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Bibliometric indicators for sustainable hydropower development

M.Y. Han[a,1], X. Sui[b,c,1], Z.L. Huang[b,c,*], X.D. Wu[a], X.H. Xia[d], T. Hayat[e,f], A. Alsaedi[e,*]

[a] College of Engineering, Peking University, Beijing 100871, PR China
[b] Research Center for Sustainable Hydropower Development, China Institute of Water Resources and Hydropower Research, Beijing 100038, PR China
[c] National Research Center for Sustainable Hydropower Development, Beijing 100038, PR China
[d] Institute of China's Economic Reform and Development, Renmin University of China, Beijing 100872, PR China
[e] NAAM Group, Faculty of Science, King Abdulaziz University, Jeddah, Saudi Arabia
[f] Department of Mathematics, Quaid-i-Azam University, Islamabad, Pakistan

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ABSTRACT

Hydropower fuels the overall societal development by contributing a notable proportion to the whole global power generation. Although much attention has been paid to the development of hydropower, few of them attempted to gather global systematic data and conduct a large-scale review of scientific studies. In such situation, a bibliometric approach is employed in this study to quantitatively evaluate global scientific research on hydropower sustainable development, with a long time span ranging from 1991 to 2012. 434 publications in accordance with the search criteria from Science Citation Index Expanded (SCI-Expanded) database are analyzed statistically, and assessments on research development, current trends, and future directions are conducted in regard to eight categories. By synthetically analyzing the keywords, the dominant hotspots of hydropower sustainable research could be concluded as "Turkey", "Eco-", "Small hydro-", and "Fish". Along with a comparable number of publications to the United State, the keyword "Turkey" has exhibited a notable increase since 2000, revealing its predominance in the research on the hydropower sustainable development. Increasing attention has also been directed to the prefixes "Small hydro-" and "Eco-" in recent years. The keywords related to fish are identified from the keyword analyses as well, suggesting that the significance of fish studies has been recognized by researchers. Given the trend during the past several years, these topics are likely to become primary research focuses in the coming period.

1. Introduction

The world witnesses a rapid economic growth stimulated by urbanization. As the essence of urban sustainable development, a tremendous consumption of fossil fuel energy can be an impulsive force in industrialization and overall societal development. According to International Energy Agency (Clerici, 2004; IEA, 2008), urban areas maintain the dominance in global primary energy demand and energy-related carbon dioxide (CO_2) emissions respectively responsible for 67% and 71% in 2006. As for methane (CH_4) emissions, it is estimated that urban activities contributes to 7–15% of the global anthropogenic methane emissions (Wunch et al., 2009). A series of studies have been carried out to analyze the energy use and greenhouse gas emissions on different scales, covering the global scale (Chen and Chen, 2011a,b, 2013), regional scale (Chen and Chen, 2010; Chen and Zhang, 2010; Chen et al., 2010; Zhang and Chen, 2010a,b), and local scale (Chen et al., 2013; Guo et al., 2012; Li and Chen, 2013; Li et al., 2013).

Mainly consisting of carbon dioxide, methane, nitrous oxide, energy-related greenhouse gases (GHGs) are considered as the incentive for climate change. A large proportion of the GHGs stay in the atmosphere for long periods of time. As a result, even though no further atmospheric GHG is released into the atmosphere, surface air temperatures would continue to rise. It is expected that the average global temperatures will increase by 2–11.5 °C by 2100, depending on the outcomes from various climate models (National Research Council, 2010). The potential climate change impacts society and ecosystems in a broad variety of ways, e.g., influencing rainfall and agricultural crop yields, affecting human health, causing changes to forests and other ecosystems, or even impacting energy supply.

In recognition of the possible damages above, it is necessary to slow down the pace of economic growth to satisfy the current

* Corresponding authors at: Research Center for Sustainable Hydropower Development, China Institute of Water Resources and Hydropower Research, Beijing 100038, PR China; NAAM Group, King Abdulaziz University, Jeddah, Saudi Arabia. Tel.: +86 10 62767167; fax: +86 10 62754280.
E-mail addresses: hzliwhr@gmail.com (Z.L. Huang), aalsaedi@hotmail.com (A. Alsaedi).

[1] The authors contributed equally to this work.

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demands without compromising the ability of future generations to meet their own needs (Brown and Sovacool, 2007; Gallego Carrera and Mack, 2010; Liu et al., 2013; Parris and Kates, 2003). Global goals have been put forward to adapt economic development to resource utilization, environmental protection as well as a sustainable societal development (Onat and Bayar, 2010; Ribeiro et al., 2011; Sternberg, 2008; World Commission on Environment and Development, 1987). As part of the Kyoto Protocol, many developed countries have agreed to legally binding limits in their emissions of GHG in two commitments periods. 15 European Union (EU-15) members have made a commitment to reduce their collective emissions to 8% below 1990 levels by the years 2008–2012 (United Nations Framework Convention on Climate Change, 2009). Though not required by any binding targets under the Kyoto Protocol, the developing countries are still committed under the treaty to reduce their emissions.

Several approaches can be put into action to mitigate climate change. Aside from the exiting solutions including promoting the energy utility efficiency, improving industrial practices, and cleaning energy sources, renewable energy is also deemed as a crucial part of worldwide low-carbon development strategy. Around 13.1% of global primary energy supply was produced by renewable sources in 2009, and 19.5% of global electricity generation and 3% of global energy consumption for road transport were contributed by renewables in the same year (Birol, 2010). Several ecological analysis methods have been applied to analyze real-life case studies (Chau, 2007; Muttil and Chau, 2006, 2007; Wu and Chau, 2006; Xie et al., 2006; Zhao et al., 2006). Besides, the researches focusing on the renewability of a series of ecological engineering works have been conducted (Chen et al., 2011a,b,c,d; Han et al., 2013; Shao and Chen, 2013; Shao et al., 2013a,b; Yang and Chen, 2013; Yang et al., 2013). The aforementioned studies have enhanced the understanding of ecological performances of renewable engineering and provided useful recommendations for its management. As one-fifth of the world's power generation contributor, hydropower, due to its huge reserves as well as its economic and social benefits, is regarded as the vital part to orient the development of renewable energy, thus playing a positive role in the sustainable development (Caspary, 2009; Integrated Healthcare Association, 2007).

Critical remarks have been made among the topic of hydropower development. Regarding energy supply, hydropower can help optimally allocate resources, preserve fossil energy resources, improve power source structure, and optimize the electricity network (Liu et al., 2013; Tang et al., 2012). In terms of the social aspect, hydropower can be interrelated with flooding, supplying water, and making rivers navigable (International Commission on Large Dams, 2012). Besides, hydropower contributes to land irrigation and erosion prevention (Pérez et al., 2008; Sternberg, 2010; Yu and Xu, 2012). However, regarding the requirement of sustainability, relatively high initial capital costs as well as the social and environmental concerns are unfavorable to the sustainable development of hydropower. There are also some influences on river flows, ecosystem regimes, and flooded areas, which can result in resident relocation, loss of agricultural land, silt deposition, and impacts on certain sensitive species (Ashraf et al., 2007; Nadim et al., 2007; Sherman et al., 2007; Yüksel, 2010).

Although much attention has been paid to the development of hydropower, few of them attempted to gather global systematic data and conduct a large-scale review of scientific studies related to hydropower sustainable development. As mentioned above, deploying a sustainable hydropower development strategy has become a common goal for the coordinated development of society, economy, and environment. To address this literature gap, we aim at performing a systematic evaluation of peer-reviewed literature concerning the global trends of hydropower sustainable development with 434 target publications in this study.

2. Methodology and data sources

Coined by Alan Pritchard in 1969, bibliometrics is a set of methods to quantitatively analyze academic literature and describe distribution patterns within a given topic, field, institute, or country (Ho, 2008; Pritchard, 1969). Furthermore, based on the online base Science Citation Index Expanded (SCI-Expanded), the bibliometric method can assess development trends or future research orientations using author keywords, title keywords, and keywords plus (Li et al., 2009a,b; Zhi and Ji, 2012). Ever since statistical analyses on the keywords and title words by Garfield (1990a,b) in 1990 successfully suggested the future science directions, bibliometric analysis using keywords to analyze research trends has proved to be effective in recent years (Chiu and Ho, 2007). The article title, which calls for much deliberation from authors, would provide essential information regarding the entire paper to readers. In addition, keywords plus has been generated independently by the author keywords as a supplement to describe the paper contents (Garfield, 1990a,b).

Data used in this study are derived from the SCI-Expanded database from the Institute for Scientific Information, a part of the Thompson Reuters Corporation. The Journal Citation Reports (JCR) Science 2011 edition maintains statistical citation data. SCI indexes 8281 major science and technology journals, with citation references across 176 scientific disciplines. Considering the size, accuracy, and comprehensiveness of the data, SCI-Expanded database from ISI are applied to perform a systematic evaluation of peer-reviewed literature in this study. However, since there is no abstract included in the SCI-Expanded database before 1991, in order to adopt the same standard, articles published after 1991 were discussed in this study.

Relevant information like titles, abstract, or keywords can be collected simultaneously in a topic search. Document information includes author(s), title, source (journal title), language, document type, author keywords, addresses, cited reference count, times cited, publisher information, page count, ISSN, and subject category, among other source data. Therefore, the search keywords related to "hydropower sustainable development" or "hydropower sustainability" for 1991–2012 can be searched based on the online SCI-Expanded database, Web of Science, to compile a bibliography of all papers related to this topic.

3. Results and discussion

In this study, "hydropower" "hydroelectricity" "sustainable" "sustainability" are selected as the basic search keywords. To ensure the comprehensiveness of the search results, words such as "economic" "ecological" "environmental" "immigrant" are chosen to provide supplementary information for the list of literatures. 434 publications are obtained from the online version of SCI-Expanded, within which a long-term publication output trend could be obtained. The analyses about different document categories including publication year, authors, journals, countries, institutes, author keywords, title keywords and keywords plus of these publications are presented as follows.

3.1. Publication year

The earliest article in the SCI-Expanded database that directly related to "hydropower sustainability" was published in 1991. From 1991 to 2011, the article number increases from 2 in 1991 to 73 in 2011, followed by a decline in 2012 to 57 (shown in Fig. 1(a)), which can be attributed to an uncompleted statistical analysis in the latest year. An evident increase occurs from 1998 to 2011 due to increasing concerns on this concept.

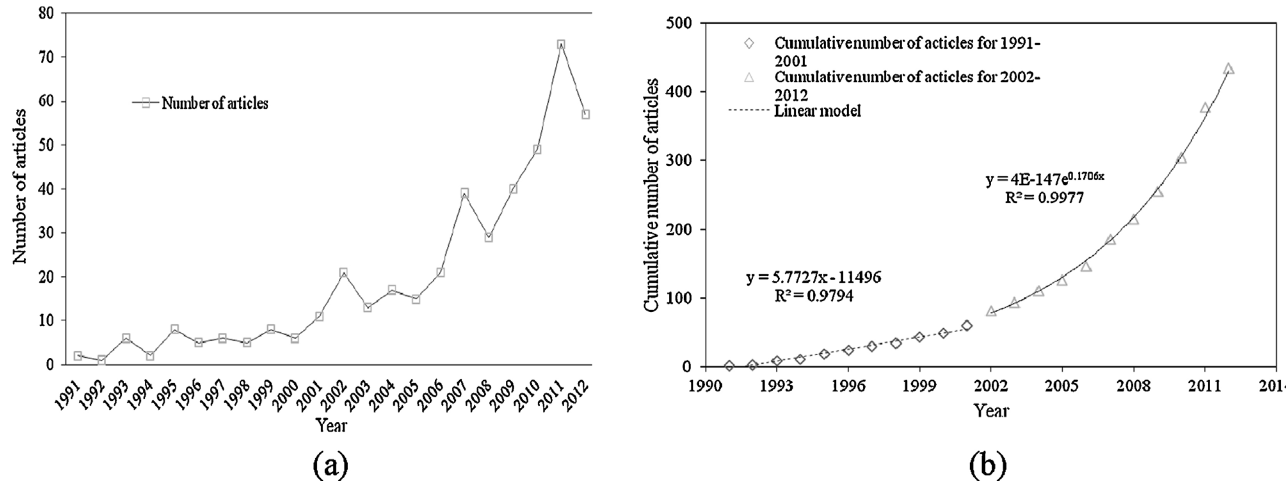

Fig. 1. The trend of (a) number of articles and (b) cumulative number of articles from 1991 to 2012.

According to Fig. 1(a), the difference in trends between 1991 and 2001, and 2001 and 2012 is significant. As a result, the linear and power models are established to describe the relationships between the annual cumulative number of articles, and the publication year for the two periods, respectively (shown in Fig. 1(b)). A correlation between the number of articles and the publication year is observed, with high coefficients of determination ($R^2 = 0.9794$ for 1991–2001, and $R^2 = 0.9977$ for 2002–2012). The linear and power curve fitting results are $y = 5.7727x - 11{,}496$ and $y = 4\text{E}{-}147\text{e}^{0.1706x}$, respectively, where y is the annual cumulative number of articles, and x is the years since 1991. The power curve fitting indicates a high growth rate for articles in the periods from 2001 to 2012. The power model predicts a respective double and triple increase in the number of future articles published in 2016 and 2018 compared with those in 2011, based on the assumption that the growth rate maintained at the level of 2001–2012.

3.2. Authors

The total number of authors related to the accounted 434 publications is 1081. The most common numbers of authors are two and single, representing 112 (25.81%) and 111 (25.58%) papers, respectively. Three and four authors are responsible for 96 (22.12%) and 56 (12.90%) papers, respectively. The article with the maximum number of authors as 23 is *NSERC's hydroNet: A national research network to promote sustainable hydropower and healthy aquatic ecosystems*. From 1991 to 2011, the article number increases from 6 in 1991 to 248 in 2011, followed by a decline in 2012 to 176 (shown in Supplement Fig. S1(a)).

Similar to the number of the articles, the linear and power models are established to describe the relationships between the annual cumulative number of authors, and the publication year for two periods, respectively (shown in Supplement Fig. S1(b)). A correlation between the number of articles and the published year is observed, with high coefficients of determination ($R^2 = 0.9649$ for 1991–1998, and $R^2 = 0.9972$ for 1999–2012). The linear and power curve fitting results are $y = 10.134x - 20{,}195$ and $y = 2\text{E}{-}172\text{e}^{0.2x}$, respectively, where y is the annual cumulative number of authors, and x stands for the year since 1991. The rapid increase in researchers in the field of hydropower sustainability indicates a prospect of more researchers participating in this field.

Among the 1081 authors, 999 (92.41%) are credited in one article, followed by 63 (5.83%) in two, and 8 (0.74%) in three. The most two productive authors are Kaygusuz, K and Yuksel, I, with the publication number of 18 and 13, respectively. Furthermore, only 1.02% of all the authors are credited in more than three articles. A model is established to describe the relationship between the number of authors and articles. Results detect a correlation by applying a power model: $X^{2.274}Y = 257.88$ (shown in Fig. 2(a)). A double logarithmic data plot depicts the linearity between the two numbers, with a coefficient of determination ($R^2 = 0.8506$) ranging from 1 to 18. Lotka's law describes authors' publication frequency, and the general Lotka model is described as: $X^nY = C$, where X is the number of articles, Y is the number of authors publishing X articles, n is an exponent, which is normally a flexible value between 1.2 and 3.5, and C is a constant depending on the specific discipline. Thus, the number of articles in the field of hydropower sustainability from 1991 to 2011 conforms to Lotka's law with reliable results.

3.3. Journals

The 434 publications are published in 161 journals. Renewable and Sustainable Energy Reviews ranks first in the number of published articles (55, 12.67%), followed by Renewable Energy (25, 5.76%), and Energy Policy (25, 5.76%). Results identify that 10 journals are responsible for more than 40% of the 434 articles. A comparison of growth trend among the top six productive journals is presented in Fig. 3(a). Results show that the total number of articles exhibits an overall growth trend from 1991 to 2011, with slight fluctuation from 2000 to 2008. In recent years, articles contributed to Renewable and Sustainable Energy Reviews increases significantly, especially in the period of 2008–2011, with a high Impact Factor (IF) of 6.018 in 2011. Based on the IF, it ranks the 4th in the subject category as Energy & Fuels compared with the other 80 journals in the same category. As for Energy Sources, it has been divided into two journals namely Energy Sources Part A-Recovery Utilization and Energy Sources Part B-Economics, Planning and Policy. Among the two journals, Energy Sources Part B-Economics, Planning and Policy shows a declining trend in the recent years.

Among all the 508 journals, 97 (22.35%) of them publish one article on hydropower sustainability, and 27 (6.22%) journals publish two. A correlation between number of journals and articles is observed with a power model (shown in Fig. 2(b)), followed by the curving fitting results as $x^{0.601}y = 14.529$. A double logarithmic data plot shows the linearity between the number of journals and articles, with a coefficient of determination ($R^2 = 0.7275$) ranging from 1 to 55.

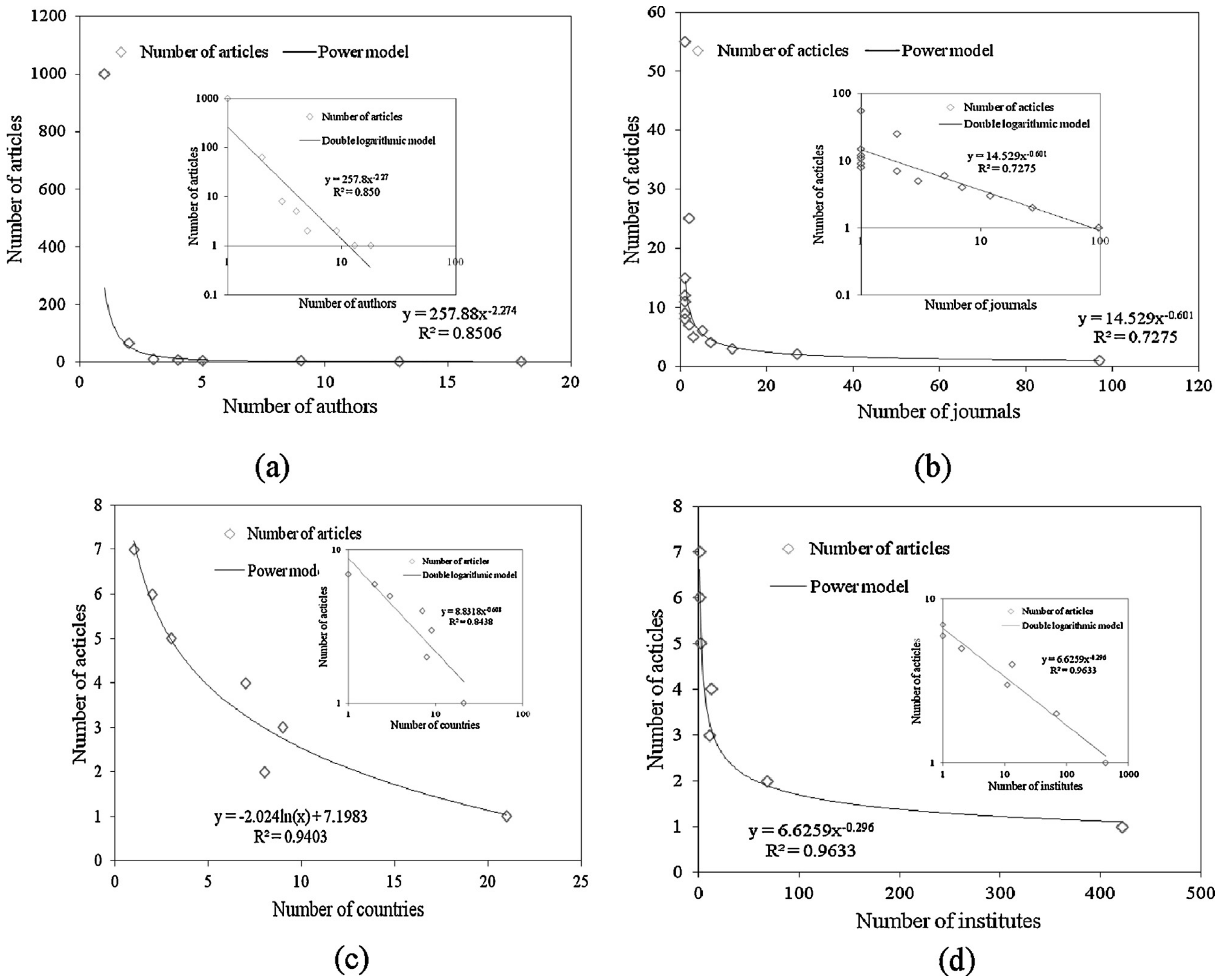

Fig. 2. The curve fitting of relationship between (a) number of articles and authors, (b) number of articles and journals, (c) number of articles and countries, and (d) number of articles and institutes.

3.4. Countries and institutions

The contribution of countries and institutions is estimated by affiliation location of at least one author of the published paper. Due to a lack of author address information, seventeen articles are excluded from the total 434 papers.

3.4.1. Countries

Of the remaining articles from 68 countries, approximate one third of the world's countries are involved in hydropower sustainable research during the last 22 years. The United States, Turkey, Brazil, China are the four dominant countries generating publications on hydropower sustainability. Results indicate that the United State is identified as the largest contributor with a number of 81 (33%) publications in total, followed by Turkey with a number of 75 (14%). In addition, the seven major industrialized countries (G7: Canada, France, Germany, Italy, Japan, the UK, and USA) rank in the top 15 for total publications, making up 32.69% of the total from 1991 to 2012. Furthermore, three developing countries namely China, India, and Brazil are listed in the 10 most productive countries. Publication trends for the four most productive countries (i.e., the United States, Turkey, Brazil, China) reveal the predominance of the United States and Turkey in the research on hydropower sustainable development since 2000 (shown in Fig. 3(b)).

Among the 68 countries revealed in this research, 21 (64%) countries have only one article related to hydropower sustainable research, 8 (14%) two articles, and 9 (6.7%) three articles. An evident correlation between number of institutions and articles is observed by applying a logarithm model (shown in Fig. 2(c)) with a high coefficient of determination ($R^2 = 0.9403$). A double logarithmic data plot exhibits the linearity between the number of countries and article, with a curve fitting result as $x^{0.608}y = 8.8318$ ranging from 1 to 81.

3.4.2. Institutions

The 434 articles represent 543 institutions from 68 countries, in which Karadeniz Technical University (25), Sakarya University (13), Chinese Academy of Sciences (9) University of Split (9) University of Zagreb (9) are the top five research institutions (shown in Fig. 3(c)). It should be noted that the Chinese Academy of Sciences is an integrated research center with many independent branches throughout the country.

Among the 543 institutions revealed in this search, 422 institutions have only one article related to hydropower sustainable research, 68 two articles, and 11 three articles. A significant correlation between the number of institutions and articles is observed by applying a power model (shown in Fig. 2(d)), with a curve fitting result of $x^{0.296}y = 6.6259$. A double logarithmic data plot exhibits a

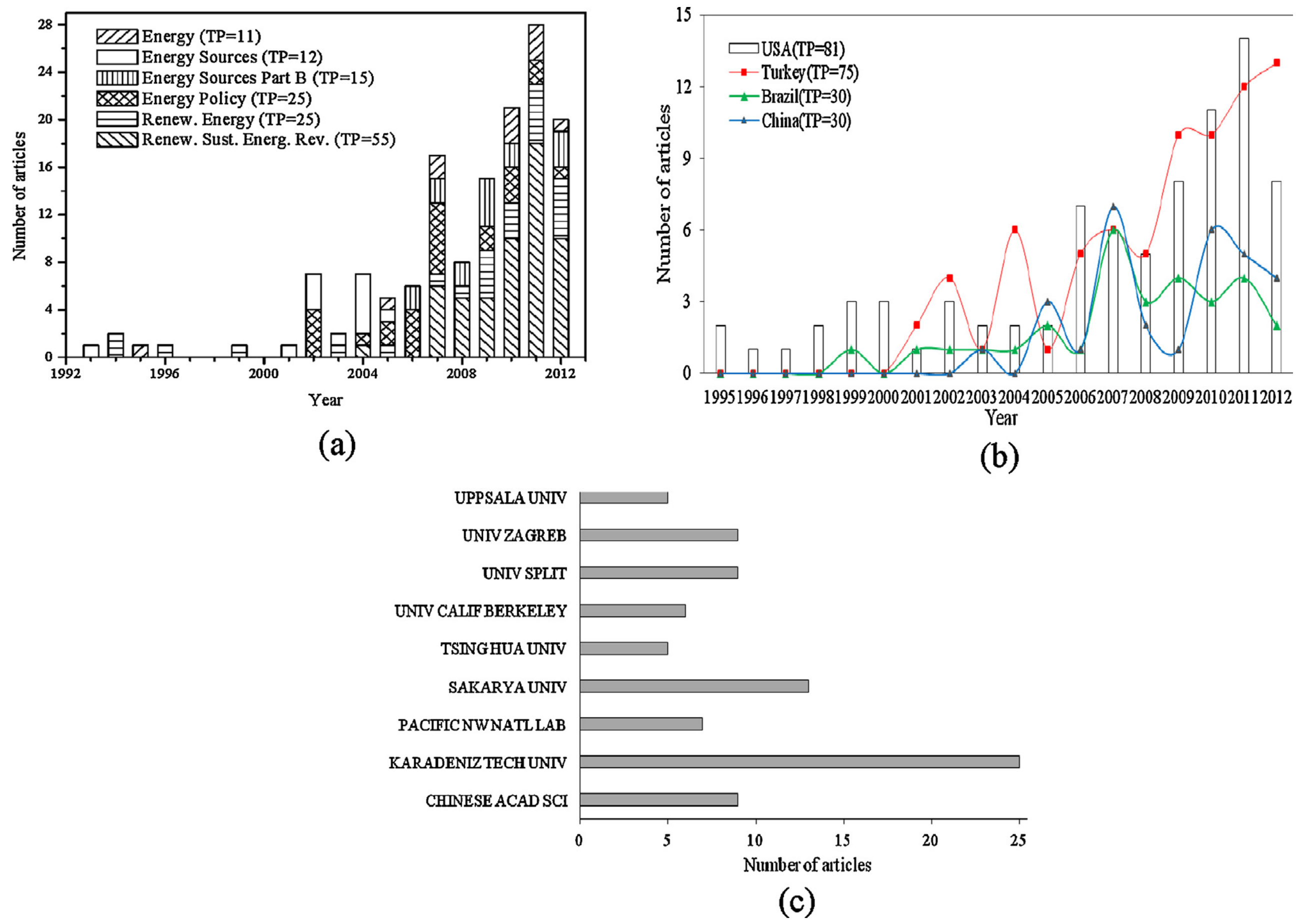

Fig. 3. (a) The number of articles of the six most productive journals, (b) The trends of the article number of the four most productive countries, and (c) The number of the articles of the nine most productive institutes.

good linearity between the two numbers, with a high coefficient of determination ($R^2 = 0.9933$) ranging from 1 to 25. The results indicate the majority (66.71%) of the 543 institutions published no more than three articles related to hydropower sustainable research during the last 22 years. Each institution made a limited contribution individually, while the institutions made a substantial contribution to the number of publications cumulatively.

3.5. Author keywords, title words, and keywords plus

Author keywords, title keywords, and keywords plus are used to provide a reasonably detailed panorama of article theme and focus in this paper.

3.5.1. Author keywords

In terms of author keyword records, 343 articles in the SCI-Expanded database are analyzed. Discontinuity in the research or a diverse research focus may lead to the fact that the use frequencies of large number of author keywords are less than three times (Li et al., 2009a,b). In addition, the various usages of synonymous terms, spelling variations, and abbreviations might not be standard or widely accepted by researchers. The top 20 commonly used author keywords for the study are listed in Table 1, using 5-year intervals to guarantee a reasonable time-span, as well as to minimize year-to-year fluctuations.

Excluding those top search keywords (“Hydropower”, “Sustainable development” and “Sustainability”), which are the topic search keywords, “Renewable energy” (80), “Turkey” (31), “Energy policy”(13), “Biomass” (13), “Dams” (10), “Energy utilization” (9), “Climate change” (9), “China”(9), “Solar energy”(8), and “Small hydropower” (8) remain as the top 10 commonly used author keywords (Table 1). Besides, “Eco-” (22) and “Small hydro-” (20) are frequently used prefixes in the author keywords. The trends of the four most concerned author keywords are depicted in the Supplement Fig. S2(a).

During the entire period concerned, the author keyword “Turkey” is on a rapid rise between 2008 and 2010, with the highest value in 2012, while the author keyword “China” shows a steady rise during 2001–2010. It should be noted that the use frequency of “small hydro-” (e.g. “small hydropower plant (SHP)” “small hydropower” “small hydroelectric power station”) reaches a peak in both 2007 and 2011. The increased attention is also given to the prefix “Eco-” in recent years, with the related author keywords, e.g. “Eco-tourism” “Ecosystems” “Ecosystem services” “Ecosystem rehabilitation” “Ecosystem-mapping” “Ecosystem index for sustainability” “Ecosystem goods and services” “Eco-labeling” “Ecological land classification” “Ecological services”. The author keywords related to fish (i.e. “Atlantic salmon” “Brown trout” “Fish” and “Migratory fish”) (14) are identified from the word analysis, suggesting that the significance of fish studies has been recognized by researchers in recent years.

3.5.2. Title keywords

The analyses on single title word are also undertaken in our study. Individual words can be used to identify the authors’ focus and emphasis (Zhang et al., 2010). Prepositions, including “of” and “in”, are frequently used in titles, however these words obviously make no sense in a research trend analysis. Therefore, “of” “to” “in”

Table 1
20 most commonly used author keywords from 1993 to 2012.

Author keywords	Total	1993–1997	1997–2002	2003–2007	2008–2012
Renewable energy	79	2	4	13	60
Hydropower	62	1	11	10	40
Sustainable development	57	1	7	18	31
Turkey	31	1	0	6	24
Sustainability	22	0	1	1	20
Energy policy	13	0	0	4	9
Biomass	13	0	2	3	8
Dams	10	0	3	3	4
Energy utilization	9	0	1	2	6
Climate change	9	0	0	0	9
China	9	0	1	4	4
Solar energy	8	0	0	2	6
Small hydropower	8	0	0	5	3
Electricity generation	8	0	0	4	4
Electricity	8	0	0	3	5
Biodiversity	7	0	0	2	5
Environment	7	0	2	2	3
Optimization	7	0	0	0	7
Renewable energy sources	7	0	1	0	6
Water resources	7	0	1	0	6

Table 2
15 most commonly used title word from 1991 to 2012.

Keywords plus	Total	1993–1997	1997–2002	2003–2007	2008–2012
Sustainable development	35	1	1	7	26
Hydropower	28	0	2	4	22
Energy	27	0	2	7	18
Future	27	0	3	1	23
Renewable energy	21	0	1	2	18
Power	19	0	1	4	14
Biomass	16	0	2	4	10
Management	16	0	4	3	9
Systems	16	0	0	2	14
River	14	0	2	5	7
Turkey	14	0	1	3	10
Geothermal-energy	12	0	1	0	11
Water	12	1	1	2	8
Wind energy	11	0	0	1	10
System	10	0	1	1	8

"and" "the" "a" "an" "for" "with" "by" "using" along with other similar words are excluded from the analysis. Exclusive of the topic search keywords "Energy" "Sustainable" "Hydropower" "Development" and "Renewable", the top three most frequently used single title keywords are "Turkey" "River" and "Power", with the use frequency of 56, 51 and 36, respectively. The trends of the five concerned title keywords (i.e. Turkey, China, Reservoir, Brazil, Fish) are depicted in the Supplement Fig. S2(b). During the entire study, the title keyword "Turkey" shows a rapid rise between 2007 and 2012, with the highest value in 2012, presenting a consistent trend with that of the author keywords; the other title keywords show a slow growth trend during the study period.

3.5.3. *Keywords plus*

The keywords plus generated by ISI are words or phrases that appear in the titles of an article's references, but do not necessarily appear in the article titles. Keywords plus might be applied to articles that have no author keywords, or include important terms not listed among the title, abstract, or author keywords (Zhang et al., 2010). Keywords plus is employed just in the same way with the analysis of author keywords or title keywords. Keywords plus analysis identifies the 20 most frequently used keywords in different time periods (shown in Table 2). As a whole, the research trends revealed by keywords plus indicates that "Power" "Biomass" "Management" "River" "Turkey" as feature keywords are consistent with the analysis of author keywords, and title keywords. In addition, "Future" "Systems" "Conservation" appear exclusively in keywords plus. The keywords plus related to fish (i.e. "Brown trout", "Chinook salmon", "Habitat") also show a notable trend that is same as the analyses on author keywords and title keywords.

4. Conclusion

Due to its huge reserves as well as the economic and social benefits, hydropower will orient the development of renewable energy, thus promoting urban sustainable development. Hence deploying a sustainable hydropower development strategy becomes a common goal for the coordinated development of society, economy, and environment. Based on the 434 publications obtained from the SCI-Expanded database, a bibliometric exploration concerning the global trend is conducted to provide a systematic overview of hydropower sustainability researches from 1991 to 2012.

There are some limitations on the citation data, which are incomplete or biases to some extent, though citation indexes have be applied. Thus, with a sound understanding of the citing rationale, further efforts are required to taken to ensure the facticity and reliability of the data. Besides, this study only focused on performing a systematic evaluation of peer-reviewed literature concerning the global trends of hydropower sustainable development through different document categories including publication year, authors, journals, countries, institutes, author keywords, title keywords and keywords plus. On that basis, further studies should be conducted with the focus on the development history and driving factors of sustainable hydropower development, contributions of the previous studies, and selective analysis on academic frontiers.

The number of related published articles has shown a rapid growth from 2001 to 2012. By applying the power model in this study, it is predicted that the future number of related articles will respectively double in 2016 and triple in 2018, compared to the basis year of 2011. The most two productive authors are identified as Kaygusuz, K. and Yuksel, I., possessing a publication number of 18 and 13, respectively. Journal Renewable and Sustainable Energy Reviews ranks the first in the number of published articles, followed by Renewable Energy and Energy Policy. Among the involved 68 countries, the United States, Turkey, Brazil, China are noticed as the four dominant countries generating publications on hydropower sustainability. Karadeniz Technical University, Sakarya University and Chinese Academy of Sciences are the most reprehensive institutions among the 534 ones from the countries mentioned above.

The dominant hotspots of hydropower sustainable research are concluded as "Turkey", "Eco-", "Small hydro-", and "Fish". During the entire study, the keyword "Turkey" shows a rapid rise between 2007 and 2012, with the highest value in 2012; on the contrast, the other title keywords show a slow growth trend during the study period. It should be noted that the use frequency of "small hydro-" (e.g. "small hydropower plant" "small hydropower" "small hydroelectric power station") reaches a peak in both 2007 and 2011. Increasing attention is also given to the prefix "Eco-" in recent years, expressing by the related keywords in terms of "Eco-tourism" "Ecosystems" "Ecosystem services" "Ecosystem rehabilitation" "Ecosystem-mapping" "Ecosystem index for sustainability" "Ecosystem goods and services" "Eco-labeling" "Ecological land classification" "Ecological services". The author keywords related to fish (i.e. "Atlantic salmon" "Brown trout" "Fish" and "Migratory fish") are identified from the word analysis, suggesting that the significance of fish studies has been recognized by researchers in recent years. These topics are predicted to remain as the leading research emphases in the near future.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at http://dx.doi.org/10.1016/j.ecolind.2014.01.035.

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