

A Bibliometric Analysis Environmental Impact Assessment Literature: an Expanding and Shifting Focus

Milton F. Coba^{a,*}, Guillermo E. Valencia^b, Carlos H. Acevedo^c

^a PhD. Mechanical Engineering, Grupo de Investigación Ingeniería de Materiales y Tecnología de Fabricación-IMTEF, Faculty of Engineering, Universidad del Atlántico.

^b MsC. Mechanical Engineering, Grupo de Investigación en Gestión Eficiente de la Energía, Kaí, Faculty of Engineering, Universidad del Atlántico.

^c PhD. Mechanical Engineering, Grupo de Investigación de Diseño Mecánico y Mantenimiento, Faculty of Engineering, Universidad Francisco de Paula Santander.

miltoncoba@mail.uniatlantico.edu.co

A bibliometric analysis of the literature on the subject of Environmental Impact Assessment for a period from 2007 to 2015 was carried out under an expanding and shifting focus. For this purpose, the metadata used was obtained through web of science and analyzed with the Histcite software. The search identified a total of 683 publications related to Environmental Impact Assessment in the period studied, allowing to study the main journals involved in this topic. The country with the highest number of publications was the United States with 88 papers on the subject. On the other hand, the journal with the greatest influence on the subject was Environmental Impact Assessment Review, with 1090 citations, representing the 8.7% of the total citations between 2007 and 2015. Analyzing the evolution of publications per year, there was an increase in research activity on the subject between 2012 and 2014, amounting to 45.6% in those years. According to the type of document from the 683 publications, the 84.6% (578) were articles and 4.4% reviews. These results obtained show an increase in the interest of researchers in the environmental impact assessment topic, which is in line with the climate changes presented on the planet and the global concern to reduce the effects of greenhouse gas, and the better use of natural resources.

1. Introduction

Environmental impact assessment (EIA) is an analysis tool specifically designed to assess the risk involved in implementing a project on the environment and the measures needed to mitigate the damage caused, which has different stakeholders who may intentionally carry preferences in opinions, where sometimes the line between preferences and manipulation is not so clear (Cardenas and Halman, 2016), (Enriquez de Salamanca, 2018), (Williams and Dupuy, 2017), but this is only on a zonal scale, because there is a way to assess these damages in a global way, which gives a guideline for the construction of environmental laws. An indication of their importance is that approximately \$25 million was invested in 2006, in addition to the substantial bonus of research in this area (Alcamo 2017), (Riousset et al., 2017). The evaluation of the impact of a project, whether positive or negative, on the environment, affects the constitution of a country's laws, for example, in Turkey it is not permitted to initiate a project unless it has government approval or is considered not to require an EIA (Elvan 2018), (Mercure et al., 2018). In 1969, the USA created NEPA, in charge of implementing EIA as a formal legal system (Chang et al., 2017), but the implementation of this study tool prior to the development of a project varies from country to country (Galaś et al., 2015). Although significant progress has been made in the appropriate legislative and administrative development in a wide range of developing countries, implementation is still considered weak, and several authors have investigated the reasons for this trend (McCullough 2017).

The world's energy consumption is continuously increasing, where transport contributes significantly to greenhouse gas emissions, given that 95% of the world's energy consumption is dependent on fossil fuels, and also contributes 23% of CO₂ emissions, which is why the use of alternative fuels and the effect they have on clean vehicles (Bicer and Dincer, 2018) have been compared. These studies are not only limited to the

transportation industry, but also to the area of civil construction where about 7% of total CO₂ emissions are emitted and about 15% of energy is consumed worldwide, where a comparison is made between which type of cement production produces the least environmental damage and the way in which production is affected by this method (Sagastume et al., 2017). Therefore, it has become necessary to implement energy management systems and their rational use in industrial processes (Orellanos et al., 2017), (Valencia et al., 2017), (Valencia and Ramos, 2017). One of the alternative ways of obtaining energy is biogas, although the energy potential offered by it is high, its use throughout the European region is quite small and could therefore be considered an untapped source of energy; the use of biomass in specific areas of application depends on economic factors, legal and technical requirements, which are mainly delimited by geographical location and social demand, in Germany and Sweden there are 90 and 60 biomethane plants respectively, which is a high number considering the other countries of the European Union (Niesner et al., 2013).

The primary objective of this article is to provide a stochastic analysis of trends in EIA research and the impact of external events on EIA behaviour, and to take into account the impact and quality of publications in this area through parameters that allow for a clear quantitative assessment.

2. Methodology

2.1 Bibliometric methods

Bibliometrics allows us to obtain a deeper concept from a rather broad study, showing parameters that allow us to qualify quantitatively, which allows us to find patterns in the research carried out on specific subjects of interest. There is still no unification in the existing differences between scientometrics and infometria, but several authors have expressed differences between them. (Hood and Wilson, 2001), (Siluo 2017).

The bibliometric tools allow categorizing and analyzing large amounts of historical data from research conducted over a specified period of time in order to obtain metadata from the Web of Science (WoS) database. For this article, the search was performed as an "Environmental Impact Assessment" search parameter, which resulted in a total of 683 publications.

2.2 Information processing and results generation

In order to analyze the information obtained and the necessary results it is necessary to take into account 4 fundamental aspects, which allow a quantitative and qualitative analysis, in Figure 1 an example of a workflow generally used for a bibliometric analysis is shown.

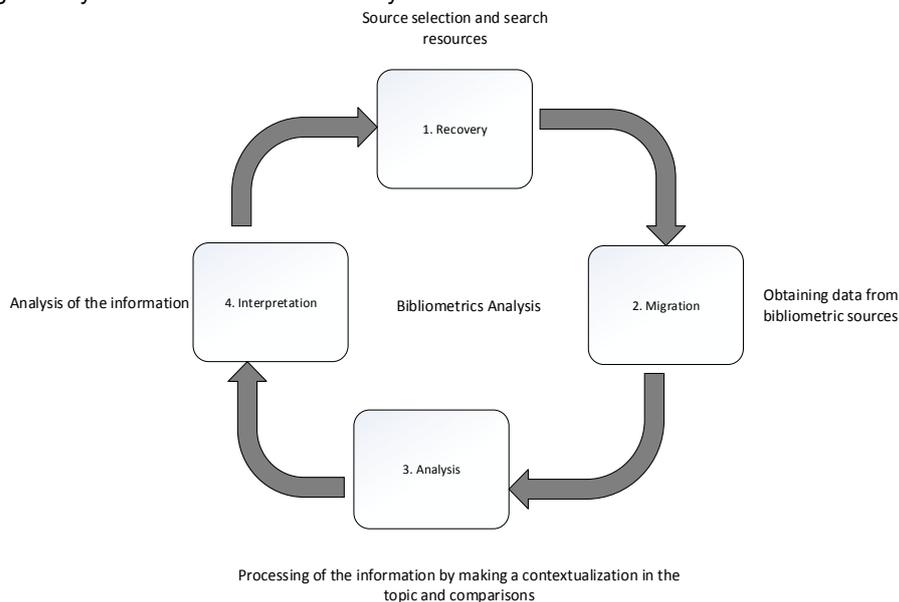


Figure 1: Process for performing a bibliometric analysis

In the recovery stage the search parameters are defined, it is defined where the metadata will be obtained and which parameters will be used to carry out the analysis, in the next migration stage the data is transferred to the Histcite software where finally the analysis is carried out, in the last stage the tables and graphs are obtained that allow a clearer visualization of the graphs.

The H index proposed by Hirsh allows the production and impact of scientific research to be measured by quantitative parameters, as well as by journals, institutions and countries. The main advantage of the H index is that it combines the quantity of documents and the quality of these texts. This article presents this index and evaluates the quality of different journals and organizations using this parameter as a rating criterion (Hirsch, 2005), (Kinney, 2007).

3. Results and discussion

In order to make an analysis of the types of documents and their impact on the total published per year, an analysis of the 4 most commonly used types is presented as a means of disseminating research on this topic, and their impact on the number of total publications per year, as shown in Figure 2a, where the Total Global Citation Score (TGCS) represents the total number of citations received in the current year throughout the WoS database. Figure 2b shows that publications on the subject of EIA were widely accepted due to the high rate of references they received, where the TGSC generally tended to increase, with respect to the type of documents used it is shown that the behavior of the publications made in the period of time studied, is mainly marked by the article type documents, the rest has a low rate of use in the scientific community.

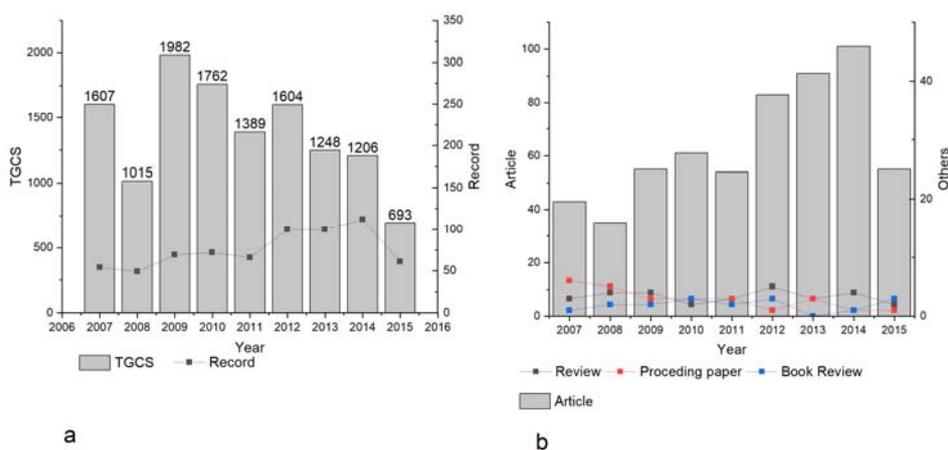


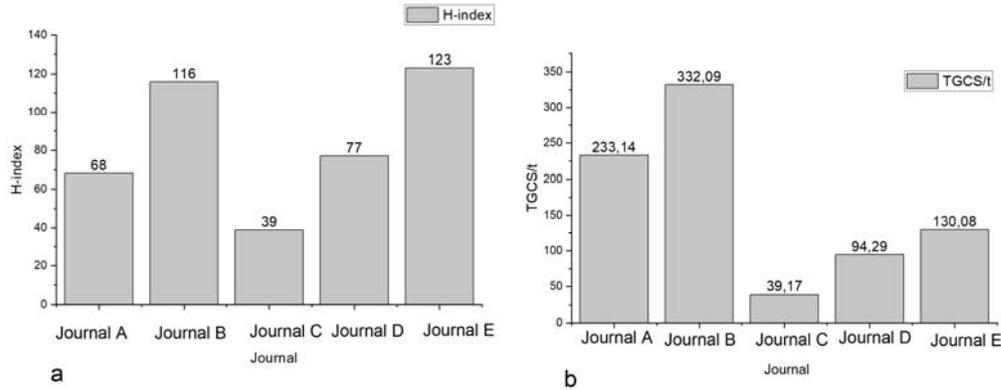
Figure 2: bibliometric indicators, a) Total publications per year and number of citations, b) Type of publication per year

Table 1 shows that although environmental impact assessment review is the journal with the most publications, with little margin for difference with respect to the second, it does not have the best citation rate taking into account the number of articles published, even so it would enter the ranking of the first three, ranking them from the highest to the lowest in this parameter, which has the Journal of environmental management in first place, with an average of 29 citations per article, Given the small number of publications it has and the high rate of citations it has, it can be considered a high impact journal in this area of research, where the first two located in the table should also be considered, where they have a high degree of citations within the WoS database, taking into account this these three journals should be considered as priorities when conducting research in the area of EIA.

Table 1: Top 5 journal

#	Journal	Recs	TLCS	TGCS	TLCS/Recs	TGSC/Recs
1	ENVIRONMENTAL IMPACT ASSESSMENT REVIEW	43	55	1090	1,279	25,349
2	JOURNAL OF CLEANER PRODUCTION	38	14	973	0,368	25,605
3	IMPACT ASSESSMENT AND PROJECT APPRAISAL	18	5	70	0,278	3,889
4	INTERNATIONAL JOURNAL OF LIFE CYCLE ASSESSMENT	15	5	243	0,333	16,200
5	JOURNAL OF ENVIRONMENTAL MANAGEMENT	15	8	440	0,533	29,333

Taking Figure 3a into account, it can be stated that the journal with the greatest impact among the 5 magazines with the most publications is the Journal of Environmental Management, since it has the highest H-index of these 5, another of the magazines to be taken into account in this ranking is the International journal of life cycle assessment, given that despite the fact that it has a low number of articles published, its impact factor is one of the highest in the list shown above, which allows us to locate the publications referring to the area. On the other hand, Figure 3b shows the number of citations received by each journal per year (TGCS/t), which shows a similar behavior to that shown in Figure 3a. In this item, the Journal of Cleaner production has a wide advantage over the rest of the journal, indicating the large flow of citations it receives annually not only in the subject matter researched, but also in a large part of the WoS database.



- Journal A: ENVIRONMENTAL IMPACT ASSESSMENT REVIEW
- Journal B: JOURNAL OF CLEANER PRODUCTION
- Journal C: IMPACT ASSESSMENT AND PROJECT APPRAISAL
- Journal D: INTERNATIONAL JOURNAL OF LIFE CYCLE ASSESSMENT
- Journal E: JOURNAL OF ENVIRONMENTAL MANAGEMENT

Figure 3: bibliometric indicators by journals, a) H-index of the journals with most publications, b) TGCS/t of the journals with most articles published

Figure 4 shows that this type of publication focuses mainly on the Eastern Hemisphere, while for the Western Hemisphere it is concentrated only in the region located in the north of America, where the countries in which the range of publications is focused are considered world and economic powers.

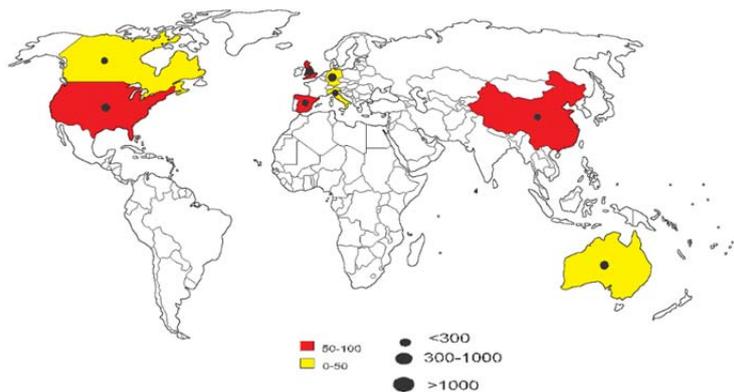


Figure 4: Geographical distribution of publications

The results presented for the countries of North America are due to the fact that they have included the evaluation of environmental impacts as a previous and obligatory step in the execution of projects, in order to minimize such impacts from the planning phase. For this purpose, you have placed as requirements different documents that must be prepared and presented before the corresponding environmental authority, in case

the scope of the project requires it, such as the Environmental Diagnosis of Alternatives, where alternatives for the same project must be compared, in order to make significant decisions prior to the execution of the project. These alternatives may have to do with the location of the project, the technology to be used, the production capacity, among others. In addition, an Environmental Management Plan is required, which is a document that specifies, generally in the form of management files, the measures to be implemented to mitigate the potential impacts of the project. Such measures can be compensation, correction, mitigation or prevention of the impacts identified, and are applied to those impacts considered to be the most significant. The Plan can be part of the Environmental Impact Study or serve as a monitoring and control tool for the project. Finally, these countries require an Environmental Impact Study, commonly published in related journals in the document area that includes, and contains a detailed description of the project, the activities carried out, the baseline of the project's area of influence and the relationship (through identification and evaluation) between the potentially affected factors of the baseline and the project's actions that will produce impact.

4. Conclusions

The accelerated advance in the industry can produce a great impact on the environment that can be considered positive or negative, given the need to preserve the integrity of the environment and preserve the well-being of future generations, it is necessary to implement an assessment to determine the degree of damage that a project will produce not only on the environment, but on the civilian population near the area of application of the project. From the previous bibliometric study we can observe that the countries that make the most publications focus on the countries that are global powers in economic and educational terms, it can be assumed that the great predisposition of these countries to mitigate the harmful effects on the environment is the fact that it is considered that the USA and China are among the countries that produce the most pollution from their industry, this added to the fact that the high pollution produced on the environment is penalized due to various environmental government treaties. The high rate of citations received by the USA suggests the quantitative quality of their publications, while China, despite being the second most published country on the subject, is surpassed by other countries in the top 5, which suggests that the impact of their publications does not go hand in hand with the amount of annual publications they produce.

Taking into account the parameter of TGCS as one of the main determinant indicators used to judge the quality of publications, the environmental impact assessment review should be considered the best journal since it has 1090 citations in the entire WoS database, with a total of 43 publications published, i.e. for each article published, receives approximately 25 citations which places it as a reference in the field of environmental impact assessment or a magazine to be taken into account not only when researching, but also when making publications on the subject, another magazine to be taken into account is journal of environment management taking into account that despite having only 15 publications, has a total of 440 TGCS, ie, it receives a total of approximately 29 citations per article being a good indicator of growth over time. The scientific analysis has great relevance in the academic field, since it allows to qualify in a quantitative way if it is viable or productive to carry out research in a subject, also allows a deeper investigation, since it allows to identify in a clear way where it is possible to carry out the researches required for the realization or planning of a project, besides that it allows to carry out comparisons of research results in an impartial way and with punctual data of countries, magazines and institutions throughout the world.

References

- Alcamo, Joseph. 2017. "Evaluating the Impacts of Global Environmental Assessments." *Environmental Science and Policy* 77(April):268–72. doi.org/10.1016/j.envsci.2017.03.009
- Bicer, Yusuf and Ibrahim Dincer. 2018. "Life Cycle Environmental Impact Assessments and Comparisons of Alternative Fuels for Clean Vehicles." *Resources, Conservation and Recycling* 132(January):141–57. doi.org/10.1016/j.resconrec.2018.01.036
- Cardenas, Ibsen C. and Johannes I. M. Halman. 2016. "Coping with Uncertainty in Environmental Impact Assessments: Open Techniques." *Environmental Impact Assessment Review* 60:24–39. doi.org/10.1016/j.eiar.2016.02.006
- Chang, I. Shin, Qimanguli Yilihamu, Jing Wu, Huilei Wu, and Bo Nan. 2017. "Health Impact Assessment in Environmental Impact Assessment in China: Status, Practice and Problems." *Environmental Impact Assessment Review* 66(April):127–37. doi.org/10.1016/j.eiar.2017.05.007
- Elvan, Osman Devrim. 2018. "Analysis of Environmental Impact Assessment Practices and Legislation in Turkey." *Environmental Science and Policy* 84(January):1–6. doi.org/10.1016/j.envsci.2018.02.008
- Enriquez-de-Salamanca, Álvaro. 2018. "Stakeholders' Manipulation of Environmental Impact Assessment." *Environmental Impact Assessment Review* 68(July 2017):10–18. doi.org/10.1016/j.eiar.2017.10.003

- Galaś, Slávka et al. 2015. "Environmental Impact Assessment in the Visegrad Group Countries." *Environmental Impact Assessment Review* 55:11–20. doi.org/10.1016/j.eiar.2015.06.006
- Hirsch, J. E. 2005. "An Index to Quantify an Individual's Scientific Research Output." 102(46):16569–72. doi.org/10.1073/pnas.0507655102
- Hood, William W. and Concepción S. Wilson. 2001. "The Literature of Bibliometrics , and Informetrics Scientometrics ,." *Scientometrics* 52(2):291–314. doi.org/10.1023/A:1017919924342
- Kinney, A. L. 2007. "National Scientific Facilities and Their Science Impact on Nonbiomedical Research." *Proceedings of the National Academy of Sciences* 104(46):17943–47. doi.org/10.1073/pnas.0704416104
- McCullough, Aoife. 2017. "Environmental Impact Assessments in Developing Countries: We Need to Talk about Politics." *Extractive Industries and Society* 4(3):448–52. doi.org/10.1016/j.exis.2017.07.002
- Mercure, Jean Francois et al. 2018. "Environmental Impact Assessment for Climate Change Policy with the Simulation-Based Integrated Assessment Model E3ME-FTT-GENIE." *Energy Strategy Reviews* 20:195–208. doi.org/10.1016/j.esr.2018.03.003
- Niesner, Jakub, David Jecha, and Petr Stehlík. 2013. "Biogas Upgrading Technologies: State of Art Review in European Region." *Chemical Engineering Transactions* 35(January):517–22. doi: 10.3303/CET1335086
- Orellanos Camargo, Ismael A., Guillermo E. Valencia Ochoa, Javier E. Rendón Lafarie, and Marisol Osorio Cardenas. 2017. "Exergoeconomic Analysis of a 30 KW Micro Turbine Cogeneration System Using Hysys and Matlab." *Chemical Engineering Transactions* 57:475–80. doi: 10.3303/CET1757080
- Riousse, Pauline, Christian Flachslund, and Martin Kowarsch. 2017. "Global Environmental Assessments: Impact Mechanisms." *Environmental Science and Policy* 77:260–67. doi.org/10.1016/j.envsci.2017.02.006
- Sagastume Gutiérrez, Alexis, Juan J. Cabello Eras, Carlos A. Gaviria, Jo Van Caneghem, and Carlo Vandecasteele. 2017. "Improved Selection of the Functional Unit in Environmental Impact Assessment of Cement." *Journal of Cleaner Production* 168:463–73. doi.org/10.1016/j.jclepro.2017.09.007
- Siluo, Yang. 2017. "Are Scientometrics, Informetrics, and Bibliometrics Different?" 16th International Conference on Scientometrics & Informetrics (ISSI2017) (August):12.
- Valencia, Guillermo, Erni Ramos, and Lourdes Meriño. 2017. "Energy Planning for Gas Consumption Reduction in a Hot Dip Galvanizing Plant." *Chemical Engineering Transactions* 57:697–702.
- Valencia Ochoa, Guillermo, Yulineth Cardenas, Emi Ramos, Alexis Morales, and Juan Carlos Campos. 2017. "Energy Saving in Industrial Process Based on the Equivalent Production Method to Calculate Energy Performance Indicators." *Chemical Engineering Transactions* 57(September):709–14. Retrieved (https://www.researchgate.net/profile/Erni_Ramos/publication/319928522_Energy_Saving_in_Industrial_Process_Based_on_the_Equivalent_Production_Method_to_Calculate_Energy_Performance_Indicators/links/59c1d86c458515af305c8ab2/Energy-Saving-in-Industrial-Proce). doi: 10.3303/CET1757119
- Williams, Aled and Kendra Dupuy. 2017. "Deciding over Nature: Corruption and Environmental Impact Assessments." *Environmental Impact Assessment Review* 65(May):118–24. doi.org/10.1016/j.eiar.2017.05.002.