# A Scientometric Analysis of Water Resource Management Research Output in Sri Lanka

T.Janen[1] and S.S.Sivakumar[2]

*[1]Library, University of Jaffna, [2] Faculty of Engineering, University of Jaffna*

**Abstract**

**This paper presents results of the Scientometrics analysis of Water Resource Management research output from Sri Lanka during the period from 1990 to 2019. Research output indexed in Web of Science database. A detailed computational analysis was done and obtained the comprehensive research output, citation impact, collaboration patterns, total research output, citation impact, collaboration patterns, top institutions/authors/publication sources. The analytical results present a detailed and useful picture of status and competence of water resource management domain research in Sri Lanka.**

**Keywords: water resource management research, informetrics, scientometric, Sri Lanka**

## Introduction

The Government of Sri Lanka has been developing water resources for the agro-economic and social wellbeing of the community. Water resources available in freshwater ecosystems in Sri Lanka are estimated as 52 BCM surface water, 7 BCM groundwater and 7 BCM overlapping water which is renewable. Out of the total water withdrawal of 13 BCM, agriculture remains the major user with current usage of 87 percent, while nearly 6 percent is for the industrial sector and another 6 percent for the urban sector (Thushara and Hornberger, 2019). Agriculture sector receives a substantial portion of government subsidies and assistance directly and indirectly, given its importance for food security and in consideration of the large number of the population dependent on the sector. Contribution towards GDP stands at around 7 to 8 % only, as per annual report 2018 of the Central Bank, while around two million people or 30% of the labour force are employed in the agriculture sector, its. Objective of water research in water resources management is to ensure the use of water resources in an effective, efficient and equitable manner, consistent with the social, economic and environmental needs of present and future generations. Sri Lankan researchers are much involved in efficient water resource management practices. Number of publications were done on this discipline from Sri Lankan researchers and there is a need to study the trend of water resource management research.

This study aims to analyse the research output published in indexed web of science database on Water Resource Management (WRM) from Sri Lanka during 1991 to 2019. WOS have been the main resources for systematic analysis of the impact of scholarly communication. It launched the Science Citation Index and citation indexing multidisciplinary as the tool for out measuring response to scientific publications. This analytical work mat reveals important and useful indicators of WRM research in Sri Lanka. The research output not only explain the status of WRM in Sri Lanka but also produce useful and relevant information for policy making. The policy makers can trace the findings with facts and figures to develop appropriate policies in WRM. Also researchers who have the interest on this topic, can find the publication trend with year wise, most productive authors on this subject, publication which has been highly cited by other authors, international collaboration among other countries on the WRM research and top sources or journals used by the Sri Lankan researchers to publish their research output.

**Research objectives**

1. To find out the annual research output of water resource management
2. To study the type of documents on WRM.
3. To analyse the authorship pattern and collaboration coefficient of WRM research output.
4. To identify the most prolific authors on WRM research publications in Sri Lanka.
5. To study the distribution of WRM publications from Sri Lanka.
6. To identify the international collaboration strength on WRM.

**Literature**

A substantial number of scientometric studies has been performed on water related topic (Zhang, L., 2019, Nishy, P., Saroja, R., 2018, Francis, D.J., and Das, A.K., 2019). Scientometric is a quantitative analysis methodology to assess the amount of research work carried out in a domain, the domain has to be defined by coverage year, scope, keywords, author collaboration, co citation coupling, and subject dominants. It measures the amount of research, by calculating various indicators using multiple publication data, as suggested by bibliometricians over the years (Singhal, K,2015 and Heilig, L. and Voß, S., 2014).

**Methodology**

This study aims to quantify the scholarly literature on WRM in Sri Lanka, published in WOS database. Published articles in WRM were collected using general search option of WOS. The search option was limited from 1990 to 2019 and 182 records were downloaded. The retrieved data were analysed using MS-Excel and R-studio. Data were analysed using R tool, according to the objectives of the study.

**Result and Discussion**

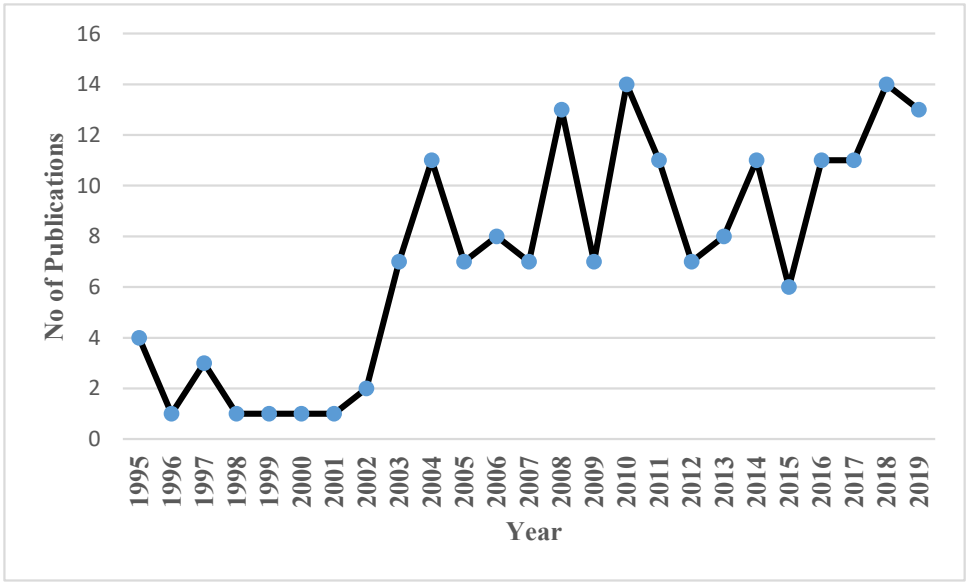


Figure 1: Distribution of research publications

**Publication trend and citation analysis**

Figure 1 shows the number of articles published in every year from 1990 to 2019. Sri Lanka has contributed 182 publications on WRM indexed in WOS during the study period. Data analysis on publications reveals that 2018 had the highest number of publications with 14 (7.69%) and the year 1996, 1998,1999,2000, and 2001 had the lowest number of publications with 1 (0.55%). There is a gradual increase in terms of number of publications from 2015 to 2019. The WRM publications having h-index of 42 and total citation received during the study period is 8223. Highest citation was observed 1428 for the article published during 2010, titled on "The ecological limits of hydrologic alteration (ELOHA): a new framework for developing regional environmental flow standards".

**Analysis of authors of publication**

Scientific communities could be conceived as clusters of researchers with essential roles in modern science (Mao et al. 2017). Authorship analysis is an important step in scientometric studies, as it's played a significant role in information dissemination and communication activities of an institution. in the present scenario, collaborative work enables the scientist from various disciplines together, to find solutions for challenges. Collaborative research publications are not limited to authors, but extended to institutions and countries.

There are 637 authors contributed for 182 publications on WRM in Sri Lanka. Among them there were thirteen articles were single authored articles while 169 were multiple authored. Collaboration index for the publications 3.9.

Table 1: Top 10 authors based on number of publications

| No | Author | Records | Citation | Average citation per item | h index |
|---|---|---|---|---|---|
| 1 | Giordano,M | 19 | 87 | 46.21 | 15 |
| 2 | Molden,D | 11 | 703 | 63.91 | 11 |
| 3 | Smakhtin,V | 9 | 196 | 21.78 | 7 |
| 4 | Qadir,M | 8 | 411 | 51.38 | 8 |
| 5 | Bastiaanssen,WGM | 7 | 417 | 59.57 | 7 |
| 6 | Bekchanov,M | 6 | 91 | 15.17 | 5 |
| 7 | Karimi,P | 6 | 231 | 38.5 | 6 |
| 8 | Hanjra,MA | 5 | 520 | 104 | 5 |
| 9 | Qureshi,AS | 5 | 320 | 64 | 5 |
| 10 | Ringler,C | 5 | 87 | 17.4 | 4 |

Table 1 showed the most productive author identified based on the number of publications with WOS during the study period. Giordano, M lead the top 10 author list with 19 publications in WRM and with h index of 15, followed by Molden, D with 11 and Smakhtin, V with 9 publications. When considering the number of citations, Molden, D leads with 703 citations for his 11 publications followed by Hanjra, MA, with 520 citations for his 5 publications and Qureshi, AS with 320 citations for his 5 publications.

**Document type**

Table 2 reveals the document types of the publications on WRM. Among the 182 publications, nearly 91% of the publications were journal articles while about 10% of them full paper published in the conference proceedings. Though only 7.7% of the publications were the review articles., the average citation recorded was the highest for them.

Table 2: Document type used by the authors

| Document type | No of records | Citations | ACPP | h index |
|---|---|---|---|---|
| Journal article | 166 (91.20%) | 6131 | 36.93 | 40 |
| Full paper of conference proceeding | 18 (9.9%) | 1605 | 89.17 | 11 |
| Review articles | 14 (7.7%) | 2075 | 148.21 | 9 |
| Book chapter | 02 (1.10%) | 446 | 223 | 2 |
| Editorial Material | 02 (1.10%) | 17 | 8.5 | 2 |

**Distribution of Research disciplines**

Table 3: Categories of WRM research disciplines

| Research discipline | No of records | Citation | Average citation per item | h index |
|---|---|---|---|---|
| Water resources | 89 (48.90%) | 4045 | 45.45 | 33 |
| Environmental sciences Ecology | 71 (39.01%) | 4259 | 59.99 | 25 |
| Agriculture | 47 (25.82%) | 2219 | 47.21 | 25 |
| Engineering | 28 (15.38%) | 904 | 32.29 | 15 |
| Geology | 15 (8.24%) | 591 | 39.4 | 13 |
| Marine fresh water biology | 9 (4.94%) | 1612 | 179.11 | 7 |
| Science technology other topics | 9 (4.94%) | 61 | 6.78 | 4 |
| Meteorology atmospheric science | 7 (3.84%) | 201 | 28.71 | 3 |
| Business economic | 6 (3.3%) | 188 | 31.33 | 5 |
| Government law | 5 (2.74%) | 208 | 41.6 | 5 |

The top 10 WOS research disciplines on WRM during the study period from 1990 to 2019. It that, water resources obtained the top rank with 89 (48.9%), followed by environmental sciences ecology 71 (39.01%), and Agriculture 47 (25.82%). The citations received for the respective research areas, environmental sciences ecology received high citation 4259 among the total citation of 8223, followed by water resources with 4045 and agriculture 2219. Marine fresh water biology having the high average citation per item was 179.11. h index explains the number of publication equal to number of citation, in this study water resources obtained the h index of 33 which means, in the water resources 33 publications out of 89 publications received more than 33 citations.

**Sources of published articles**

Top 5 sources chosen by Sri Lankan authors to publish the research articles on WRM listed in Table 7. Agricultural water management is a leading WOS indexed journal chosen by the authors. It revealed that, 14 research articles of WRM in Agriculture water management, followed by eight research articles, each by International Journal of water resource development and by Irrigation and drainage. The sources of Land degradation development and of water international published only six research articles in each of them.

Table 4: Top 5 sources research publication

| Sources | No of records | Citation |
|---|---|---|
| Agricultural water management | 14 | 1009 |
| International journal of water resource development | 8 | 294 |
| Irrigation and drainage | 8 | 208 |
| Land degradation development | 6 | 237 |
| Water international | 6 | 133 |

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**International collaboration**

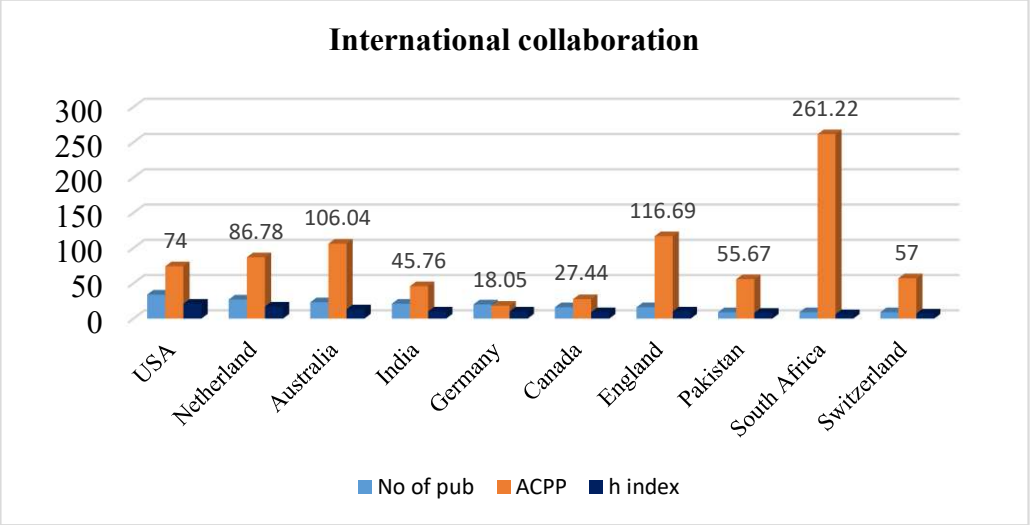


Figure 2: Country wise publication details

Figure 2 shows the international collaboration of WRM research publications. It showed the number of publications, Average Citation Per Publication (ACPP) and h index with 10 leading countries in WRM research. Out of 182 research publications, 34 were collaboratively done with USA, followed by Netherland (27), and Australia (23). Highest number of citation trailed by USA.

Highest h index was observed for USA with 21, i.e among 34 publications 21 publications received more than 21 citations, followed by Netherland 17 and Australia 13.

**Conclusion**

Research publications published in WOS database on WRM domain were analysed and computed the key parameters such as total WRM research output, impact and the trend of WRM researches. The top level authors as per the number of publications, the citations for the researches carried out in Sri Lanka on WRM domain and the journals/conferences in which these research articles published were taken into consideration. This study computed collaboration patterns nationally and internationally. Collaboration facilitated to create knowledge hub among scientific researchers. The results obtained by computation facilitated to measure the research output on WRM. The output would be useful to take policy decision towards encouraging collaborative researches and for identifying the key research professionals in the WRM domain and the institution which involves in these researches in Sri Lanka, collaborative research outcomes in the discipline of WRM would improve an efficient WRM in Sri Lanka.

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