

A Bibliometric Study of Research Activity in Sustainable Development

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Introduction

In this paper we present a bibliometric study of research activity in Sustainable Development. Sustainable Development concerns nature (e.g., climate, ocean, rivers, plants, and other components of the natural environment), artifacts (e.g., machinery, biotechnology, materials, chemicals, and energy), and society (e.g., economy, industry, finance, demography, culture, ethics, and history) (Le'le', 1991; Goodland, 1995). In recent years, Sustainable Development and its various sub-areas such as Renewable Energy and Climate Change have been declared as national priority areas by numerous countries and international organizations. Given the recognized critical need for countries to develop more sustainable development paths and the rapid increase in resources now being invested in this area, it becomes important to clearly understand the current state of research activity in this area. For this quantitative bibliometric analyses are well suited, but conducting such analyses in highly interdisciplinary and emerging areas like this is highly challenging.

Previous bibliometric analyses of research activity in Sustainable Development have procured scientific articles by searching for the term "sustainability" or "sustainable" in the titles, abstracts and keywords (Yarime et al., 2010; Kajikawa et al., 2007). But such an approach cannot adequately retrieve articles in the field and cannot be used to conduct analyses of research activities in the sub-areas. Our

present work seeks to build a rich hierarchy representing the field of Sustainable Development and its sub-areas. Since Sustainable Development is highly inter-disciplinary in nature and yet evolving, it has been a matter of debate as to what should be included in a definition of the field. There have been efforts to provide a research core and framework of Sustainable Development by identifying sub-areas of Sustainable Development through bibliometric analysis (Kajikawa, 2008). In particular, using topological clustering, Kajikawa et al. (2007) identified the following sub-areas of sustainability science: Agriculture, Fisheries, Ecological Economics, Forestry, Business, Tourism, Water, Urban Planning, Rural Sociology, Energy, Health, Soil, Wildlife and Climate Change. In this paper we use this taxonomy as our definition of Sustainable Development and its sub-areas.

Methodology

A combination of bottom-up and top-down approach is adopted where we identify the keyword queries for each sub-area and then take the union of these to create the query for Sustainable Development as a whole. Keywords are associated with the various nodes in the taxonomy. A set of keywords generally relating to Sustainable Development is associated with the top-level node. Sub-area nodes are associated with keywords that are specific to work in that area. This is needed for two reasons. First we must be able to identify articles in each of the sub-areas. Second, articles

specific to a sub-area of Sustainable Development may not mention terms like “sustainability”, so a query to retrieve all articles in Sustainable Development must contain these field-specific terms such as “organic photovoltaics” which is relevant to solar energy. Some terms that have field-specific meanings can have additional meanings in other fields, so these are ANDed with (“sustainable development” OR “sustainability”) to restrict their meaning. (Other methods of restricting scope are possible such as limiting to a set of journal titles or excluding a set of journal titles.) The query for Sustainable Development overall is then taken to be the union of all keywords for all nodes in the hierarchy. The query for each sub-area is simply the set of keywords associated with that node. Retrieval is performed on the Scopus database with keywords in the query matched against keywords in the title, list of author defined keywords, and abstract.

In this paper, we examine research activity of nine countries which have the highest number of publications in Sustainable Development during period 2000 to 2008: USA, United Kingdom, China, Canada, Germany, Australia, Japan, France and Spain. We analyze research strengths in terms of publications and citations. A sliding time window is utilized to capture citation activity and to smooth small random variations from year to year in order to better highlight important trends. To determine this time window, we computed the median citation half-life of scientific articles in Sustainable Development, which turns out to be six years. Consequently, we utilize six-year sliding window to plot the publication output and citation counts, e.g. papers published in 2000 get 6 years citation time including publication year i.e. till year 2005.

Results and Discussion

Figure 1 shows that USA is by far the leading country in terms of number of

publications and citations. China and UK are very close in publication output in the most recent time window i.e. 2003-2008, while UK is considerably ahead of the remaining countries in citations and has increased its lead in recent years. China’s strong steady growth in publication output has resulted in China overtaking Germany, Canada, and the UK in terms of publications in recent years. While China stands second to USA in terms of publication output, it shows relatively less strength in terms of citations and stands just above Spain.

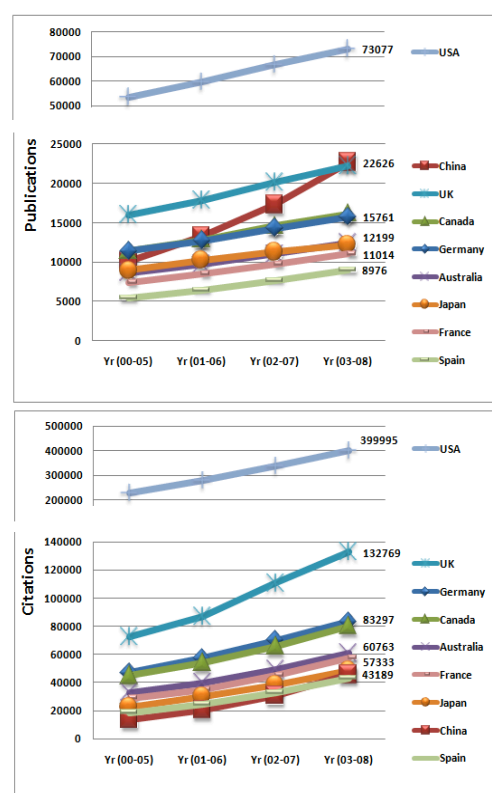


Fig 1: Publication output and citation counts in Sustainable Development

Table 1 shows publication output of the countries in Sustainable Development and the sub-areas Renewable Energy and Climate Change relative to their total publication output during 2003-2008. While Figure 1 showed USA and China to be dominant in terms of absolute numbers of publications and citation in 2003-2008, they do not appear in top tier in Sustainable Development in terms of their relative publication output during the same

time window. Using this measure, Australia and Canada are ahead of the other countries in Sustainable Development and sub-area Climate Change. Germany and Japan show high level of relative publication output in Renewable Energy.

Table 1. Publication output of selected countries in Sustainable Development and its sub-areas (Renewable Energy and Climate Change) relative to their total publication output during 2003-2008.

| | % Sustainable Development Pubs | % Renewable Energy Pubs | % Climate Change Pubs |
|-----------|---|----------------------------------|--------------------------------|
| Australia | 5.05% | 0.51% | 1.25% |
| Canada | 4.27% | 0.47% | 1.21% |
| Spain | 3.23% | 0.64% | 0.73% |
| UK | 3.16% | 0.51% | 1.04% |
| USA | 2.73% | 0.53% | 0.76% |
| Germany | 2.49% | 0.73% | 0.82% |
| France | 2.40% | 0.50% | 0.82% |
| China | 2.27% | 0.65% | 0.48% |
| Japan | 1.81% | 0.71% | 0.46% |

Concluding Remarks

The analysis of relative publication output shows rather different focuses. Countries that are active in Sustainable Development may not show the same level of activity in all of its sub-areas. This kind of information is important to guide government research policy makers and funding agencies. Similar analyses can be conducted at university level to understand how to more effectively nit together the various niche strengths in a country, to help universities to find strategic partners that can complement their strengths, and make important resource allocation decisions.

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