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ScienceDirect

Procedia Environmental Sciences 31 (2016) 65 – 74

Procedia Environmental Sciences

The Tenth International Conference on Waste Management and Technology (ICWMT)

Global trends and performances of publication on sewage sludge from 1991 to 2012

Yunyi Li , Shuai Shi , Li Zhang, Yangsheng Liu*

College of Environmental Sciences and Engineering, Peking University; Beijing Key Laboratory for Solid Waste Utilization and Management, Beijing 100871, China

Abstract

This study is a bibliometric analysis of sewage sludge researches to quantitatively and visually evaluate the global publication trends and research emphases using the Science Citation Index Expanded (SCI-Expanded) database from 1991 to 2012. Both "evaluative bibliometrics" and social network analysis methods were used to analyze the following aspects: publication characteristics, publication performances and collaborations of countries/territories and research emphases on author keywords, words in title and hotspots. An evaluating indicator, a-index, was applied to value the journals. The most productive country were USA, while the most productive journal was Bioresource Technology. Based on the network analyses of author keywords and words in title and the analysis of hotspots, "compost" and "anaerobic digestion" were the most popular disposal and treatment methods. "Heavy metals" were the contaminants with the greatest concerns. "Organic matters" such as "PPCPs" (abbreviation of pharmaceuticals and personal care products) and "PBDEs" (abbreviation of polybrominated biphenyl ethers) attracted comprehensive attention in recent years. "Soil" owned the most intimate relationship with sewage sludge due to its frequent appearance in titles and abstracts as an important approach for sewage sludge disposal.

Peer-review under responsibility of Tsinghua University/ Basel Convention Regional Centre for Asia and the Pacific

Keywords: sewage sludge; bibliometric; trend; performance; network analysis

1 Introduction

Sewage sludge is the solid, semisolid, or liquid organic material that results from the treatment of domestic

* Corresponding author. Tel.: +86-10-62751756; fax: +86-10-62751756.
E-mail address: yshliu@pku.edu.cn

Peer-review under responsibility of Tsinghua University/ Basel Convention Regional Centre for Asia and the Pacific
doi:10.1016/j.proenv.2016.02.009

wastewater by municipal wastewater treatment plants (WWTPs). The wastewater contains domestic wastewater alone or with industrial wastewater and run-off from various sources that must be treated prior to municipal sewers[1,2]. With WWTPs springing up in many countries, sewage sludge has become a particularly important problem all over the world. The annual production (dry-weight basis) of sewage sludge in European Union increased from some 5.5 Million tonnes per year (Mton/year) in 1992 to more than 10 Mton/year in 2010[3]. Annual production (dry-weight basis) in United States (USA) reached nearly 8 Mton/year[4] and that in China came to 9 Mton/year in 2010[5]. Contaminants like heavy metals, organic pollutants and pathogens in wastewater are concentrated in sewage sludge through wastewater treatment process, which threaten environment and human health. Sewage sludge possesses high contents of moisture and organics depending on the original pollution load of wastewater, making it difficult for the sewage sludge to be treated or disposed of[1,6,7]. In recent years, many researchers have been attracted to this field.

Since Hering[8] and Winslow[9] published the first two sewage sludge research articles on American Journal of Public Health in 1912, nearly 1,000 publications have been published on various aspects of sewage sludge, such as landspreading[6], composting[10], incineration[11] and landfilling[12]. However, no systematic analysis of the scientific research on sewage sludge has been carried out to date. A common systematic research instrument, bibliometric method, has already been applied to measure scientific trends in many themes of science and engineering, including solid waste[13], risk assessment[14], Helicobacter pylori[15], Meta-analysis in psychology[16]. Furthermore, the Science databases in Thomson Reuters Web, especially Science Citation Index Expanded (SCI-Expanded), have been widely used to analyze research performances from an international perspective[17]. Since Narin et al.[18] first proposed the concept "evaluative bibliometircs", many publications about the evaluation of the research trends through countries, and journals of a group of publications have been reported[19,20].

In addition, network analysis was introduced into bibliometric research in recent years and was used to indicate the research trends. Ding et al.[21] employed co-word analysis to reveal patterns and trends in information retrieval field during the period of 1987 – 1997. Lee and Su[22] used research focus parallelship network, keyword co-occurrence network and a two-dimensional knowledge map to understand the knowledge structure of electrical conducting polymer nanocomposite field. Zhu and Guan[23] applied small world complex network proposed by Watts and Strogatz[24] to analyze research in service innovation field.

Both "evaluative bibliometrics" and network analysis were applied to evaluate not only publication characteristics including document type, publishing trend, journal, publication performances and collaborations including country level, but also research emphases including author keywords, words in title and hotspots. Network analysis was first used to analyze words co-occurrence in title replenishing the analysis of author keywords co-occurrence network to obtain hotspots in the sewage sludge field.

2 Material and methods

2.1 Data collection

Data in the present study were based on the online version of the Science Citation Index Expanded (SCI Expanded), the Thomson Reuters Web of Science. In order to retrieve the publications in the subject of sewage sludge, the search was performed in topic field (including title, abstract, author keywords and keywords plus) and used keywords "sewage sludge*" and "biosolid*". Biosolid was often used as an interchangeable term of sewage sludge in USA or a term to describe sewage sludge that has had additional processing for land application in other situation[2]. Documents were restricted from 1991 to 2012, for abstracts have been added to each publication in SCI Expanded Since 1991.

A total of 13156 publications were initially retrieved. However, keywords plus were significant keywords from cited-by papers assigned to the source documents[25-27], which means that publications in which the keywords "sewage sludge*" or "biosolid*" only appeared in the keywords plus field (n = 4187) were not closely related to the subject. To be accurate, this study removed these publications and focused on publications where retrieve keywords appeared in titles, abstracts or author keywords[16].

2.2 Data analysis