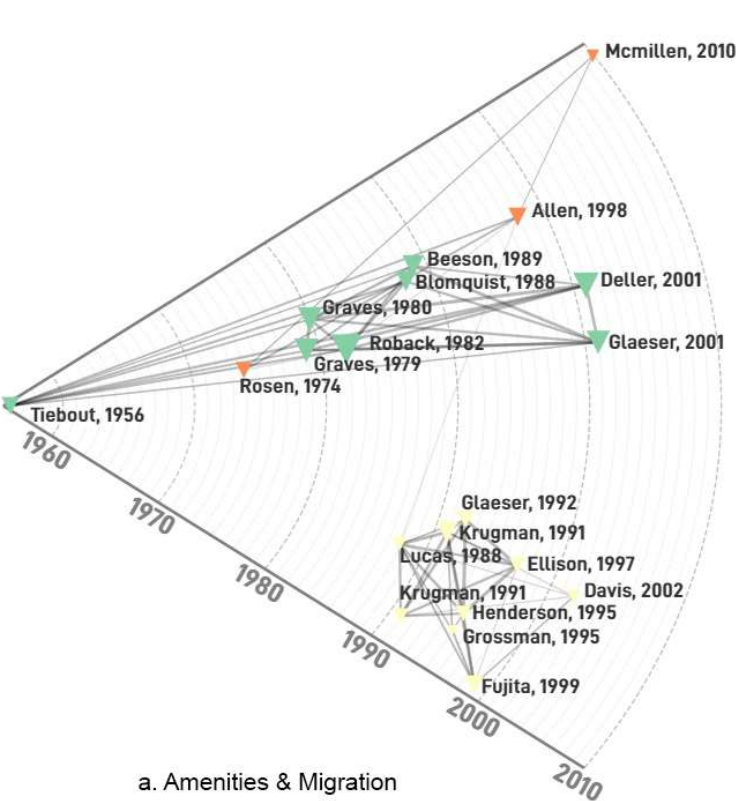
| Environmental topics | Search terms or expressions |
|---|---|
| Topical approach | |
| <i>Intraregional and interregional environmental issues</i> | |
| Natural and extractive resources | natural resource OR natural resources mining OR (mine AND resource) OR mineral |
| Amenities and disamenities | amenit* OR landscape OR noise |
| Forest | forest* OR deforest* |
| Land | land |
| Biodiversity | biodiversity |
| Waste | waste |
| Energy | energ* |
| Air pollution and quality | air AND pollution OR air quality |
| Water, including: - Water pollution and quality | water - water AND pollution OR water quality |
| <i>Regional-global and global-regional environmental issues</i> | |
| Ecological footprint | ecological AND footprint |
| Climate change | climat* AND change |
| Greenhouse gas | greenhouse |
| Natural hazard and disasters | natur* AND hazard OR disaster |
| Integrative approach | |
| Sustainability | sustainab* |
| Transition | transition |
| Green growth and green economy | green growth OR green economy |

Appendix 2. Evolution of article distribution across thematic groups (1999–2019)

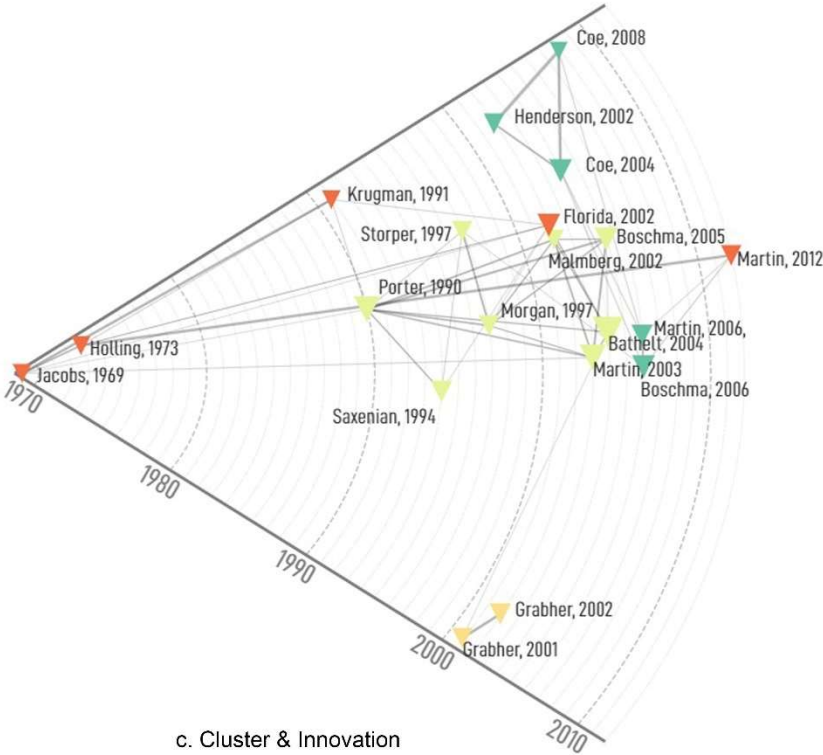


Note: Trend lines corresponding to the three-year moving average.

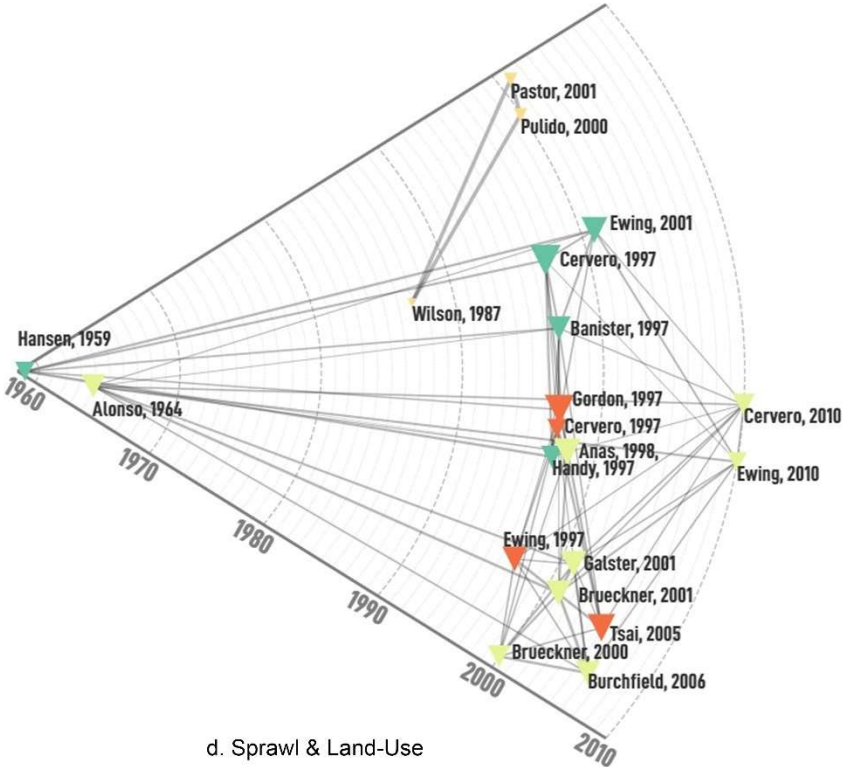
Appendix 3. Results of cocitation analyses



Appendix 3. Results of cocitation analyses (continued)



c. Cluster & Innovation



d. Sprawl & Land-Use

