Ecosystem services as determinants of poverty

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1. Introduction

Traditionally and extensively, economic growth has been considered the key to obtaining results in reducing poverty, but the increase in aggregate production by itself is not enough to achieve it, and even less if this growth is accomplished by sacrificing the sustainability represented in natural system quality, equality of income, and social justice. However, this approach continues to predominate in developing countries when conceiving their plans, programs and public policies, so that the concept of "grow (pollute) first, clean up later" is the *modus operandi* of most countries in the world that have provoked and continue to cause serious impacts on the sustainability of the planet, predating nature, causing high levels of pollution and disastrous effects on the human race, by aggravating patterns of inequality, inequity, marginalization and misery (Urquidi, 1999; Liu, 2010b; Yang, 2007). Specifically, with respect to the quality of the natural environment, as expressed by Nixon (2011), environmental degradation constitutes a "slow violence" that is produced by humanity and causes extremely hazardous effects concerning its level of well-being with two aggravating factors: the first is a violence that affects the poor more intensely because they have fewer opportunities to adapt, and the second factor is practically imperceptible as it occurs gradually and is dispersed in time and space (Nixon, 2011).

Interest in environmental issues at the international level was introduced by the United Nations–UN at the Stockholm, Sweden conference in 1972, and continues to raise awareness about the unsustainability of the current development model, which does not guarantee life and rights of people or the planet. In 1987 the term "sustainable development" was coined in the Report "Our Common Future" of the World Commission on Environment and Development, which means the condition is attributed from sustainability to the progress of the countries. In this sense, the notion of sustainability becomes

a condition that completely modifies the way in which economic growth was conceived at a global level until then (World Commission on Environment and Development of United Nations, 1987; Gómez de Segura, 2014).

Within the framework of the SDG Sustainable Development Goals established in the 2030 Agenda signed by the UN Member States in 2015, environmental sustainability is conceived as the key to promoting inclusive sustainable development in the world. Inference resulting from recognizing that 86 of the 169 targets set in the SDGs directly links environmental elements with poverty, hunger, social protection (health–education–gender), water, basic sanitation, energy, economic growth, human settlements, sustainable consumption, sustainable production, climate change, oceans and terrestrial ecosystems – all aspects that are fundamental and decisive at the moment of conceiving society's well-being. In other words, from the framework of sustainable development, environmental sustainability implies not only the reduction of damages and negative impacts of anthropogenic activities on the environment, but also "the role of natural resources and ecosystem services in human well-being, economic opportunities and social and ecological resilience" (United Nations Development Program UNDP Colombia, 2020).

Since the Brundtland Report and regarding the SDGs, there have been numerous investigations that attempt to clarify the characteristics, the real situation of each of the areas of sustainable development and the interrelationships between society, environment and economy. Specifically, with respect to environmental sustainability, there are several authors who encourage in their publications to consider the conditions of natural capital and ecosystem services as explanatory and decisive elements of poverty, exclusion and social marginalization that humanity faces today (Rockström et al., 2015; Zhang et al., 2015; Gonzáles de Olarte, 1997). However, much progress remains to be achieved in studying the interrelationships between social and environmental dimensions, specifically related to the relationship and interaction among conditions of natural environment–environmental dimension–and situations of poverty and social marginality, two of the most serious problems of social dimension that are currently experienced and on which actions should be promoted (Meynard, Hajek, 1999).

In this direction, by proposing a scientometric study for the last ten years, which allows us to review the way in which the scientific community has thought about and linked ecosystem services with poverty, this paper aims, on one side, to contribute elements from the environmental dimension of sustainable development, so that future research can re-signify the notion of poverty from the articulation of all dimensions of sustainable development; and on the other, point out possible alternative lines of research concerning the analysis of the multidimensionality that determines people's poverty condition. It highlights the idea that, from the authors' perspective, sustainable development framework provides the notion of poverty with the approach that is required to address this social problem from its own complexity; which,

in turn, allows public and private actions to reduce, mitigate or eliminate it, to be more effective when considering the real needs of people living under this condition.

2. Scientometrics to address ecosystem services as determinants of poverty

Understanding scientometrics "the quantitative analysis of scientific production (especially scientific articles) to investigate development, structure, dynamics, trends and relationships of scientific practice" (Michan, Muñoz, 2013), one should bear in mind that in the case of social sciences, instead of scientometrics, there is a systematic literature review. Scientometrics or systematic literature review, is an analysis that allows identifying trends in the study and the approach that has been used to a particular topic in articles published in scientific databases over a period of time. For the specific interests of this study, the review is an analysis that allows us to examine, evaluate and compare what has been reflected in scientific articles published in recent years, regarding the articulation of ecosystem services with the notion of poverty. Therefore, conceiving poverty within the framework of sustainable development, the systematic literature review that is proposed provides evidence on the way in which ecosystem services operate as an analysis variable that represents the environmental dimension of sustainable development. A representation that is of vital importance, considering that, only when poverty is addressed from its complexity, it shall be possible to abolish this problem of the human condition.

The object of analysis for the processing of electronic literature is constituted by scientific publications of the last ten years related to the subject of study. The methodological process of the systematic review consists of four consecutive phases, such as: planning, search–selection, analysis, and construction of the report of the Systematic Literature Review; such methodological process represents an adaptation to the methodological process proposed by the CetiSME Consortium that was reflected in the document "Economic and Technological Intelligence. Guide for beginners and professionals" (Araujo Ruiz, Ricardo Arencibia, 2002; Gómez Meza, 2014; CetiSME, 2002). An explanation what each of the phases consists of and how they are operationalized in order to achieve the purposes of this article is briefly explained below.

Phase 1. Planning. To specify and delimit the systematic review, criteria are defined that result from the preliminary exploration of the topic of interest, criteria that in turn become descriptors and keywords, on which the search for scientific articles in databases carried out in the next phase of the methodological process is based. In this study the authors narrowed down nine (9) keywords: "ecosystem services", "cultural services", "regulation services", "support services", "utilization services", "poverty", "Low Quality of Life", "Inequality", "inequity". Descriptors that are derived from the two main

categories of analysis of the present study and the importance and hierarchy of these keywords were validated by a panel of experts, made up of seven researchers in social and environmental sciences.

Phase 2. Search and selection of scientific information. It begins with an unstructured search on the web once the sources of information and databases that will be considered for the review are identified; this preliminary search allows to refine the subject and then proceed to structure the search equation for information analysis. For the purposes of this study, Scopus database is chosen to perform scientometrics or systematic literature review, as it is a database of textual quotations and abstracts of published scientific articles, which enjoys a high prestige and recognition within the academic and scientific community, since its indexed content comes from more than 5,000 publishers around the world; it contains more than 75 million publications, 24,600 active titles, more than 20,000 peer-reviewed journals, of which about 20% are open access; all these aspects make Scopus a base that combines quality content with tools that allow the use, analysis and management of the contents of the publications (Elsevier, 2020).

Using Boolean operators to combine keywords, search equations were designed in Scopus, applying the period between 2010 and 2020 as a selection criterion for the analysis of scientometric indicators, since in this period about 60% of publications are on the topic of interest; and for in-depth analysis, only documents with more than 50 textual quotations are selected within the search results, considering those with the greatest impact on the scientific community. The study of technological surveillance and the analysis of scientometric indicators is carried out from 733 results that gives the following search equation: TITLE-ABS-KEY (“ecosystem services”) OR TITLE-ABS-KEY (“cultural services”) OR TITLE-ABS-KEY (“regulation services”) OR TITLE-ABS-KEY (“support services”) OR TITLE-ABS-KEY (“utilization services”) AND TITLE-ABS-KEY (“poverty”) OR TITLE-ABS-KEY (“Low Quality of Life”) OR TITLE-ABS-KEY (“Inequality”) OR TITLE-ABS-KEY (“inequity”) AND DOCTYPE (ar) AND PUBYEAR>2009 AND PUBYEAR<2021.

Phase 3. Information Analysis. With the results obtained in the previous phase, two types of analysis are carried out: the first is a statistical analysis, which perceives the analysis of scientometric indicators related to the number of scientific publications, institutions, researchers and the most distinguished countries in publishing on the study topics; this analysis is carried out on the 733 search result articles: the second, an in-depth analysis that allows foresight generation to visualize the main trends on the subject. The list of documents on which the in-depth analysis is carried out considers the articles with fifty or more textual quotations, which in turn are debugged using the coding proposed by David Whetten, by selecting the articles that provide answers to “what”, “how”, “why” or “who/where/when” of the relationships or links between ecosystem services and poverty (Whetten, 1989). The in-depth analysis for 93 scientific articles is initiated.

Phase 4. Systematic Literature Review Report. In this fourth and last phase of the methodological process, the report that allows the dissemination of the results of scientometrics or systematic review is developed, through which recurring themes related to: backgrounds, dimensions, mechanisms–mediators, consequences and foresight of the subject of study are reflected. The report also presents trends in terms of possible lines of research that can be addressed to advance knowledge of the topic of interest. The results of the review report proposed in this article are presented in the following section of the article.

3. Discussion and results

Statistical analysis from scientometric indicators

Evolution of publications

In the last ten years, it has been observed that a growing number of researches tend to establish links between ecosystem services and poverty – research interests that translate into an increasing trend for the number of publications. From 2010 to 2020, a total of 733 publications were registered on the subject of study; in 2019 alone, 105 scientific articles were registered, since this period becomes the highest inflection point within the trend (Figure 1). The boom in the analysis of ecosystem services in relation to poverty shows a high degree of interest on behalf of academic institutions and multilateral organizations to clarify the link that exists between these two categories of analysis.

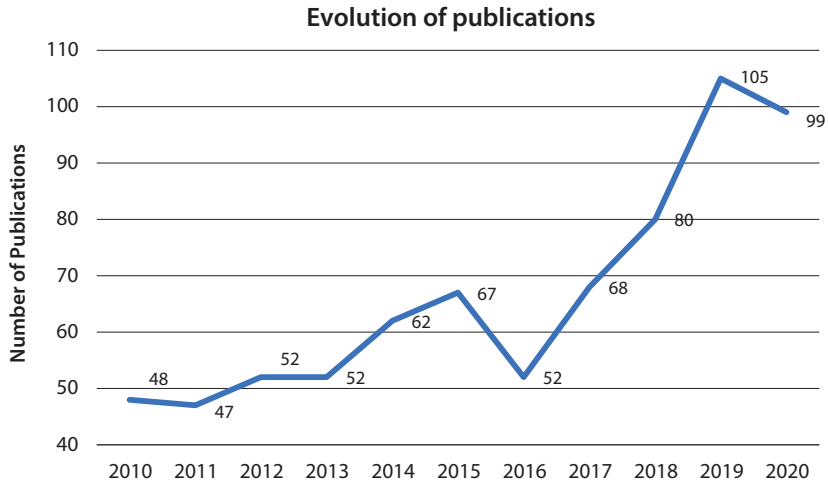

Figure 1. Evolution of scientific papers on ecosystem services and poverty

Source: Authors' elaboration, based on information from Scopus

Representative institutions

At a global level for the period of analysis, among universities, research centers and multilateral organizations, 160 institutions contributed to the research aimed at establishing links between ecosystem services and poverty. It should be highlighted that 3% of the institutions contribute to10% of the publications in absolute terms, which is to say that five institutions have published 94 scientific articles between 2010 and 2020 (Table 1).

Table 1. Publications on ecosystem services and poverty by institution

Number of publications by institution, 2010-2020	Number of institutions	
20 or more publications	2	1%
15-19 publications	3	2%
10-14 publications	11	7%
5-9 publications	67	42%
4 publications	46	29%
3 publications	31	19%
Total Institutions	**160**	**100%**

Source: Authors' elaboration, based on information from Scopus

Within the statistical analysis of the scientometric indicators of the representative institutions, it has been found that thirteen (13) universities, two (2) research centers and one (1) multilateral organization, which represent 10% of the 160 institutions, have produced 24% of the scientific publications that have been generating contributions to the subject of study. From this group, the most representative ones by having the largest number of publications up to 2020 are: Chinese Academy of Science with 27 articles and Stockholms Universitet with 20 publications (Table 2).

There are several high impact products that have been published with the affiliation of the Chinese Academy of Science, among the most cited are the following: improvements in ecosystem services from investments in natural capital (455 textual quotations); extending the timescale and range of ecosystem services through paleoenvironmental analyzes, exemplified in the lower Yangtze basin (107 textual quotations); global importance of large-diameter trees (89 textual quotations) and poverty alleviation strategies in eastern China leading to critical ecological dynamics (53 textual quotations). These are the articles that refer to the need to consider natural capital and ecosystem services when making decisions in favor of sustainability, decisions that mean actions from public and private sectors to promote changes in favor of well-being for present and future generations, represented in the reduction of poverty, sustainable levels of growth and consumption, sustainable

Table 2. Institution ranking of publications on ecosystem services and poverty

Institution's name and country	Number of publications
Chinese Academy of Sciences, China	27
Stockholms Universitet, Stockholm	20
Wageningen University & Research, Netherlands	16
Stanford University, United States	16
University of East Anglia, United Kingdom	15
University of Southampton, United Kingdom	13
James Cook University, Australia	12
University of Oxford, United States	12
The University of Edinburgh, United Kingdom	12
McGill University, Canada	11
Harvard University, United States	11
University of Leeds, United Kingdom	11
University of Toronto, Canada	11
Nature Conservancy, TNC (non-governmental environmental organization)	11
Center for International Forestry Research, West Java-Indonesia	11
Michigan State University, United States	10

Source: Authors' elaboration, based on information from Scopus

productive activities, among others (Ouyang et al., 2016; Dearing et al., 2012; Lutz et al., 2018; Zhang et al., 2015). Chinese Academy of Science is also the institution with the most documents in Scopus that have tried to link poverty with sustainable development (Orjuela, Ramírez, 2020). Therefore, it is a scientific society and a comprehensive research and development network, which comprises 104 research institutes, 12 affiliate academies, 3 universities and 11 support organizations with a broad presence nationwide and which stands out in the international scientific field today for its valuable contributions and leadership, when it comes to understanding poverty from its complexity from a multidimensional approach.

Leading authors on the subject

The production generated by 83% of the authors who have been investigating the relationships or links that exist between ecosystem services and poverty, consists of the writing and publication of two or three scientific articles in the last ten years. The other authors in the same period have published between 4 and 7 scientific articles (Table 3).

Table 3. Publications on ecosystem services and poverty, by author

Number of papers by author	Number of publications	
	Number of authors	Percentage of the total
7 papers*	2	1%
6 papers	6	4%
5 papers	3	2%
4 papers	16	10%
3 papers	45	28%
2 papers	88	55%
Total Authors	**160**	**100%**

* Note: Gretchen C. Daily at Stanford University from the United States, and Cong Li at Xi'an Jiaotong University from China.

Source: Authors' elaboration, based on information from Scopus

Among the 160 authors that are registered in the search results, Gretchen C. Daily, attached to Stanford University in the United States, stands out with publications related to natural capital and the valuation of ecosystem services as strategies to promote and strengthen sustainable development. Daily is a researcher with an extraordinary h-index of 79, an index that reflects its important scientific production, regarding quantity and quality (textual quotations received) and is a co-author of the article *Improvements in Ecosystem Services from Investments in Natural Capital*, mentioned in the previous section as the document with the highest number of textual quotations (Ouyang et al., 2016; Li, Feldman, Li, Daily, 2011; Guerry et al., 2015).

On the other hand, considering the number of Cong Li's publications on the subject of interest during the period of analysis, it also stands out that she is affiliated with the University of Xi'an Jiaotong of China, a university that is part of the society of knowledge conformed by Chinese Academy of Science. Li, as well as Daily, has contributed elements of analysis and evidence that link ecosystem services with the reduction of ecological pressure at a local level and with improvements in human development (Li et al., 2015; Li et al., 2019).

Countries of origin of the publications

In the analysis of the scientometric indicators, it is possible to identify that scientific articles have been produced and published by 97 countries around the world. It has been observed that the United States is the country with the highest number of publications in Scopus (227) during the study period, followed by the United Kingdom (158) and China (87). In addition, ten countries originate about 70% of the scientific production that links environmental services with poverty in some way (Figure 2).

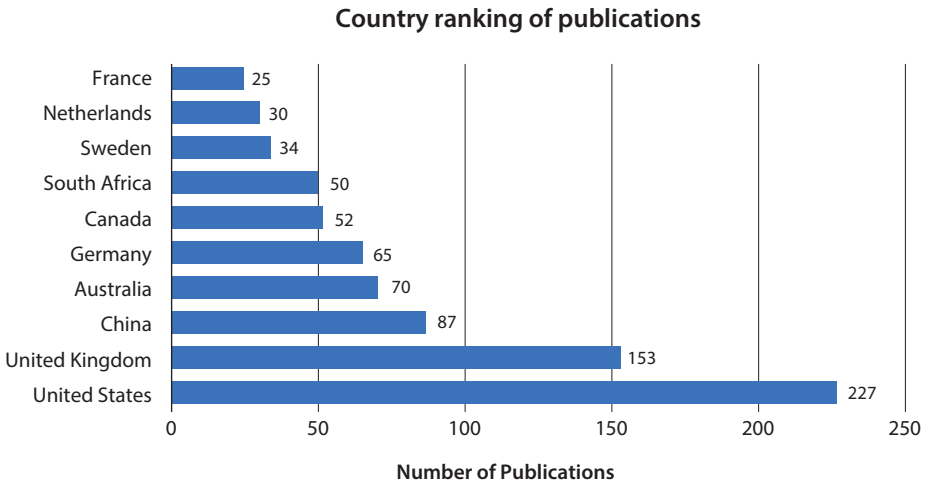

Figure 2. Publications on ecosystem services and poverty by country

Source: Authors' elaboration, based on information from Scopus

Meanwhile, Colombia contributes twelve publications in the area of interest between 2010 and 2020, with one of the articles listed as the most quoted in the initial part of this section of this article. This is a study that integrates the results of a global analysis that seeks to establish, on the one hand, the contribution of large trees to the density, richness and biomass of forests, and on the other, to the conservation of the ecosystem services regulating these natural systems. In this study, el Instituto Amazónico de Investigaciones Científicas Sinchi [the Amazonian Institute of Scientific Research Sinchi], based in Bogotá, and the Department of Forest Sciences at Universidad Nacional de Colombia [National University of Colombia], based in Medellín, participated representing Colombia; and the findings provide evidence on the importance of natural capital management to conserve and enhance ecosystem services, which are fundamental to well-being of humankind (Lutz et al., 2018).

In-depth analysis

As part of the results of the systematic literature review proposed in this paper, regarding articles exploration in Scopus that have sought to articulate ecosystem services with poverty in the last ten years, this section presents the cluster analyses obtained from VOSviewer, a free-to-use software tool for building and visualizing bibliometric networks to analyze scientific literature.

In VOSviewer the concurrency neural network analysis represents the coincidence and interconnection of important terms that are extracted from scientific literature that was selected for the study, in this particular case, from the scientific production that has been developed in an attempt to articulate ecosystem services and poverty. In Figure 3 it can be seen that the terms

of ecosystem services, poverty reduction and poverty, in addition to being the largest nodes, are relatively close to and in the center of the neural network, characteristics that denote the connection and importance of these categories within the 93 published scientific articles that are the object of study in this in-depth analysis.

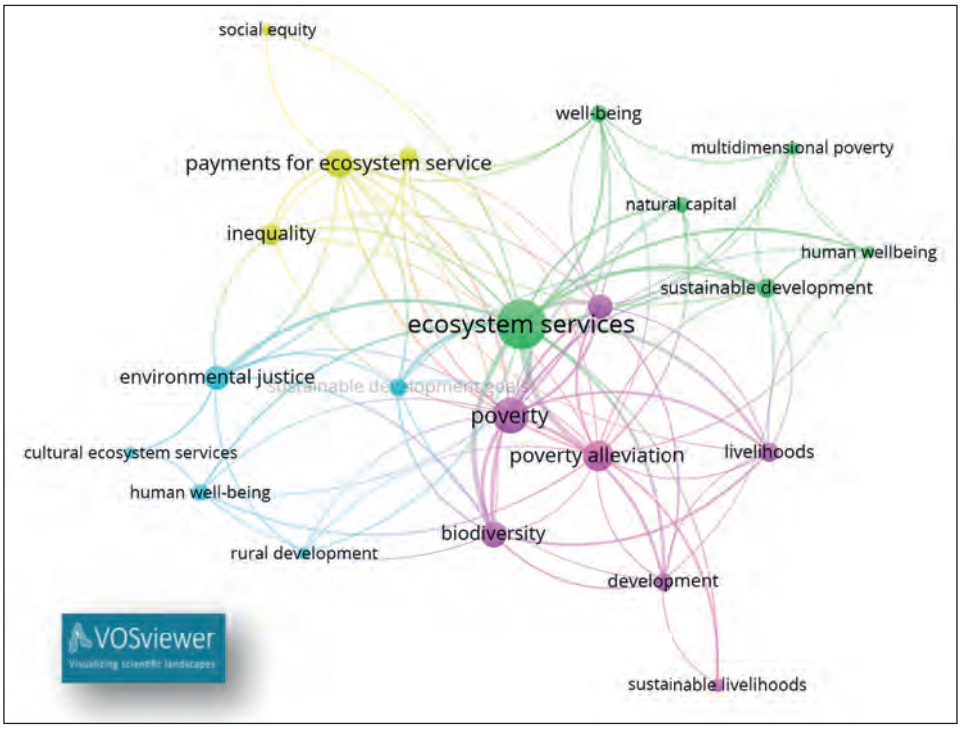

Figure 3. Neural network of keywords

Source: Authors' elaboration of VOSviewer based on information from Scopus

The topic with the greatest number of publications, due to the size of the node in the neural network, is that of ecosystem services, a term that is part of the green cluster made up of words that are related to inclusive sustainable development, from which the value of natural capital to achieve social welfare and environmental sustainability is recognized. In order of importance by the size of the nodes, there is the purple cluster whose central axes are poverty and the goal of shrinking it as a society, a purpose provided by sustainable development from the multidimensional perspective; it will only be abolished from human condition to the extent that environmental sustainability strategies are conceived and promoted.

The third cluster is the yellow one, whose central node is payment for environmental services; as it is interpreted from the words it links, it constitutes a strategy to promote social and environmental equity. Finally, the