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MAPPING THE DUALISM OF NATURE/SOCIETY AND NATURE/CULTURE IN ENVIRONMENTAL SCIENCES IN VIEW OF THE ANTHROPOCENE

ABSTRACT

This study uses the qualitative method of chronological and analytical literature review complemented with the visualisation (VOSviewer) of documents extracted from the Scopus database to consider a fundamental dualism of "culture and nature" and/or "society and nature" in the context of interdisciplinary approaches to environmental studies. The visualisations reveal clusters that manifest themselves differently when the nature/culture and nature/society pairs are compared. The term Anthropocene, adopted as a concept, is highlighted as a model to test the flattening of the dualism in question. The concept of the Anthropocene can serve as a prototypical link in research on environmental interdisciplinarity.

KEY WORDS: *nature/society, nature/culture, bibliometrics, environmentalism, anthropocene*

Kartiranje dualizma narava – družba in narava – kultura v znanostih o okolju v luči antropocena

IZVLEČEK

Študija s kvalitativno metodo kronološkega in vsebinskega pregleda literature in komplementarno vizualizacijo (VOSviewer) korpus ekstrahiranih dokumentov v podatkovni zbirki Scopus analizira enega temeljnih dualizmov kulture in narave ali družbe in narave v kontekstu interdisciplinarnih okoljskih pristopov. Rezultati

vizualizacije nakažejo klastre/pristope, ki se različno manifestirajo v paru narava – kultura in narava – družba. Izpostavljen je termin antropocen, v obravnavi uporabljen kot koncept za testiranje sploščanja dualizma. Koncept antropocen se izkaže za prototipično povezavo pri interdisciplinarnem okoljskem raziskovanju.

KLJUČNE BESEDE: narava – družba, narava – kultura, bibliometrija, okoljevarstvo, antropocen

1 Introduction

The Cartesian, dualistic relationship between humans and non-humans has underpinned most ontologies and epistemologies of “Western” (natural) science since its inception. Non-humans (e.g. plants, animals) are objects that are studied for the benefit of humans (Aldeia and Alves 2019). Scientific objectivity in the production and practice of knowledge ensures the relative intactness of the dualism of nature and culture (or nature and society). The questioning as well as defence of this dualism is an academic constant. It has been gaining considerable momentum with the acuteness of environmental problems and the growing “eco-anxiety” (Coffey et al. 2021), which is hypothesised as an emergent human condition in the seemingly new geological era of the “Anthropocene”.

In the dilemma of “who knows nature best”, it is reasonable to ask whether long-term environmental uncertainty might be the impetus for a serious “destabilisation” of established disciplinary epistemologies in science (Neckel 2021). It could lead to integration, further differentiation and fragmentation, or perhaps hybridisation (Dogan 2019; Kolawole 2019). One of the ways to find an answer is to trace various forms of interdisciplinarity, in this case the coexistence, permeation and possible novel connections between constructivist (interpretative) and essentialist (positivist) perspectives in the published literature over time (Schatzki 2010). Given the ever-growing volume and diversity of work on this topic, a comprehensive literature review seems elusive even for the best experts in the field. A review of the bibliographic data source Scopus (a citation database) used in this article shows that there are many individual, i.e. discipline- or paradigm-specific discussions as well as reviews, assessments and comprehensive qualitative analyses of the dualism of nature and culture/society.

In designing this article, we started from the assumption that the accumulated knowledge about the nature/culture or nature/society dilemma can be visualized in order to gain an exploratory insight into the indexed bibliographic data in terms of clustering and over time. By creating suitable search strings, we extract documents for visual output, which are then analysed using selected

bibliographic parameters. We observe how divergent disciplinary approaches, current focus areas, trends and different uses of terminology behave at the level of these metadata aggregates (Hočevár in Bartol 2021; Wang et al. 2021). With a preliminary analysis of the latest environmental discourses in the context of nature/culture and nature/society, we have singled out the concept of the Anthropocene because of the frequency with which environmental terms have appeared in recent years. We treat the term Anthropocene hypothetically as a recent potential interdisciplinary link.

2 Conceptual background, research questions and the structure of the article

In the broadest sense, the introductory overview concerns two related and indeed inseparable domains: Research perspectives on environmental issues and the nature of environmental knowledge production. In this dilemma, different understandings and approaches to the concepts of nature, environment, natural environment, space and built environment play a central role. What is “thinking through the environment” (Rose et al. 2012) and how is it reflected, distributed and grouped in published knowledge production? It has primarily been a concern of environment-related sub-disciplines within the social sciences, humanities and sociology of science, but it is increasingly unfolding almost everywhere in academia.

In this article, we do not aim to discuss the environmental/natural issues associated with knowledge production in a way that raises new conceptual questions. Rather, our main intent is to chart (science mapping) the disciplinary clusters of research topics or focus areas as they emerge over time. We conduct this through a visual bibliographic analysis using VOSviewer (programme/software) to interpret default separation (duality) and the elements of disciplinary connections. Emerging trends towards interconnectivity are also identified. We therefore examine the relationships between textual and some bibliographic elements of published knowledge in the database. By mapping the bibliographic elements of: a) author keywords, b) words (noun phrases) in the titles and in the abstracts, and identifying relationships among documents in which these elements appear, we address three questions:

- firstly, what is the general scholarly production of knowledge about the dualism of nature/culture or nature/society in connection with environmental issues,
- secondly, whether in the context of the dualism nature/culture or nature/society the social sciences and humanities are becoming more open to “naturalistic” suggestions and, conversely whether the natural sciences are becoming more “social”¹,
- thirdly, what role does the “Anthropocene debate” play in connecting the scientific disciplines and the shifts in the argumentation of the nature/culture and nature/society dualism.

The article is structured as follows: Before beginning with the breakdown of aggregate bibliographic data, we briefly discuss and summarise the course of academic literature on the dualism *nature and culture* or *nature and society* and typical attempts to overcome it. The brief overview of the conceptual literature also includes the review of selected bibliographic studies on this topic that use visualisation methods. The methodological approach, parameters and limitations of Vosviewer are then outlined. This is followed by a detailed analysis of the approaches which appear in the form of clusters, their specificities and disciplinary compactness and connections. We conclude the analysis with a condensed presentation of the results. The article summarizes the main findings and provides some suggestions for researchers on how to search the literature in databases when dealing with dualism in an environmental context.

3 Nature in culture/society and culture/society in nature: an overview of the evasive approaches

An examination of the bibliographical characteristics of published knowledge on the *nature/culture* and *nature/society* dualism from an environmental perspective cannot overlook neither origins and the persistence of dualisms in science nor various attempts at reducing it. Most of the knowledge production on this dilemma has been published in recent decades in connection with the “environmental turn” and the subsequent critique. Studies and debates in scholarly publishing in times of so-called intra-disciplinary twists and turns (e.g. spatial turn, eco-spatial turn, boundary works, etc.), which are accompanied by high-profile works and the emergence of new metaphors or “buzzword” terms can also be indicators of

1. A more sociologically specific question of this type is asked, for example, by Maurizio Meloni, when he comprehensively analyzes boundaries between realms commonly demarcated as “the social” and “the biological” (2014: 593–614).

the emergence of interdisciplinary links (Gaziano 1996; Warf and Arias 2009; Löw and Steets 2014). A brief overview of the more general trajectory of modern discussions on this topic is useful, as the entire corpus of published documents from the database is included².

3.1 Beyond two perspectives: objective and constructed reality of nature

Since “scientists of nature” are first and foremost objective observers and measurers of the object the question nature/culture or nature/society is for them not an issue. They are detached, at least that is what they assume (Rosen 2015). Philosophical and practical social questions of the subject are the domain of others. This is what “another science” with “unnatural thinking” deals with (Williams 2012). Recent, albeit rare, bibliometric and scientometric analyses show that the “separate worlds” in science are less pronounced than in the past, but still exist (Einecker and Kirby 2020; Wang et al. 2021). Even with complex, obviously intertwined topics from nature and society, the two perspectives tend to remain more separate, which is reflected in scientific databases and their classifications of disciplines. To what extent can a convergence in the reflexivity of the separate approaches to climate change and sustainability be identified and then defined? The position that there is not just one science but various ways of making knowledge (Knorr Cetina 1999), advocates scientific diversity and plurality. The assumption of the classical view of interdisciplinarity that complex realities such as environmental issues studied in different disciplines, which together form different knowledge on the subject, is no longer necessarily sufficient.

Opposing objectification “at all costs” of the nature/human dualism gradually leads to an increasingly pronounced distinction in the approaches to society and culture, including the emphatic distinction between the social sciences and the humanities. The separation of natural and social science and humanities perspectives on nature has been gradually consolidated through intra-disciplinary differentiation, best illustrated by the environmentalism (Dunlap et al. 2012). How does this double separation in relation to nature, on the one hand between the natural sciences and the social sciences and on the other hand between the social sciences and the humanities, manifest itself in the “big picture” of metadata in the database of accumulated knowledge?

2. This article confines itself entirely to a “Western” philosophical and scientific perspective. We are aware that such an approach to the question of nature/culture and society/culture dualism is reductionist, as it neither chronologically nor conceptually covers elaborate holistic approaches.

The divergent perspectives, the objectification of social reality in contrast to its interpretative construction, are expressed by two syntaxes: nature/society and nature/culture. Research into published knowledge production must take this paradigmatic demarcation into account, at least as a heuristic device in the interpretation of breakdowns and groupings in bibliographic databases. It is important to find out how much of this is a matter of semantics, how much is this the content orientation of the authors and what is actually their mutual connection. We believe that in this purely social science and humanities theoretical preoccupation it is possible to tentatively uncover the contextual "behaviour" of different terms and conceptual associations about nature/environment.

A preliminary review of the literature suggests that nature (or the built and natural environment) has been, both in terms of occurrence over time and in terms of frequency, a "natural" interdisciplinary link between the social and the natural sciences. It confirms that the "nature of nature" has been simultaneously questioned within the social sciences and the humanities, roughly based on two perspectives, objectivism and constructivism. However, certain terminological and conceptual associations could also be an indicator of the flattening of the nature/culture or nature/society dualism, both in relation to the natural sciences and between the social sciences and the humanities, as reflected in the bibliographic classification of published works. A preliminary review of the disciplinary classification of the frequency of the term Anthropocene in the Scopus Subject Areas (Table 1), which will be discussed below through visualisation, was assumed as a typical inter- and intra-disciplinary connector within the dualism of nature culture/society; and indeed it proved justified. At the same time, the classification system itself, as conceived, clearly shows an unbalanced granulation of the scientific fields, which points to the weight attributed to the natural sciences. Thus, the classification scheme is not equally detailed for all areas. For example, while there is only a single subject area in the discipline of Social Sciences, the Medicine-related fields are specified much more in detail, as can be seen from the table. A journal may also be labelled with several subject areas, for example, Social Sciences, Agricultural and Biological Sciences as well as Environmental Science.

Table 1: Scopus Subject Areas of documents containing Anthropocene in an abstract of the document.

Subject Area	No.	Subject Area	No.
Social Sciences	2897	Psychology	91
Environmental Science	2261	Physics and Astronomy	76
Arts and Humanities	1782	Chemistry	74
Earth and Planetary Sciences	1210	Immunology and Microbiology	74
Agricultural and Biological Sciences	1148	Mathematics	49
Engineering	365	Decision Sciences	48
Business, Management and Accounting	300	Neuroscience	32
Economics, Econometrics and Finance	256	Materials Science	23
Biochemistry, Genetics and Molecular Biology	215	Nursing	21
Medicine	195	Veterinary	21
Multidisciplinary	171	Chemical Engineering	19
Computer Science	165	Pharmacology, Toxicology and Pharmaceutics	14
Energy	159	Health Professions	7

Bibliometric experts regard the mapping of scientific knowledge as a problem of subjective, “human-assigned” metadata. The classification relies on pre-existing categories of science and does not recognize the emergence of truly new epistemic bodies of knowledge (Suominen and Toivanen 2016). However, this is primarily a cultural problem and extends to the “culture of science”, which concerns its organizational structure and also includes the nurturing of epistemic cultures (Knorr Cetina 1999).

From the beginning, epistemic autonomies within the social sciences and humanities cultivated and problematised their dualisms, dualities, dichotomies, dialectics and bifurcations (Aldeia and Alves 2019; Hočevár et al. 2022). These include body/mind, biological/social, action/structure and community/society, to name but a few. Visualising published knowledge production on the dualism of nature culture/society can reveal specific semantic groupings and connections between approaches both within and across disciplines. Some of them, such as the content of the mechanism of genetic versus environmental (including cultural and behavioural) determination, are even a dialogical constant of otherwise separate natural and social science domains (Benton 2013). Studies and debates in scientific publishing in times of so-called intra-disciplinary turns (e.g. spatial turn, eco-spatial turn, environmental turn, boundary works, etc.), accompanied by high-profile works and the emergence of new metaphors or “catchword”

terms could also be an indicator of paradigmatic shifts in terms of interdisciplinary connections (Gaziano 1996; Warf and Arias 2009; Löw and Steets 2014). The dualistic principle has not been without upheavals, both between the two domains and within them, in the sense of “what is science anyway” (Strathern 2007; Ash 2019).

3.2 Interdisciplinary turns: space, built environment, natural environment and extended reflexivity

The original anecdotal ideas that emerged in early 20th century on the concept of interdisciplinarity, relating directly to spatial and proto-environmental cultural/social issues in connection with urbanisation processes were not brought to life for a long time (Frank et al. 1988). Looking at the published knowledge since the beginning of the 20th century onwards and disregarding interdisciplinary proto-pioneers such as the polyhistor Alexander von Humboldt (Hannigan 2022), one might initially come across a rather logical connection between (urban) sociology and (cultural) geography. The proposition was quite simple. Sociology neglects the physical (material) basis of human associations, and geography does not sufficiently consider culture (landscape, differences, power, inequalities) in the production and usage of the built and natural environment.

It is no coincidence that research into the socio-spatial relationships between the built and natural environment is one of the levers of interdisciplinarity that seeks to challenge the dualism nature/culture and nature/society (Braun 2005). Rather naive and derivative from today's perspective, Chicago School sociologists sought to justify the commonalities of nature/culture in the face of the dilemmas of countryside/city and space/society when exploring “urban ecology” (Jerolmack 2012; Liu and Emirbayer 2016). From the beginning to the first third of the 20th century, documents from the fields of human geography and “ecological” sociology can be found in bibliographical records, and their connection should be understood as the unfolding of human ecology (Gross 2004; Dunlap et al. 2001; Catton 1994).

With the above, we point to the weight of the initial intertwining between geography and sociology and the applied discipline of the built environment planning as a productive confluence in the advancement of the environmental perspective. In essence, these are different understandings of environmental determinants and human agency in the face of the otherwise obvious fact that the physical environment is both a product and a setting for human interactions. This case indicates the foundation of practical needs for arrangements and engagements between the knowledge of science and social policies in the sustainable adaptive organization of society that includes predictions and planning

for social development. The post-war bibliographic records show an increased mutual engagement of even more disciplines, e.g. economics, demography and soil-science in future-oriented predictive environmental expertise with distinctive paradigmatic frameworks (Warde and Sörlin 2015; Jorgenson et al. 2019 Nash 2013). Until the breakthrough of an interdisciplinary group of scholars with the high-profile study *Limits to Growth* (Meadows et al. 1972) and after the first environmental social movements of the 1960s.³

The increasingly fragmented global academic community generally lacked the substantive mobilizing forces or reflexive impetus to think “sustainably” about environmental complexity.

The subsequent development of the “environmental turn” was characterised at least in the social sciences, philosophy, and the humanities, in part by growing, otherwise clearly heterogeneous paradigmatic orientations in the study of the production of physical space, the built environment and urban planning. A review of the literature reveals the greatest common denominator of most discussions, namely the expansion of the research horizon of the original dilemma of agency and structure. In terms of diverse discourses, this ranges from Lefebvre’s Marxian ecological critique (Foster et al. 2020) and Harvey’s dialectics of social and environmental change (Harvey 1993; Ekers and Prudham 2015) to Giddens’ and Beck’s temporal-spatial theory of reflexive modernization (Beck et al. 1994; Alexander 1996) and, more recently, Latour’s disruptive and highly contested socio-technological theory of relational, hybrid agency of things, nature, and society (Latour 2013; Flower and Hamington 2022).

The original concept of reflexivity, in conjunction with concepts such as complexity, risk and uncertainty, is not only a socio-environmental constant within the social sciences. Since the 1990s, it has also gradually gained constructive interdisciplinary weight in the environmental sciences, particularly in sustainability research and more recently in the discussions on the Anthropocene (Lowe et al. 2008; Boyce et al. 2022). By the mid-1990s, the use of the term reflexivity in conjunction with sustainability increased significantly in the published academic literature and in various disciplinary frameworks, eventually becoming both a theoretical concept and an empirical variable of applied developmental concepts at policies and management level. The analytical use of reflexivity begins to move

3. So-called “turns” in science are difficult to date precisely due to variations in different social settings. Thus David Larsson Heidenblad (2021) explains in his extensive analytical study of the “environmental turn” in Sweden that it can be dated there to the mid-60s, in the initial connection of natural science and politics. He frames it in the history of the circulation of knowledge and calls it “a social breakthrough of knowledge” (ibid.: 5).

beyond the social science and humanities frameworks, from the construction of nature-culture dualism to broader socio-material spheres. Later, the concepts of sustainability and sustainable development are increasingly used in the context of their critique. As some bibliographical studies show (Ruggerio 2021; Feil and Schreiber 2017), the concept of sustainability (in various adjectival usages, such as reflexive, social, spatial, economic) is increasingly replaced by other terms such as de-growth, but in environmental topics it retains a contextual potential to connect different disciplines.

Within the broader framework of the phrases “crisis of science” and “destabilization of science”, there are various discussions about the future disciplinary organization of science and scientific practices. Various recent concepts of integration and differentiation of knowledge promise to overcome the additive accumulation of (particular) knowledge, if not the abolition of the fundamental natural-social dualism itself (Siusiuka and Ivanov 2023). Environmental issues are not only exemplary for this process, but fundamental. Indeed, the catchphrase “limits to growth” can literally be meaningfully attributed to multiple semantics in the complex and pervasive relationship between humans and non-humans.

In reviewing the conceptual literature related to the interdisciplinary use of environmental risk and uncertainty in decision-making we can find somehow out-of-the-box assumptions about the potential disruption of the understanding of scientific knowledge when applied in the policy process, such as the concept of “post-normal science” (Funowicz and Ravetz 2018).

3.3 Review of the bibliometric literature

We complement the analytical chronological overview of the literature with a review of bibliometric studies that deal with the extraction of semantic relationship from context. These are studies that quantitatively address specific bibliographic (bibliometric, informetric, scientometric) elements based on the excavation of documents in databases and relate to a broader or narrower interdisciplinary context of the dualism of nature and culture/society.

Despite of the large body of published literature we did not find any studies that quantitatively address the dualism of nature and culture/society as an aspect of knowledge production although there are some methodologically and thematically related studies on bibliographic parameters with the extraction of documents from databases using science mapping. Most of these documents are very recent (from 2016 and onwards). Of all the specific topics related to the nature culture/society dualism bibliometrically addressed, tourism is the most frequently represented. Tourism studies mostly focus on the bibliographic parameters of tourism business destinations, e.g. tourist accommodation, guest

satisfaction and explore sustainable management and environmental responsibility through the lens of the use of natural and cultural resources (dos Santos et al. 2017; Hočevár and Bartol 2021;). Another group of studies relates to geological phenomena, geographical areas (e.g. cities), ecosystems and climate. Nature and culture/society appear in the literature as variables for various aspects of environmental problems and the use of accumulated knowledge (Wang et al. 2021; Zahoor et al. 2023).

The second group of documents dealing bibliometrically with the term and concept of the Anthropocene is more numerous, but does not refer to the problematization of the dualism between nature and culture/society. They analyse the term or conceptual framework of the Anthropocene with standard bibliographic parameters or with a combined method of structured literature review and bibliometrics (scientometrics) from different angles: as a metaphor, as a the synonym of Gaia, as a keyword in literature, as a concept in science or as a hypothetical geological period (Scartozzi 2021; Rossa-Roccor 2020). The Anthropocene has been used as a topic in the context of global environmental changes (esp. climate change) and from the perspective of policies, e.g. environmental governance, as well as from the point of view of the methodological implications using the concept in science, in the relationship between analytical and conceptual weight (Brondizio 2016; Biermann et al. 2021).

4 Materials and methods

4.1 The scope

We start from the assumption that the existing qualitative assessments of dualistic understandings of nature and culture and/or nature and society in the context of the production and organization of knowledge can also be verified experimentally and thus complement conceptual discussions and findings. We observe and evaluate how divergent approaches and different uses of terminology within documents of the scientific domain behave on the level of aggregate data analysis. We achieve this by visually representing the extracted bibliographic data in the Scopus database (Elsevier). The scope of the data is thus limited by the source of retrieval and the search query (syntax). Scopus provides advanced functionality to export structured data, in our case, both bibliographic data (keywords) as well as textual data (titles, abstracts). The VOSviewer programme enables the creation of knowledge maps and offers text mining functionality that can be used to create and visualise co-occurrence networks of terms from scholarly literature. The terms, their frequency and their trajectory over time can indicate disciplinary concepts, contexts and relationships.

4.2 Composite query

To identify the contexts in question, we developed a composite query (syntax) that included the following *nature*-related and either *society*-related or *culture*-related contextual word pairs (which occur in the abstracts of the documents):

"society and nature" OR "nature and society"	"culture and nature" OR "nature and culture"
"society nature" OR "nature society"	"culture nature" OR "nature culture"
"societal and natural" OR "natural and societal"	"cultural and natural" OR "natural and cultural"
"societal natural" OR "natural societal"	"cultural natural" OR "natural cultural"

The reason for the formation of two pairs of words in the query lies in our original assumption that, in the context of nature, the terms society and culture are semantically interchangeable and specific at the same time. The meaning attributed to one or the other term depends on disciplinary approaches, perspectives or paradigms (epistemology) as well as on topics (methodology).

Nature/society-related pairs (four possible pairs) yielded 2,800 documents, while the *nature/culture*-related pairs (also four) yielded 7,800 documents. The searches were conducted in the beginning of June 2023. All document types were considered, e.g. journal articles (which account for the greater part of all documents), proceeding papers, books chapters, books, etc.

4.3 Text maps and keyword maps

The study represents *Text maps* and *Keyword maps*. The first two maps (Figures 1 and 2) represent clusters of topics (items) that occur together in studies in related fields of research. All items belonging to a cluster are therefore identified by the same colour. Subsequent maps are presented on a timescale of occurrence of topics (items), corresponding to the average year of publication of an article in which a topic occurs. The scale is shown in blue and red shades. The blue shading represents earlier research, while the red shading represents more recent research. The scale is adjusted to the average values of the respective document set. In all maps (*Text maps* and *Keyword maps*), the size of the label and the circle of an item is determined by the weight of the item. *Text maps* based on nouns or terms (noun phrases) are determined in the text (titles and abstracts of the documents). The maps are calculated for 10 occurrences of a term.

The *nature/society* text map is based on 56,500 terms, of which the 830 most relevant are assigned to clusters (Figure 1). This is established by the program. Due to the high density of the map, only the most relevant terms can be shown. The *nature/culture* text map is based on 143,000 terms. 2136 of the most relevant terms are represented in the map (Figure 2). The terms in both maps are

grouped in the clusters of related research. There is a considerable overlap in all maps because of the large number of items in a map.

Keyword maps are based on keywords assigned to documents by the authors. These maps are calculated on a threshold of 5 occurrences of a keyword and represent the time scale of an occurrence. The *nature/society* keyword map is based on 7,130 keywords. 221 of them reached the threshold (Figure 3). The *nature/culture* keyword map is based on 17,270 keywords. 768 of them reached the threshold (Figure 4).

4.4 Anthropocene, the “catchword” or concept

In the next step, we narrowed down the totality of the above documents to documents associated with *Anthropocene*. In other words, we linked all *society*-related or *culture*-related pairs with *Anthropocene*. These combinations resulted in a total number of 183 documents. An example of a search query (eight were possible): ABS(("society and nature" OR "nature and society") AND anthropocene).

We singled out the catchword of the Anthropocene, encapsulating the concept based on the frequency of occurrence of environmental terms in recent years (Table 1). We treat the term Anthropocene hypothetically as a new potential interdisciplinary link. For these *anthropocene* and *nature/society/culture*-related documents we also created corresponding time scale maps. Since there were far fewer documents, we lowered the occurrence threshold: 5 occurrences in the text map and 2 occurrences in the keyword map. The *text map* is based on 5,300 terms. 141 terms reached the threshold (Figure 5). The keyword map is based on 78 keywords (Figure 6). Both in the search queries and in the maps, the uppercase and lowercase letters are converted to lower case (e.g. Anthropocene - > anthropocene).

4.5 Limitations

In text maps, some generic terms are always present. To this end, we created a thesaurus that excludes some of these terms, e.g. *article*, *author*, *book*, *paper*, *research*, *study*, etc., so as not to skew the visualisation too much. This visualisation method is more suitable for large corpora of data, so there are limitations to consider when interpreting maps created on the basis of a limited number of documents. Using the software, we arranged the maps according to the optimal principles of a “broader picture”, which inevitably entails some trade-offs. Therefore, the analytical interpretation is limited and the findings are preliminary rather than definitive.

5 Results and discussion: visualisation of approaches

Visualisation of documents through the mapping of terms in document titles, abstracts and key words is a complement to a condensed literature review and draws on other qualitative analyses that assess concepts of a dualistic understanding of nature and culture and/or nature and society. By analysing the documents as sources and with the help of this experimental study, the following questions are addressed: first, a general picture of scientific knowledge production in relation to this dualism; second, the relationship between disciplines, and third, the elaboration of the environmental “Anthropocene debate” in an interdisciplinary approach. We assume that the distribution of the elements (terms) of this dualism into groups (clusters) roughly reflects the conceptual contexts of the production and organization of scientific knowledge in relation to environmental matters which we have presented in the chronological and analytical overview of the literature (Chapter 2).

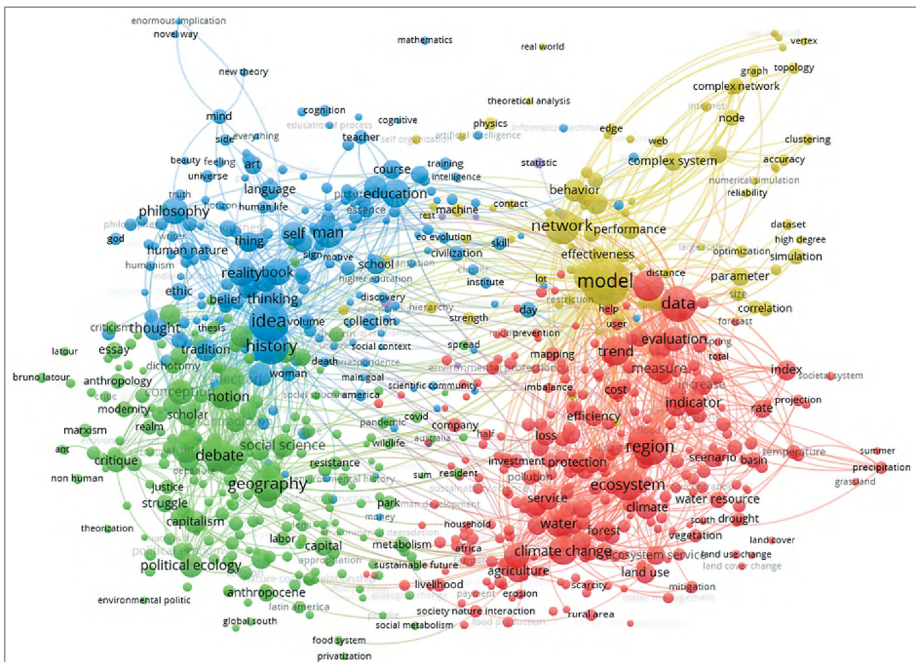
5.1 Clusters/approaches in the nature/society and nature/culture dualism

Figures 1 and 2 show text maps of the most relevant terms obtained through a query of nature-related and either society-related or culture-related contextual word pairs (occurring in the abstracts of the documents). In the previous test queries, we established that in connection with the concepts of the dualism of nature (or the natural environment) and humanity, there are two terms, culture and society, which correspond to different conceptual, paradigmatic and disciplinary approaches in the literature studied. The differences in the distribution and clustering of the terms in Figures 1 and 2 suggest this assumption, but not completely. It is also necessary to take into account the subjective understanding and use of concepts, so that the analytical interpretation can only be tentative and sometimes speculative.

The terms culture and society “behave” quite differently, which is already evident in the numerical output of the retrieved documents and the number of the terms in text maps, where the ratio of the number of retrieved documents is about one to three in favour of culture (see chapter 4). This difference partly determines the distribution and grouping of terms. Both figures show cluster division (roughly) into conceptual-theoretical and empirical research thematisation of the topic. However, we estimate that the term society paired with nature reflects the approaches within conceptual dualism more directly than the term culture, which contradicts our original assumptions. The terminological pair nature/culture (Figure 2) appears more often in the title and abstract in the context of various

specific topics. The direct connection between the two terms can be tenuous, as the treatment of the topic is descriptive and enumerative rather than dualistic (e.g., “cultural and natural heritage”, “cultural differences in the understanding of nature”, “nature in American culture”, etc.). The documents in which the authors conceptualise dualism in the title and abstract in the form of nature/culture lead to distinctly different clusters than those that conceptualise dualism in terms of nature/society. The terms culture and society are both elusive in colloquial and academic usage, even in the social sciences and humanities. However, the term culture can represent a less focused but more inclusive and broader contextual range of associations than society, including the interchangeability of culture and society outside the narrower disciplines of the social sciences and humanities.

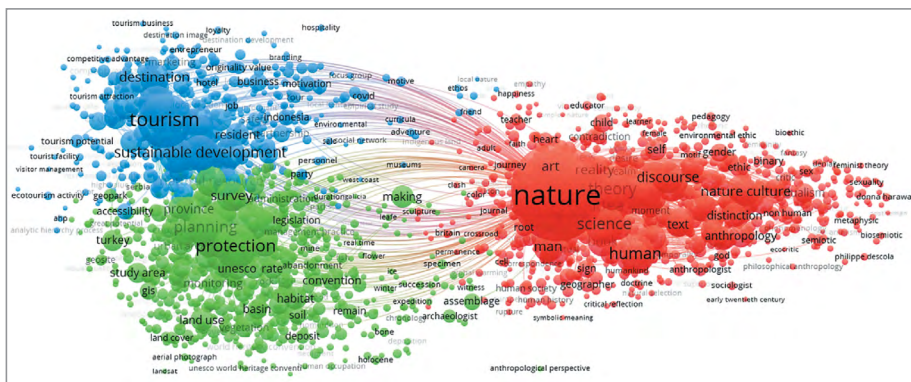
Figure 1: Nature/society text map (terms in abstracts and titles).



A comparison of Figure 1 and Figure 2 shows that the concept of society paired with nature in the environmental context is predominantly limited to the considerations of the social sciences and humanities, while the concept of culture is more interdisciplinary and indicative of natural sciences. Such an assessment may seem counterintuitive. In the nature/society pair (Figure 1), four clusters/approaches are formed, with the dispersion of terms and greater interconnection between two related pairs of clusters. In the nature/culture pair (Figure 2), the scattering is less pronounced. Three clusters/approaches are formed in this map. In two clusters that

are very much connected (blue and green), the topics of empirical exploration of the environment are noticeable, while the third cluster (red) is clearly separated and much more conceptual, showing constructivist and objectivist perspectives.

Figure 2: Nature/culture text map (terms in abstracts and titles).



We can tentatively conclude that dualism as a concept is more accurately represented in the nature/society pair than in the three times denser nature/culture map (Figure 2). On the other hand, the nature/culture pair represents a stronger interdisciplinarity and also environmental links, including distinct environmental policies and spatial planning (e.g., *climate, protection, tourism, sustainable development, land use, habitat*). The (red) nature/culture cluster (Figure 2) is clearly characterised by the humanities (with the terms: nature-culture anthropology, discourses, distinction, human, non-human, self, gender, ethics). The terminology in the nature/society (Figure 1, blue and green cluster) is more balanced in terms of the social sciences and humanities. The interpretation of the grouping of terms in the clusters in Figures 1 and 2 can be analytically defined as approaches (or perspectives):

- Ontological (O)
- Epistemological (E)
- Methodological (M)
- Applied environmental (AE)

We trace the dualism of nature and society/culture back to the two interconnected clusters on the left-hand side of Figure 1. The first cluster/approach (top) can roughly be characterised as ontological and the second as epistemological. On the right-hand side are the clusters/approaches that are characterised as methodological and environmental. The O and E clusters on the left show an association with positional proximity, suggesting related terminology. Within the O cluster, the very strongly represented terms are *idea, history, philosophy,*

belief, thought, thinking, language, education, humanism, human nature. These terms roughly indicate documents in the social sciences and humanities in conjunction with epistemological and methodological ones. Prominent terms within the E cluster are: *geography, debate, scholar, political ecology, social science, modernity, Anthropocene, environmentalism, capitalism and critique.*

Interestingly, the proper name that appears in the clusters (within the nature/society dualism) refers to Bruno Latour, the author of the controversial and widely debated socio-technological theory Actor Network Theory, or ANT, which is often mentioned in the context of the Anthropocene (Latour 2013). This name is directly associated with the concepts: *anthropocene, modernity, non-human, dualism and criticism.* It must be remembered that the retrieval programme does not distinguish between affirmative and critical contexts, but only by occurrence, so the interpretation can only be tentative. In general, the connection between the two clusters is indicated by the terms: *social structure, dichotomy, contradiction, thesis and reflection.*

Our initial hypothesis, which was also based on a review of the relevant literature, that the term culture tends towards constructivist approaches (concepts, discourses) of dualism and the term society towards objectivist approaches, is not fully confirmed. The output in the figures indicates the opposite, at least from macroscopic perspective.

Indirect insights suggest that this assumption only applies to certain types of documents, in particular monographs and conceptually theoretical articles. These make up a smaller part of the extracted corpus, which totals more than 10,000 documents. This circumstance is more characteristic of the term culture (Figure 2) and less so for the term society (Figure 1) in combination with nature. In Figure 2, with a tripling of the documents, only three clusters/approaches are formed, which are also more homogeneous than the four heterogeneous clusters in Figure 1 (society). Our assumption of distinctive scientific approaches to dualism is justified for the ontological and epistemological cluster in the nature/society pair and clearly in the homogeneous cluster in the nature/culture pair, which we perceive as an analytical cluster.

5.2 Keywords

Keyword maps complement the above analysis of clusters/approaches to the dualism of nature and society/culture in the title and abstract of the documents. Keywords (KW) are presented on a time scale of the occurrence of topics (items) corresponding to the average year of publication of an article in which a topic occurs (Figure 3 and Figure 4).

Figure 3: Nature/society keyword map.

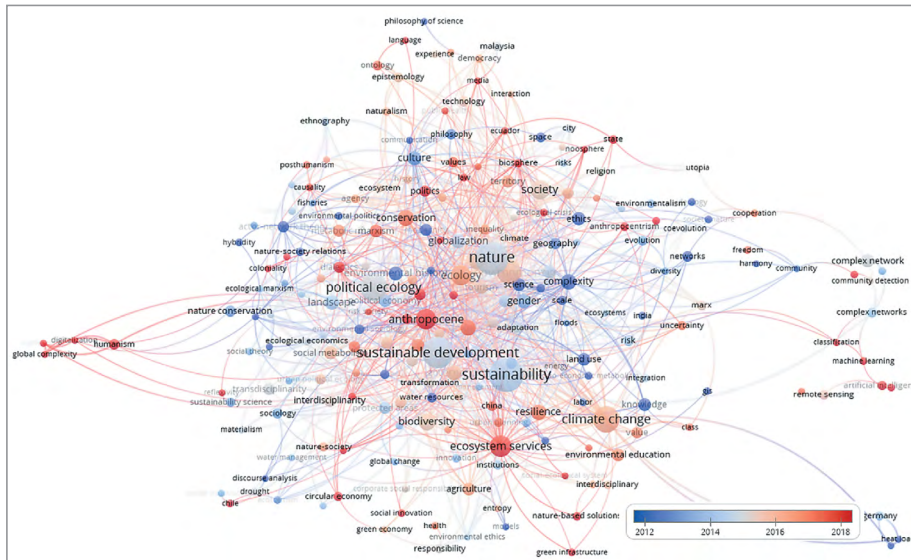
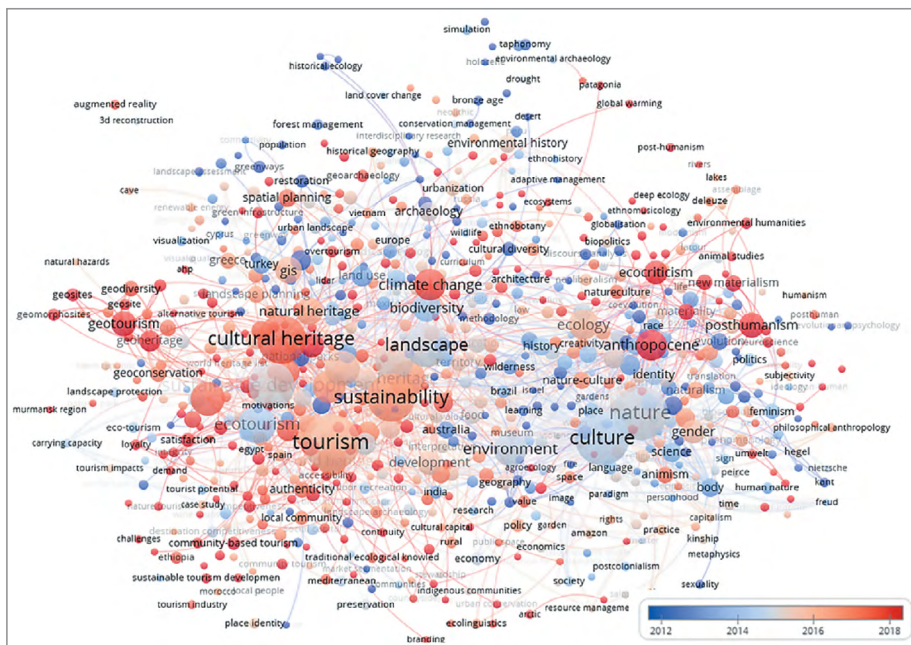


Figure 4: Nature/culture keyword map.



The frequency, distribution of KW and their occurrence over time in the nature/society pair (Figure 3) differ significantly from those in the nature/culture pair (Figure 4). The most strongly represented and also more recent KWs only partially overlap with the KWs in the nature/culture pair (*ecosystem services, anthropocene, climate change, sustainable development, political ecology, interdisciplinarity*). The conceptual KWs are of an earlier date (*complexity, nature-society relations, humanism, science, philosophy, hybridity, culture, discourse analysis, co-evolution*). This indicates the maturation of the disciplinary approaches and the connection with newer and applied KW (*complex networks, remote sensing, artificial intelligence, machine learning, green infrastructure, nature-based solutions*).

In the nature/society pair, there are no KWs that relate to business approaches (e.g., *tourism*, also in adjectival uses), which are strongly represented in the nature/culture pair and are more recent. The KW *sustainability* is the most prominent in both pairs, but in the nature/society pair it is present in earlier years, which means that the authors have been using it for a longer time than in the nature/culture pair (a more recent period). A longer period of constant or increased use of KW may indicate a mature direction in the field or a consolidation of an approach or paradigmatic framework (Small, 2003). Another prominent KW that is also associated with sustainability (also in adjectival versions) in both pairs but in different contexts, is *Anthropocene*. Based on test queries, we analyse this term in more detail.

5.3 Anthropocene: an interdisciplinary link?

In the preliminary query of recent environmental discourses, we elaborated out the concept of the Anthropocene on the basis of occurrence with which environmental and environment-related terms have appeared in recent years. We posed the research question of what role this term plays in the “Anthropocene debate” in connecting scientific disciplines and whether it is possible to recognise at least rudimentary shifts in the argumentation of nature/culture and nature/society dualism within environmental approaches. Namely, in Figures 3 and 4 we can see that the Anthropocene has been frequently discussed recently.

In the third chapter, we have presented the disciplinary classification and frequency of the Anthropocene according to Scopus Subject Areas (Table 1), which shows a considerable degree of interdisciplinary treatment. We complete the preliminary analysis by examining the terms using text map (terms in abstracts and titles) and keyword map. Here we have used both nature/society and nature/culture in a merged search syntax. Both visualisations (Figures 5 and 6) show the terms on a time scale.

In Figure 5, the terms social science and natural science are in the centre of the figure and also between mature and more recent usages indicating certain interdisciplinarity. The term social science is somewhat more recent than the term natural science. The conceptual terms (*ontology*, *Anthropocene concept*, *human agency*, *new geological epoch*, *epoch*, *scientist*) are somewhat “older”, on average, and have a weak relationship with the most recent terms (*posthumanism*, *entanglement*, *critique*, *agency*, *adaptation*, *ecological crisis*) except for the proper name Bruno Latour which is, as a term, more recent. On the basis of this analysis, we can tentatively conclude that the interdisciplinarity of the Anthropocene concept is more a matter of discussions about interdisciplinarity within the different approaches in the social sciences and humanities (and philosophy) rather than actual disciplinary integration between the natural and the social sciences.

Figure 5: Anthropocene and (society or culture)/nature text map (terms in abstracts and titles).

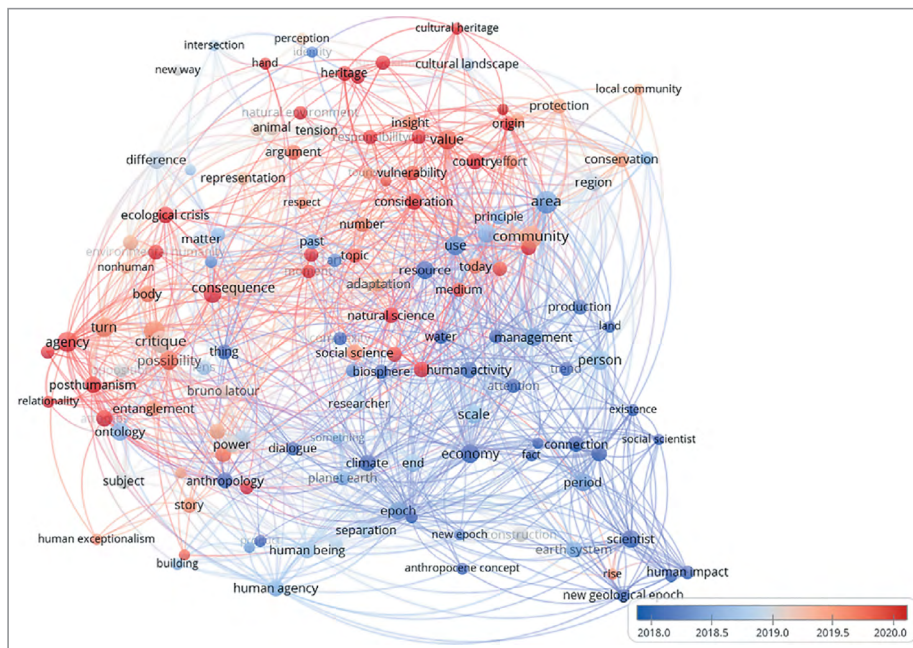
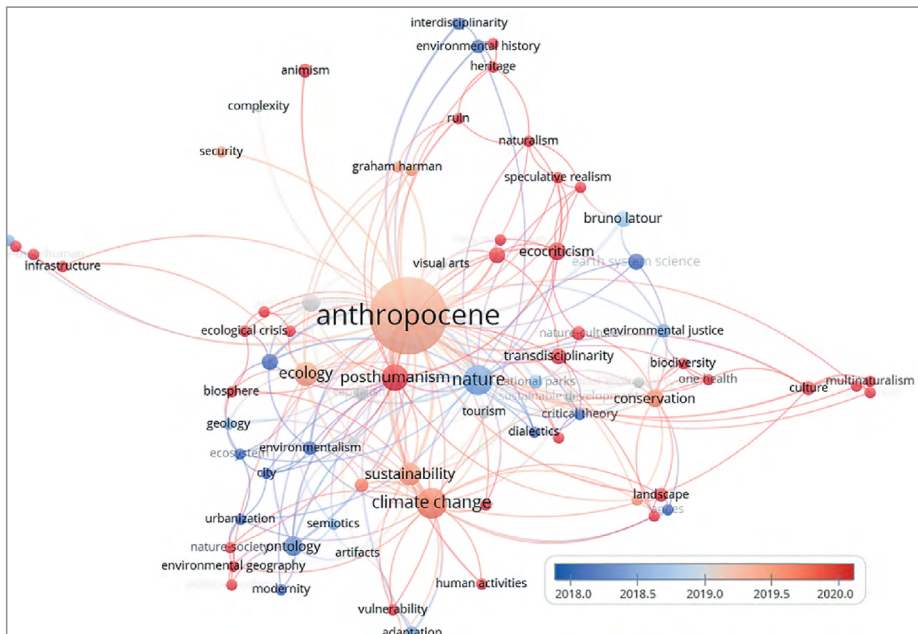


Figure 6: Anthropocene and (society or culture)/nature keyword map.



Finally, we have also created a map of keywords associated with the Anthropocene, bearing in mind that keywords are always both selective and subjective. Moreover, it is based on few keywords, some of which occur only rarely, so it can only serve for a preliminary interpretation. Nevertheless, we believe that it can provide some noteworthy information. Very common keywords are closely related to climate change and sustainability. Climate change is associated with very recent culture, nature-society, and environmental geography, while sustainability links with social theory and posthumanism. At this point, it must be mentioned that some keywords are either blurred or overlap and are not visible on the map. On average, interdisciplinarity appears earlier than transdisciplinarity. The two are not linked, perhaps indicating that different authors see these concepts as equivalent, and use either one or the other.

We tentatively conclude that the analysis of KW provides an indication that environmentalism as an approach “behaves” in an interdisciplinary/transdisciplinary manner, particularly when examining the built environment and when discussing the resources of the natural environment.

Based on this analysis, we cannot draw any firm conclusions about the flattening of the dualism between nature and society or nature and culture, also due to a relatively small number of documents and keywords. And yet, the map also contains many very recent and still rare keywords (e.g. *multiculturalism*,

security, heritage, ecosystems, biodiversity, political ecology, vulnerability, etc.). Therefore, some more meaningful conclusions may be possible after some time, when new documents are published.

6 Conclusion

In this study we complement two ways of dealing with the dualism nature/society and nature/culture, i.e. a chronological review and content analysis of this dualism in knowledge production from an environmental point of view observed through the visualisation of bibliographic parameters (science mapping).

The basic purpose was to determine the extent to which knowledge production is reflected in the visualisation of documents in the Scopus database. Based on preliminary investigations and the final design of the composite search string, we extracted the documents for visual output using VOSviewer software. After an initial analysis of current environmental discourses in the context of nature/society and nature/culture, we selected the concept of the Anthropocene.

Final conclusions are not possible as only a limited set of bibliographic parameters was used (text-maps of abstracts and titles, keywords, trajectories over time). The evaluation and interpretation of the visual output was intended as a test to complement the review and analysis of the relevant literature. In addition, the extracted "big data" also contains noise data not all of which can be removed. But for the most part, the hypotheses on the reflection of the content analysis of the literature through the bibliometric visualisation are useful enough for tentative conclusions.

We have found that the terms that form a dualism with nature - society and culture - are used by the authors of the documents in different contextual frameworks, but not necessarily, as we initially assumed, in separate, constructivist and objectivist approaches. The term culture emerges more as a descriptive, comparative and generic (or general) term for "non-nature" and not necessarily as a conceptually dualistic, while the term society is more explanatory and relates more directly to conceptual dualistic topics or phenomena. We have confirmed the initial assumption that the natural sciences treat both terms interchangeably, but more often use the term culture instead of society. Clusters of scientific approaches to dualism, established as: ontological, epistemological, methodological and applied environmental clusters, obtained by visualisations of text-maps derived from abstracts and titles, roughly correspond to the analysis of the literature. The keywords in the nature/society and nature/culture pairs partly indicate links between disciplines, but more precisely outline the long established approaches and the topics that have potentially interdisciplinary characteristics.

Our prediction that the term Anthropocene, defined as a contested and still evolving concept, can explain events between and within disciplines due to its “naturally” integrative qualities, i.e. controversiality and polyvalence. From the perspective of environmental approaches, the Anthropocene already shows a connection between dualistically organised sciences - natural sciences, and social sciences with the humanities, and within the social sciences and humanities, between objectivist and constructivist approaches.

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