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Mapping growth and trends in the category 'Green and Sustainable Science and Technology'¹

Andres Pandiella-Dominique*; Nuria Bautista-Puig** and Daniela De Filippo***

*andres.pandiella@uc3m.es; ** nbautist@bib.uc3m.es; ***dfilippo@bib.uc3m.es

Research Institute for Higher Education and Science (INAECU) (UC3M-UAM)

(Spain)

Laboratory for Metric Information Studies (LEMI), Department of Library and Information Science, Carlos III University of Madrid (Spain)

Associated unit Institute of Philosophy (CSIC), LEMI (UC3M), (Spain)

Introduction

Sustainability emerged in the late nineteen nineties as an alternative to the traditional production model. Theory postulates that the emergence and development of a new scientific discipline usually exhibit a recognisable structure and pattern. After a period of initial exploration, specialised journals tend to be issued and congresses convened, spurring exponential output (in number of scientific papers) of the new knowledge. Authors engaging in the philosophy, history and sociology of science, have identified such dynamics (Kuhn, 1962; Bourdieu, 2003). Studies have also been conducted from the standpoint of information metrics (Borner, 2003, Chen 2018).

The creation of a new WoS category would therefore attest to the scientific interest generated by certain subjects in the academic community. One of the new subject categories was 'Green and Sustainable Science and Technology'.

¹Scientific mapping is used to determine the intellectual structure of a scientific domain. Earlier studies focusing on the analysis of sustainability from a bibliometric perspective identified papers on the grounds of their keywords (Kajikawa et al 2014; Buter and Van Raan, 2013), delivering sound results. The hypothesis defined here assumes that research in the field can be examined based on the contents of the 36 sustainability journals listed under the eponymous category JCR.

Growth and development of the discipline

The three indicators used to analyse the number of papers on sustainable S&T were number and proportion per year; growth rate; and cumulative average growth rate (CAGR). The third is a useful descriptive tool for monitoring the growth of a variable over time.

Bibliographic coupling (Kessler, 1963) was used to detect possible sustainable S&T sub-specialities so as to inter-relate journals based on shared references and obtain documentary corpora of similar subject areas. Vosviewer (Waltman et al., 2010) software was used to visualise inter-journal relationships.

Subject area specialisation

Co-word analysis of keywords was used to identify the subject clusters most commonly addressed in the discipline.

Correspondence analysis was conducted to analyse these subjects over time, inter-relating

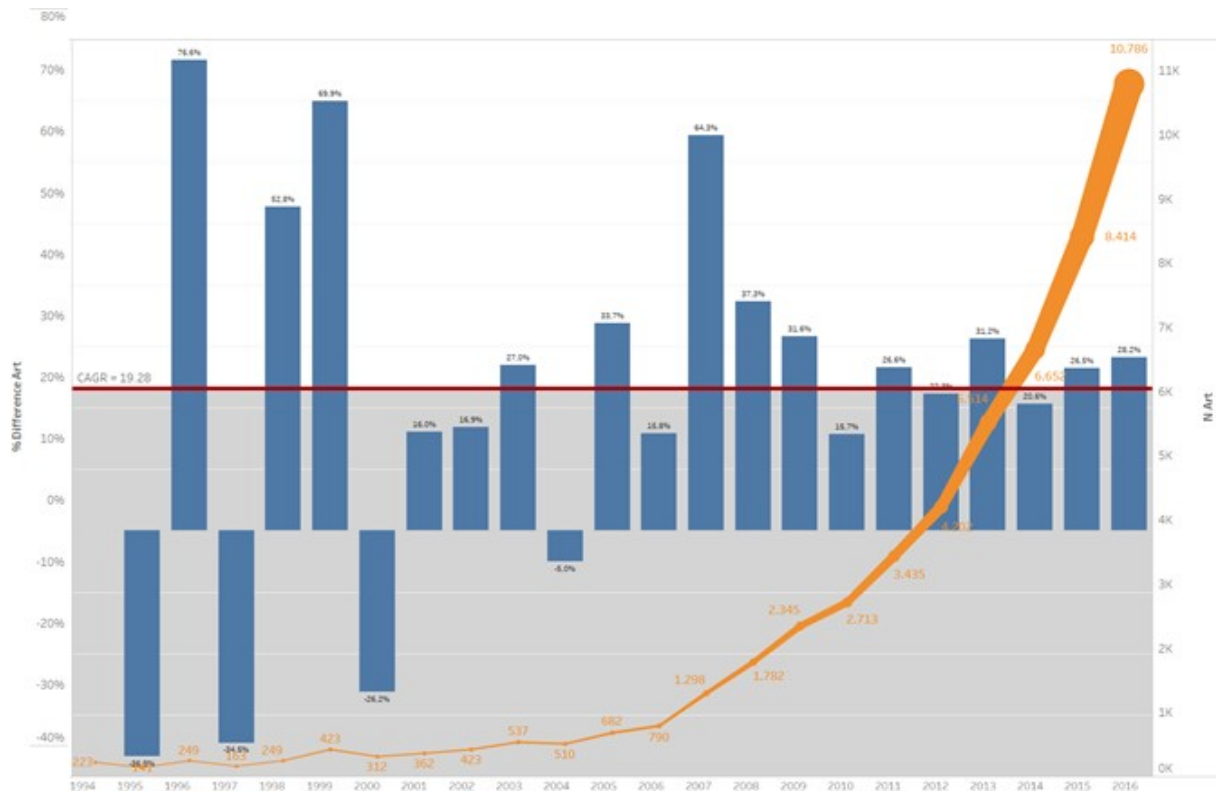
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keywords and years.

Results

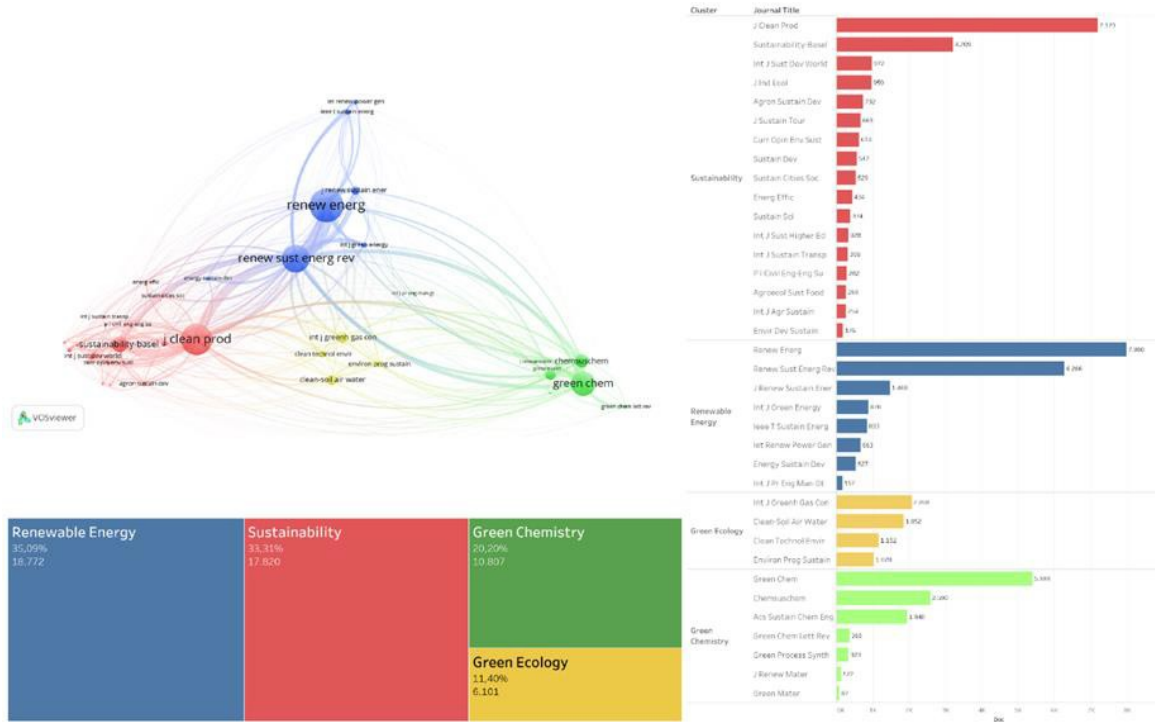
Two-thirds of the 49 065 sustainable S&T papers collected for the years 1994 to 2016 were published after 2012. The orange line, which plots the number of papers by year. The bars denote year-on-year growth, which was positive throughout the period except in 1995, 1997, 2000 and 2004. CAGR (19.28 %) as shown by the red line in the figure 1.

Figure 1. Scientific output, 1994-2016



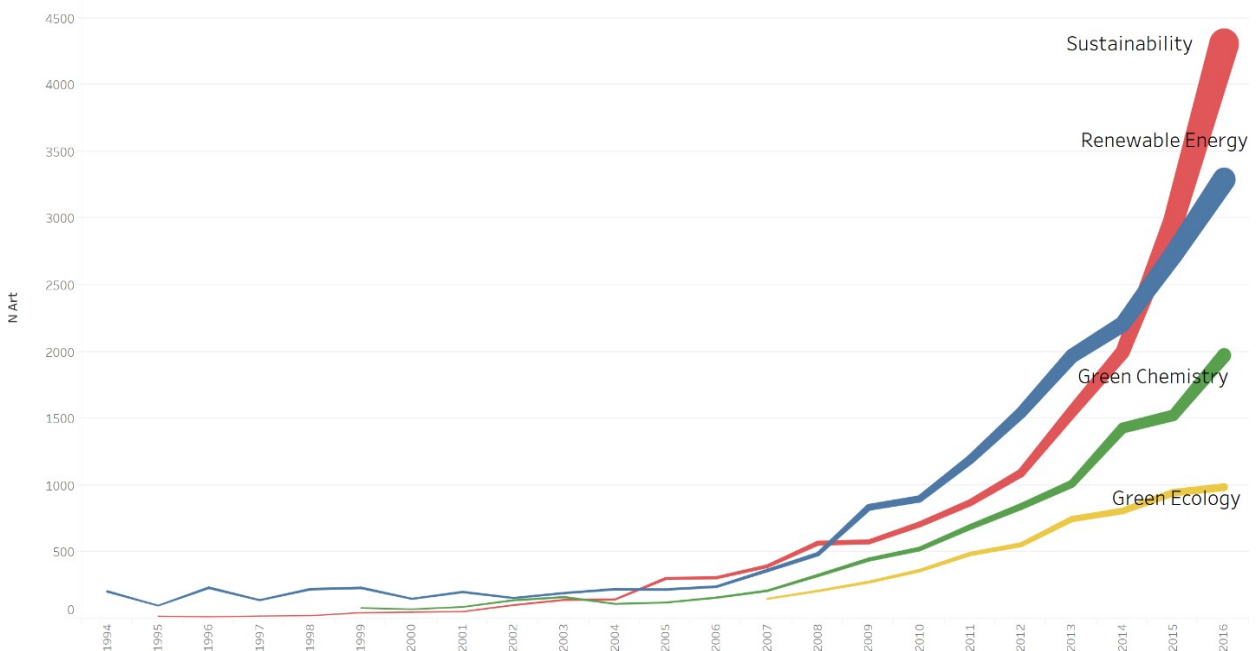
Bibliographic coupling of the journals yielded four subject clusters (see Figure 2): sustainability, renewable energies, green chemistry and green ecology.

Figure 2. Structure of WoS category ‘Green and sustainable S&T’



Renewable Energies, the first cluster to appear, had a small output until 2007 when the growth model underwent abrupt change. The earliest papers in the sustainability cluster, in turn, date from 1995, likewise with very slow growth in the first 10 years. The rate rose in 2005-2011 and with the acceleration recorded after 2012 sustainability became the most productive cluster in the area in 2014. The pattern observed for green chemistry, which appeared in 1999, ran parallel to sustainability until 2012. The first green ecology journals appeared in the Web of Science in 2007 (Figure 3).

Figure 3. Scientific output by cluster, 1994-2016



The co-word analysis of the journals listed under the WoS category sustainable S&T identified nine clusters, shown in Figure 5 with the constituent terms and their inter-relationships.

Discussion

The recently created subject category ‘Green and Sustainable Science Technology’ is an area ripe for study by application of mapping techniques. It has been found that the journals linked to Green's thematic area began to be published in 1994, but it was not until 2006 that the discipline began to grow exponentially; in fact, only 8 of the 36 journals currently in the category were active at that time.

Bibliographic coupling revealed the presence of four clusters of journals, labelled Sustainability, Renewable Energies, Green Chemistry and Green Ecology.

In this work we intend to reveal in a retrospective way which have been the first steps in the appearance and development of a new discipline, in this sense, the relational structure of the keywords has been shown. In addition, mainstream and emerging subject areas were determined by on the grounds of keyword dynamics analysis.

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