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DEBT-FOR-NATURE SWAPS: A BIBLIOMETRIC ANALYSIS OF GLOBAL RESEARCH TRENDS (1988–2025)

Abstract

This study provides the first comprehensive bibliometric mapping of the Debt-for-Nature Swap (DFNS) literature over the period 1988–2025, highlighting its intellectual structure, thematic evolution, and global patterns of scientific collaboration. A total of 117 publications were retrieved from the Scopus database using targeted keyword searches and analyzed with the Bibliometrix package in R. The analysis included annual publication trends, productivity by authors, institutions, and countries, most cited works, keyword co-occurrence networks, thematic maps, and trend topic analyses. Results show that DFNS research initially focused on environmental protection and debt relief, but since 2015 has shifted toward climate finance, blue bonds, and sustainable development. Notable turning points include the Seychelles' issuance of the first blue bond in 2018 and renewed interest following the COVID-19 debt surge. The United States, the United Kingdom, and China lead in research output, while most DFNS projects are implemented in developing countries. Citation and thematic analyses reveal integration with biodiversity conservation and emerging links to innovative financial instruments. By systematically mapping the field and identifying research gaps, this study offers evidence-based insights for environmental economics, guiding policy design at the intersection of sovereign debt management, biodiversity conservation, and climate finance.

Keywords

debt-for-nature swap, environmental finance, sovereign debt, sustainable development, bibliometric analysis

JEL Classification

Q56, F34, Q58

INTRODUCTION

The growing external debt burden of developing countries, together with the accelerating degradation of natural resources, has become one of the most critical challenges in contemporary development policy. Since the 1980s, recurrent debt crises have not only weakened macroeconomic stability but have also constrained states' capacity to finance environmental protection and climate adaptation, producing a dual crisis of debt distress and ecological decline (Oskay, 2024; Paul et al., 2023). This debt–environment interdependence has increasingly attracted academic and policy attention. Rising debt obligations limit the resources available for sustainability goals, while environmental degradation exacerbates economic fragility, leaving many developing economies trapped between unsustainable financial dynamics and escalating ecological risks (Coulibaly, 2025). This contradiction constitutes a scientific problem at the intersection of economic security and ecological security that requires deeper investigation.

Debt-for-nature swap (DFNS) emerged as an innovative response to this problem, enabling the cancellation or restructuring of external debt in exchange for commitments to environmental protection (Hansen, 1989; Bedarff et al., 1989; Kessel, 2006). Over time, the scope

of DFNS has expanded beyond traditional conservation objectives to include climate change mitigation, biodiversity preservation, and elements of the blue economy, reflecting its growing significance in global sustainability debates (Jiang & Cao, 2024; Nedopil & Sun, 2025). Recent developments have further strengthened the relevance of DFNS. The COVID-19 pandemic intensified debt vulnerabilities, while the momentum generated by international climate frameworks such as the Paris Agreement renewed interest in innovative financing mechanisms. High-profile cases, including Belize (2021) and Ecuador (2023), demonstrated the potential of DFNS to link debt sustainability with ecological resilience, placing the mechanism once again at the center of global policy and academic discussions (Chamon et al., 2022; Thomas & Theokritoff, 2021; Whiting, 2024).

Although various studies have examined DFNS, this literature remains largely fragmented and has not yet developed into a systematic body of research. Addressing this gap constitutes the central scientific problem that motivates the present study. Therefore, this study offers the first systematic bibliometric analysis of DFNS, aiming to map its conceptual evolution, thematic orientations, and institutional structures in order to overcome the fragmented nature of previous research.

1. LITERATURE REVIEW

Debt-for-nature swaps (DFNS) first emerged in the 1980s as a mechanism to ease the external debt burden of developing countries while supporting environmental conservation projects. Initially proposed by Lovejoy (1984), the first agreement was implemented in Bolivia in 1987. Early contributions by Hansen (1989), Kahn and McDonald (1995), and Kull (1996) provided valuable theoretical and descriptive accounts of DFNS, focusing on potential benefits and limitations. However, these early contributions were mostly descriptive and case-based, without offering systematic insights into the broader developmental dynamics of the literature.

At the turn of the millennium, global debt relief initiatives such as the Heavily Indebted Poor Countries (HIPC) Initiative and the Multilateral Debt Relief Initiative (MDRI) reshaped international debates on debt restructuring. Within this context, DFNS reappeared in policy and academic discussions. Deacon and Murphy (1997), Torras (2003), and Cassimon et al. (2011) examined its macroeconomic effects and implications for sustainable development. Nevertheless, these studies were largely centered on debt sustainability and fiscal discipline, while the integration of DFNS into environmental and climate policy remained limited.

Since the 2010s, the literature has increasingly linked DFNS with global climate policy and in-

novative financial instruments. Łapko et al. (2020) and Heijdra et al. (2006) explored the intersections of DFNS with resource economics and sustainable finance. At the same time, “blue DFNS” agreements implemented in the Seychelles (2016), Belize (2021), Ecuador (2023), and Gabon (2023) have gained prominence, highlighting biodiversity and marine ecosystem protection (Pilling, 2024; Laixhay & Perriot, 2025).

Thapa (1998) also contributed by examining the role of DFNS in local development and environmental governance. Yet, these contributions remain fragmented, and the interaction of DFNS with other financial mechanisms has not been comprehensively addressed.

Studies show that (DFNS often involve high transaction and monitoring costs, insufficient transparency and accountability mechanisms, and limited participation of local stakeholders (Cassimon et al., 2011; Chamon et al., 2022; Fresnillo, 2023). In addition, these mechanisms have sometimes been criticized for instances of “greenwashing” or “bluwashing” (Fresnillo, 2023). Cassimon and Essers (2017) emphasize that although DFNS has been implemented primarily in developing countries, much of the scholarly output originates from developed nations. These insights suggest that DFNS is not only a financial mechanism but also a governance and institutional capacity issue. However, the relationship between governance structures and the measurable environmental impacts of DFNS remains underexplored.

Overall, the literature provides a rich account of the historical development and practical applications of DFNS. Yet, existing studies remain largely case-driven, and issues such as thematic clustering, research collaboration, and the conceptual evolution of the field have not been thoroughly analyzed. These gaps highlight the need for a systematic bibliometric analysis of the DFNS literature, capable of mapping its conceptual evolution, thematic patterns, and institutional dynamics.

Building on these observations, the present study makes a distinct contribution by moving beyond descriptive case studies and fragmented accounts toward a systematic bibliometric assessment of the DFNS literature. By mapping its conceptual evolution, thematic clusters, and patterns of institutional and geographic collaboration, this paper not only consolidates a dispersed body of work but also highlights the structural imbalances that constrain its global policy relevance. In doing so, it provides a comprehensive analytical framework that enables scholars and policymakers to better understand the academic development dynamics of DFNS and to situate them within the broader debates on climate finance, sustainable development, and global governance. At the same time, the findings underscore the importance of expanding collaboration with scholars and institutions in the Global South and of exploring underdeveloped themes such as blue economy, debt transparency, and nature-based solutions. Addressing these gaps will not only strengthen the academic field but also enhance the policy effectiveness of DFNS as a tool for linking debt sustainability with environmental and climate goals.

2. METHODOLOGY

This study applied a bibliometric approach to examine the debt-for-nature swap (DFNS) literature. The dataset was retrieved from the Scopus database, which was selected for its broad coverage and reliable bibliographic records (Donthu et al., 2021). The search was conducted on August 6, 2025, covering the period from 1988 – when the first academic publication on DFNS appeared – through

August 2025. The search targeted the title, abstract, and keyword fields using the query: “debt-for-nature swap” OR “debt for nature swaps” OR “debt-for-environment swap.” No restrictions regarding language or document type were applied. A total of 117 publications were identified and exported in CSV format.

During data preparation, duplicate records were removed, and variations in author names, institutional affiliations, and keywords were manually standardized. The cleaned dataset was analyzed using Biblioshiny, the web-based interface of the Bibliometrix R package (Aria & Cuccurullo, 2017). The analyses included citation analysis, keyword co-occurrence analysis, thematic mapping, and trend analysis. These techniques allowed for a comprehensive assessment of productivity indicators, citation structures, thematic orientations, and temporal trends.

As the study relied exclusively on publicly available bibliographic data, it did not involve human participants, animals, or experimental interventions, and thus did not require ethics committee approval. The main limitation of the methodological approach is the restriction to Scopus-indexed publications, excluding works from other databases or non-indexed sources. Nevertheless, the comprehensiveness and reliability of Scopus enhance the comparability and robustness of the findings.

3. RESULTS AND DISCUSSION

This paper presents the bibliometric analysis results for 117 academic publications on debt-for-nature swap (DFNS) indexed in the Scopus database during the 1988–2025 period. The analyses are structured to address the research questions defined within the scope of the study.

Table 1 presents the key descriptive statistics for DFNS-related publications indexed in the Scopus database between 1988 and 2025. These indicators provide an overview of the scope, structure, and multi-actor nature of the literature, laying the groundwork for the detailed examination of temporal trends and collaboration patterns emphasized in the theoretical framework.

Table 1. Main information

Category	Value
Timespan	1988:2025
Sources (Journals, Books, etc.)	96
Documents	117
Annual Growth Rate (%)	2.51
Average Document Age	17.7
Average Citations per Document	9.838
References	4174
Keywords Plus	441
Author's Keywords	264
Authors	184
Authors of Single-Authored Documents	64
Single-Authored Documents	70
Co-Authors per Document	1.72
International Co-Authorship (%)	11.11
Articles	91
Books	2
Book Chapters	14
Conference Papers	2
Reviews	8

The descriptive statistics in Table 1 were generated by analyzing the dataset retrieved from Scopus using the Biblioshiny interface of the Bibliometrix package in R. Over the examined period, a total of 117 academic works were published across 96 different sources (including peer-reviewed journals, books, and conference proceedings). Research articles constituted the largest share, at 77.78% (91 documents), followed by book chapters (14 documents), review articles (8 documents), and conference papers (2 documents). The annual growth rate of publications was 2.51%, indicating steady but modest expansion. The average age of documents was 17.7 years, with an average of 9.83 citations per document. These figures suggest that the DFNS literature has a relatively long-standing foundation but is increasingly in need of renewal.

In terms of authorship patterns, 184 authors contributed to the DFNS literature, with an average of 1.72 authors per document. Single-authored works are relatively common, with 70 such documents authored by 64 individuals. The international co-authorship rate is limited to 11.11%, which is relatively low given the multi-actor, cross-border nature of DFNS, suggesting untapped potential for greater global collaboration. These descriptive indicators provide the basis for addressing the first research question – What is the temporal distribution of academic publications on DFNS? – and support the theoretical framework's observation

that, despite the inherently transnational character of DFNS, international collaboration remains limited.

Beyond these descriptive insights, the indicators also underscore the fragmented and niche character of DFNS research. The modest annual growth rate of 2.51% reflects its relatively slow diffusion across the wider environmental and financial scholarship, in contrast to the rapid rise of related areas such as climate finance or green bonds. Likewise, the international co-authorship rate of only 11.11% points to weak global collaboration, which appears paradoxical given the inherently cross-border nature of DFNS mechanisms. This mismatch between the transnational scope of DFNS and the limited internationalization of the academic output highlights structural imbalances in the literature, potentially constraining its policy relevance and global impact. Unless DFNS scholarship strengthens its international networks and diversifies its research base, the field risks remaining peripheral to mainstream debates on sustainable finance and global climate governance.

These findings are broadly consistent with earlier bibliometric and conceptual studies on environmental finance and debt restructuring. For example, Cassimon and Essers (2017) also identified the dominance of high-income countries and limited engagement from the Global South in debt-swap research. Similarly, Torras (2003) and Kull (1996) highlighted the early concentration of DFNS scholarship in creditor-country institutions, suggesting a persistent structural imbalance that continues today. However, unlike earlier analyses that primarily focused on debt relief and conservation outcomes, the present study demonstrates the thematic expansion of DFNS toward climate finance, blue economy, and sustainable development. This evolution reflects the increasing integration of DFNS into global sustainability debates, confirming that the field is gradually shifting from a niche conservation mechanism to a multidimensional policy instrument. These patterns set the stage for the subsequent analysis of temporal dynamics and the evolution of scholarly attention over time.

The analysis aims to evaluate the periods of acceleration and stagnation since DFNS entered the academic agenda and to relate these fluctuations

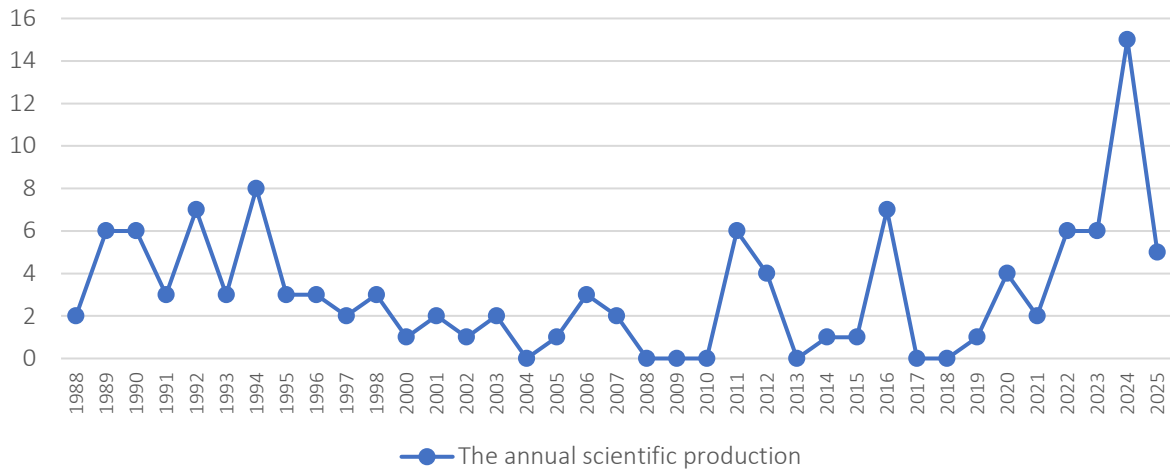


Figure 1. Annual DFNS publications

to global economic, political, and environmental developments. The DFNS literature began in 1988 with two publications, followed by its first momentum in 1989–1990 with six publications. Early peaks occurred in 1992 (seven publications) and 1994 (eight publications), directly linked to the first large-scale debt-for-nature swap agreements in Latin America and Africa (1987–1994) and the 1992 Rio Earth Summit. After 1995, production dropped sharply, with some years between 2004 and 2008 recording no publications. This stagnation can be attributed to the emergence of large-scale debt relief programs such as HIPC and MDRI in the early 2000s, which pushed DFNS to the background of both policy and academic agendas.

In 2011, the field experienced a short-lived revival with six publications, followed by a notable rise in 2016 (seven publications). Although output declined again in 2018–2019, interest resurged in the post-2020 period, driven by the global economic downturn triggered by the COVID-19 pandemic and high-profile DFNS applications (e.g., 2021 Belize, 2023 Ecuador). The renewed debt burdens of developing countries after the pandemic increased interest in innovative instruments such as DFNS, which combine debt relief with environmental commitments. In this context, the post-2021 rise in publications can be regarded as a tangible example of macroeconomic shocks being reflected in academic literature. The renewed rise of publications after 2016 illustrates not only the impact of global macroeconomic shocks but also the thematic broadening of DFNS within academ-

ic debates. The Seychelles’ “blue DFNS” agreement in 2016, followed by high-profile cases in Belize (2021), Ecuador (2023), and Gabon (2022), placed biodiversity and marine ecosystem protection at the center of debt-swap mechanisms. This shift indicates that DFNS is increasingly perceived as more than a debt relief tool, evolving into a hybrid financial instrument that links fiscal sustainability with climate governance and conservation. The historical peak of 15 publications in 2024 confirms this diversification, reflecting both heightened policy relevance and growing academic recognition of DFNS as part of global environmental finance architecture. In 2024, DFNS publications reached a historical peak of 15. As of August 2025, five publications have been recorded, with the potential for further growth by year’s end.

Table 2 examines productivity indicators at the author, institutional, and national levels for DFNS-related publications indexed in the Scopus database between 1988 and 2025.

Table 2. Most productive authors

Author	Articles	Total Citations
Isla, A.	3	27
Nedopil, C.	3	12
Wallander, S.	3	10
Burnett, M.T.	2	46
Chambers, P. E.	2	23
Essers, D.	2	46
Page, D.	2	16
Potier, M.	2	31
Prowse, M.	2	46
Restivo, M.	2	35

Table 2 shows the top ten most productive authors in the DFNS literature between 1988 and 2025. Isla, A. ranks first with three publications and 27 total citations. His work focuses on the environmental governance dimension of debt-swap mechanisms, particularly through case studies from developing countries. In second place, Nedopíl, C. also has three publications but a lower citation count (12), illustrating that high productivity does not always result in high visibility or scholarly impact. Wallander, S., in third place, contributes to the institutional and policy aspects of the field with three publications and 10 citations.

Despite having only two publications, Prowse, M., Burnett, M.T., and Essers, D. each achieved the highest citation impact on the list (46 citations), indicating that certain studies exert a field-defining influence. Similarly, Restivo, M. combines solid productivity with significant impact, with two publications and 35 citations. Chambers, P.E., though with a lower citation total, demonstrates a noteworthy citation-per-publication ratio.

Overall, the list of most productive authors reveals the presence of both consistently publishing scholars and those producing fewer but highly influential works. The variation between publication count and total citations reflects the niche and multi-actor nature of DFNS research, supporting the hypothesis of impact concentration in the field. The variation between publication counts and citation impact reveals a strong concentration of scholarly influence in a limited number of works. While some authors consistently contribute to the field, a handful of studies with relatively few publications dominate the academic discourse through high citation levels. This pattern reflects the niche and multi-actor nature of DFNS research, but it also indicates a structural imbalance: the field relies heavily on a small set of influential studies rather than on a broad and diverse body of scholarship. Such concentration may constrain theoretical pluralism and limit the development of new conceptual frameworks, highlighting the need for broader and more sustained author engagement in the field. Another critical gap relates to the thematic orientation of these authors. While influential works dominate citations, very few directly address governance, accountability, or community-level impacts of DFNS agreements. This imbalance

reinforces the critique that DFNS research is shaped largely by external academic perspectives, with limited attention to the lived experiences of local stakeholders in developing countries where DFNS is implemented.

Table 3. Most productive institutions

Institution	Articles
Centre Scientifique De Monaco (CSM)	6
Joint Research Centre (JRC)	4
State University of New York at Stony Brook	4
University of Antwerp	4
Colorado State University	3
Columbia University	3
Maritime University of Szczecin	3
University of Coruña	3
University of Cambridge	3
Yale School of Forestry and Environmental Studies	3

Table 3 lists the top institutions contributing to the DFNS literature between 1988 and 2025. The Centre Scientifique de Monaco (CSM) ranks first with six publications, distinguished by its in-depth analyses of debt-swap applications in marine ecosystem conservation and the blue economy. The Joint Research Centre (JRC), State University of New York at Stony Brook, and University of Antwerp each have four publications, focusing respectively on policy analysis, environmental economics and development, and the financial sustainability of international debt mechanisms. Institutions with three publications – Colorado State University, Columbia University, Maritime University of Szczecin, University of A Coruña, University of Cambridge, and Yale School of Forestry and Environmental Studies – represent diverse geographical regions, highlighting the multidisciplinary nature of DFNS research. The institutional distribution of DFNS research highlights a striking geographic imbalance. While leading contributions come from European and North American universities and research centers, institutions from developing countries – where most DFNS agreements are implemented – are notably absent. This mismatch underscores the limited academic visibility of the Global South, raising questions about the inclusiveness and representativeness of knowledge production in this field. Moreover, the dominance of high-income country institutions suggests that DFNS scholarship is often framed from an external perspective, potentially overlooking local governance dynamics

and implementation challenges. Addressing this imbalance would not only diversify the literature but also enhance its policy relevance by incorporating perspectives from countries directly affected by DFNS agreements. The top ten institutions produced a combined total of 36 publications, accounting for approximately 31% of the dataset, indicating a degree of institutional concentration.

Geographically, 60% of these institutions are based in Europe and 40% in the United States, with no institutions from developing countries represented, pointing to the dominance of high-income countries in the DFNS literature. Thematic analysis shows that CSM's marine ecosystem focus aligns with the biodiversity/conservation core in the keyword network, while JRC's policy orientation highlights the field's governance dimension. However, terms such as blue bonds and climate finance remain peripheral in the network, suggesting that high institutional productivity does not always coincide with thematic centrality. The absence of leading institutions from Africa, Latin America, or Asia-Pacific also points to an epistemic imbalance in DFNS scholarship. Given that these are the very regions where DFNS agreements are most frequently implemented, their lack of institutional presence diminishes the diversity of perspectives in the literature. Expanding South-South and North-South academic networks would therefore be essential to make DFNS knowledge more inclusive and reflective of real-world implementation contexts.

Table 4. Most productive countries

Country	Articles	Citations
The USA	63	140
The United Kingdom	11	16
China	10	14
Canada	9	14
Australia	8	31
Italy	7	13
Monaco	7	12
Belgium	6	51
Germany	5	0
Poland	5	41

According to Table 4, the United States dominates the DFNS literature with 63 publications, representing 53.8% of the total. This dominance stems from the USA's role as a pioneering actor in DFNS implementation, as well as its long-standing aca-

demical tradition in environmental finance, climate policy, and debt management. The UK ranks second (11 publications, 9.4%), driven by DFNS projects in former colonial regions (notably in the Caribbean and Africa) and strong collaborations between London-based international environmental NGOs and academia. China (10 publications, 8.5%) ranks third, reflecting the emergence of DFNS as a new research agenda in Asia, especially in relation to marine ecosystem conservation and biodiversity financing.

Canada (nine publications) and Australia (eight publications) focus primarily on sustainable development, biodiversity, and ocean conservation. Italy and Monaco (seven publications each) are notable for their emphasis on Mediterranean ecosystems, with Monaco's ranking largely attributable to the contributions of CSM. Belgium (six publications), Germany (five), and Poland (five) tend to approach DFNS within the context of EU environmental policy and development assistance.

Notably, most of the top 10 countries are high- or upper-middle-income nations, whereas DFNS target countries, typically low- and middle-income, are underrepresented in academic production. The top 10 countries account for 131 publications in total (112% of the dataset due to co-authored publications across borders), indicating significant geographic concentration. This finding underscores the need to enhance the academic visibility of the Global South, including Africa, Latin America, much of Asia, and Oceania.

As shown in Table 4, the United States also leads in total citations, with 140 citations, well ahead of other countries. This dominance reflects both the volume of its publications and the strong international reception of its work. U.S.-based research often focuses on integrating DFNS with financial instruments, environmental economic models, and development policy frameworks.

Belgium ranks second with 51 citations, largely due to contributions from policy-oriented organizations such as the European Network on Debt and Development (Eurodad). Poland (41 citations) and the Netherlands (37 citations) contribute significantly through studies exam-

ining DFNS within the framework of European institutional practice, EU environmental policy, and regional development projects. Australia (31 citations) occupies a strong position through research on DFNS initiatives in small island states of the Pacific. While having lower total citation counts, Montenegro (22 citations), Sweden (20), the United Kingdom (16), Canada (14), and China (14) nonetheless contribute to the literature through diverse case studies on DFNS applicability, policy design, and environmental impacts in various geographical contexts.

Overall, the list of most-cited countries indicates that DFNS research engages both developed and developing nations on a global scale. However, the concentration of citation impact in certain centers suggests a need for more balanced international collaboration. This observation aligns with the study's research questions regarding geographic and institutional diversity. The country-level distribution of DFNS publications reinforces the structural imbalance observed at the institutional level. High-income countries such as the United States, the United Kingdom, and European Union members dominate academic production, while low- and middle-income countries – despite being the primary sites of DFNS implementation – remain underrepresented. This asymmetry suggests that much of the scholarly framing of DFNS is produced externally, raising concerns about the marginalization of local perspectives and priorities. At the same time, the concentration of citation impact in advanced economies underscores the unequal visibility of research outputs, which may limit the global policy relevance of the literature. Strengthening the participation of Global South scholars and fostering cross-regional collaborations are, therefore, essential to create a more balanced and representative research agenda. For policy design, this imbalance risks producing a one-sided global narrative in which DFNS is predominantly conceptualized from the standpoint of creditor nations, rather than from debtor countries that directly experience economic and environmental consequences. Strengthening research capacity in the Global South is therefore not only an academic priority but also a matter of policy equity and legitimacy.

Table 5. Most cited documents

Cited Document	Total Citations
Kahn and McDonald (1995), <i>Ecological Economics</i>	79
Kull (1996), <i>International Environmental Affairs</i>	74
Hansen (1989), <i>Ecological Economics</i>	52
Deacon and Murphy (1997), <i>Land Economics</i>	47
Cassimon et al. (2011), <i>Global Environmental Change</i>	45
Torrás (2003), <i>World Development</i>	41
Łapko et al. (2020), <i>Sustainability</i>	41
Heijdra et al. (2006), <i>Resource and Energy Economics</i>	37
Thapa (1998), <i>Int Journal of Sustainable Development & World Ecology</i>	27

As shown in Table 5, the most-cited studies in the DFNS literature have played critical roles in shaping the field from both theoretical and applied perspectives. The most cited work, Kahn and McDonald (1995, *Ecological Economics*), with 79 citations, examines the relationship between economic efficiency and environmental benefits within a theoretical model, serving as a foundational academic reference. Kull (1996), with 74 citations, is based on field observations and presents detailed findings on the socio-economic and ecological outcomes of DFNS initiatives in tropical regions. Hansen (1989) focuses on early policy implementations of DFNS, particularly the effects of debt-relief strategies on environmental governance, and stands as an important reference in the literature's formative years with 52 citations. Deacon and Murphy (1997) and Cassimon et al. (2011), with 47 and 45 citations respectively, present empirical analyses linking DFNS to macroeconomic growth, natural resource management, and climate finance. Torrás (2003) and Łapko et al. (2020), both with 41 citations, examine socio-economic inequality in relation to environmental quality and measure the effects of DFNS on sustainability indicators, respectively. Heijdra et al. (2006) analyze the macroeconomic impacts of DFNS in the context of resource economics and energy markets (37 citations), while Thapa (1998) represents early field-based research addressing implementation challenges.

Collectively, this list supports the research questions' premise that the field is built upon a combination of seminal theoretical works and methodologically diverse empirical studies. The concentration of citations in a small set of seminal works

also points to a structural dependency within the DFNS literature. While these influential studies have established the theoretical and empirical foundations of the field, the relatively lower visibility of more recent contributions suggests that conceptual renewal has been limited. This reliance on earlier frameworks may constrain the ability of DFNS research to fully engage with emerging global challenges such as climate finance, debt transparency, and biodiversity governance. Strengthening the impact of contemporary studies would therefore be essential to ensure that the field evolves beyond its formative classics and remains relevant to current policy debates. It is noteworthy that most of the highly cited works were published before 2010, whereas more recent studies – despite addressing emerging themes such as climate finance and blue economy – have yet to reach comparable visibility. This time lag between academic innovation and citation impact suggests that the field has been slow to adapt to evolving global sustainability debates. Encouraging wider engagement with new conceptual tools could help DFNS research remain relevant alongside rapidly developing domains like sustainable finance.

Table 6. Most relevant sources

Source	Articles
International Environmental Affairs	5
Development (Basingstoke)	4
Ecological Economics	4
Environment	3
Natural Resource Conflicts: from Blood Diamonds to Rainforest Destruction: Volumes 1-2	3
Ambio	2
Environmental Politics	2
Intereconomics	2
International Journal of Sustainable Development and World Ecology	2

Table 6 shows the sources with the highest number of DFNS publications between 1988 and 2025. International Environmental Affairs ranks first with five articles, reflecting its interdisciplinary focus on international environmental policy and governance mechanisms.

Development (Basingstoke) and Ecological Economics, each with four publications, illustrate the dual focus of the literature from both development and environmental economics perspectives. Ecological Economics is particularly notable for

its emphasis on ecosystem services, natural resource management, and economic sustainability in the context of debt-swap mechanisms.

With three publications each, Environment and the book series Natural Resource Conflicts: From Blood Diamonds to Rainforest Destruction address DFNS within broader discussions of natural resource management, environmental conflicts, and development. Journals with two publications – Ambio, Environmental Politics, Intereconomics, and the International Journal of Sustainable Development and World Ecology – tend to focus on regional policy analysis, sustainability indicators, and environmental cooperation models.

This distribution indicates that DFNS research is not confined to a narrow set of economic or environmental journals but also appears in interdisciplinary outlets related to policy, development, and sustainability, reinforcing the field's multidimensional and methodologically diverse nature. The distribution of DFNS-related publications across a wide range of journals highlights the interdisciplinary nature of the field but also reveals its fragmented academic positioning. Unlike more established areas of climate finance or environmental economics, DFNS research does not have a central disciplinary outlet, which may hinder cumulative knowledge building and reduce its visibility in mainstream debates. While the presence of diverse publication venues demonstrates methodological and thematic plurality, the absence of a concentrated publishing platform suggests that DFNS remains a peripheral topic within broader disciplinary agendas. Addressing this fragmentation by fostering greater integration into high-impact environmental finance and policy journals could enhance both the coherence and global influence of the literature. For the policy community, the lack of a central journal outlet means that DFNS research often remains scattered and less visible in global policy debates. Mainstreaming DFNS into high-impact journals on climate finance, environmental economics, and development studies could facilitate stronger dialogue between academia and policymakers, ensuring that research findings more effectively inform international negotiations and financing strategies.

To examine the keyword structure and thematic concentration of DFNS literature, a co-occurrence

analysis of Keywords Plus terms from 1988 to 2025 was conducted. The analysis was performed in R using Bibliometrix/Biblioshiny, and the results are presented in Figure 2. In the visualization, each color represents a thematic cluster, node size indicates the frequency of term co-occurrence, and edges represent the strength of the connections between terms.

The results indicate that the purple cluster contains core concepts such as “debt-for-nature swap,” “environmental economics,” and “environmental protection,” confirming that DFNS research fundamentally integrates environmental economics and conservation policy. The green cluster, featuring “developing country,” “environmental management,” and “international debt,” focuses on the application and governance of debt-swap mechanisms in developing countries.

The red cluster, comprising “sustainable development,” “financial market,” and “investment,” represents the intersection between financial instruments and development goals. The blue cluster, including “debt,” “climate change,” and “political economy,” reflects macroeconomic and climate policy dimensions of the field.

At the center of the network, “debt-for-nature swap” strongly connects to both the purple and green clusters, demonstrating its integrated treatment across conservation policy and geographical application domains. The network structure reveals intense interdisciplinary relationships and integration of different policy fields within DFNS research. The keyword co-occurrence network illustrates both the strengths and limitations of the DFNS literature. While core concepts such as “debt-for-nature swap” and “environmental protection” are strongly positioned at the center, emerging themes including “climate finance,” “blue bonds,” and “nature-based solutions” remain peripheral. This suggests that, despite their growing policy relevance, these innovative financial instruments and sustainability frameworks have not yet been fully integrated into the academic discourse. Similarly, the limited presence of terms related to governance and local participation reflects the underrepresentation of Global South perspectives in knowledge production. The structure of the network thus reveals a field anchored in conservation and environmental economics but still struggling to consolidate its connections with contemporary debates on global finance and climate policy.

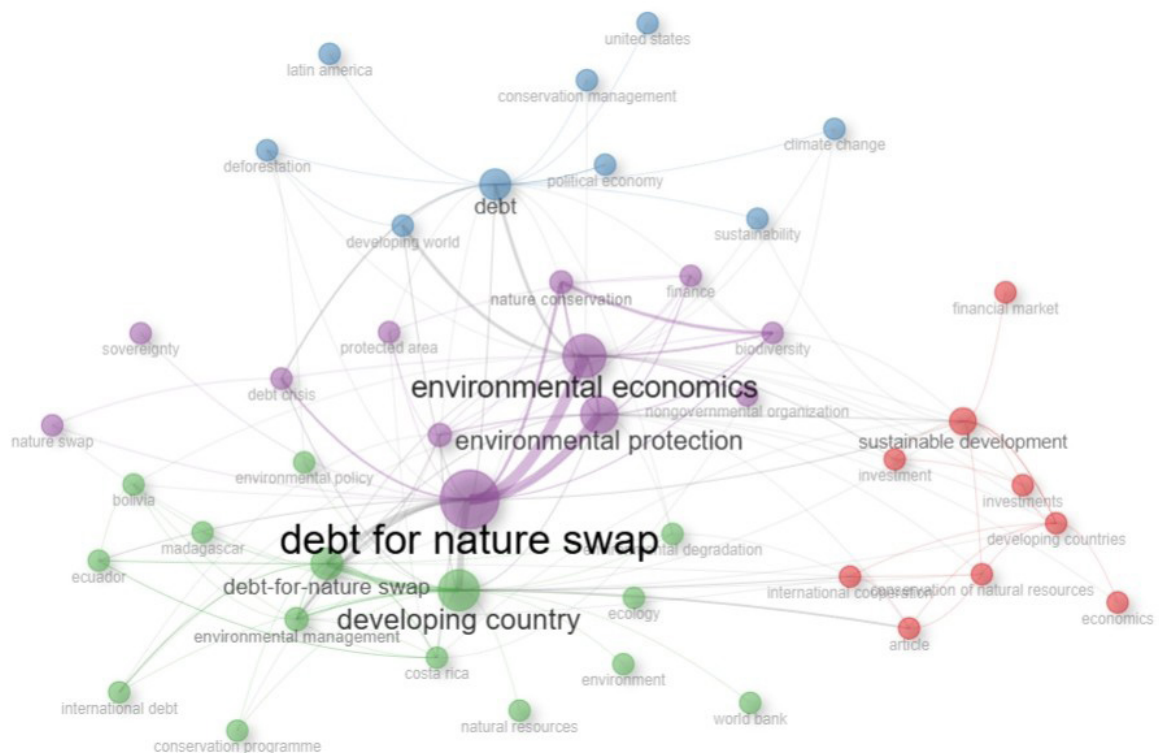


Figure 2. Keywords co-occurrence network

The analysis also shows that innovative financial instruments such as “blue bond” have limited co-occurrence networks in the DFNS literature. Similarly, “climate finance” and “green bonds” appear on the periphery rather than at the center, suggesting that the academic connection between debt-for-nature swaps and climate finance has yet to be fully institutionalized, signaling potential for growth in this area.

A thematic mapping analysis was conducted to visualize the conceptual structure of DFNS literature. Using author keywords with a minimum frequency threshold of three, the analysis was performed in R (Bibliometrix/Biblioshiny). The thematic map in Figure 3 divides the field into four quadrants based on two dimensions: centrality (x-axis, measuring connectivity to other themes) and density (y-axis, measuring theme development).

Upper-right quadrant (Motor Themes: high centrality, high density): Includes climate finance, green bonds, debt-for-nature swaps, and biodiversity, indicating that debt-swap mechanisms are increasingly integrated with climate and green finance tools, playing a critical role in biodiversity conservation strategies. The thematic map rein-

forces the observation that DFNS research is expanding its connections with climate finance and biodiversity, yet key emerging areas remain insufficiently developed. Although “climate finance” and “green bonds” occupy a strong position among motor themes, the relatively peripheral placement of “blue bonds” and “nature-based solutions” highlights the incomplete integration of DFNS into the broader sustainability agenda. At the same time, the appearance of “debt transparency,” “political economy,” and “developing countries” in the emerging cluster suggests that critical governance issues and Global South perspectives are beginning to gain visibility, particularly in the aftermath of the COVID-19 debt crisis. These trends underline the need for future research to strengthen the field’s engagement with innovative financing tools and to deepen its analysis of governance and equity dimensions in DFNS implementation.

Upper-left quadrant (Niche Themes: low centrality, high density) contains adaptation finance and nature-based solutions, which are well-developed within their own domains – particularly in climate adaptation strategies and ecosystem service-based conservation models – but remain less integrated with DFNS mechanisms.

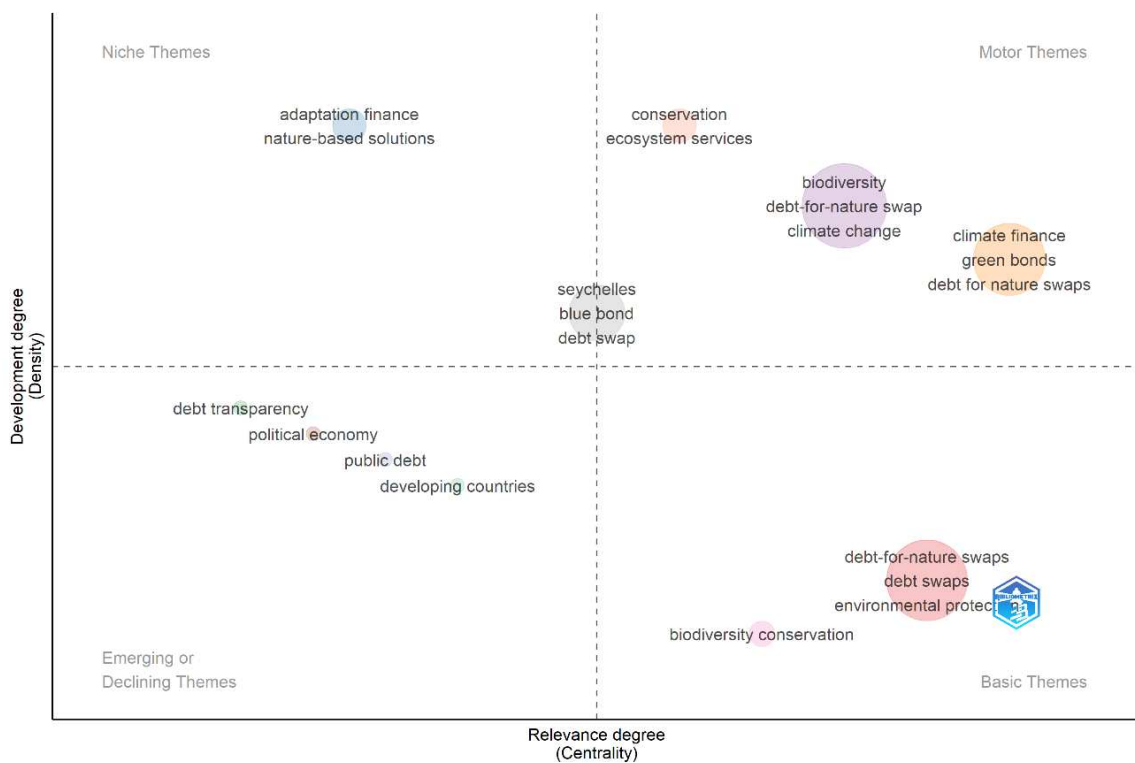


Figure 3. Thematic map

Lower-right quadrant (Basic Themes: high centrality, low density) includes environmental protection, biodiversity conservation, debt swaps, and blue bond, suggesting these are widely recognized reference points in the literature but underexplored in depth, especially in relation to blue economy and marine ecosystem debt-swap models.

Lower-left quadrant (Emerging or Declining Themes: low centrality, low density) includes debt transparency, political economy, public debt, and developing countries. Post-COVID-19 debates on public debt and debt transparency may increase the relevance of these themes in the near future.

Overall, the bibliometric results reveal a field that is conceptually rich but structurally imbalanced. While DFNS research has established a solid foundation in environmental economics and conservation policy, it remains only tentatively integrated into the rapidly expanding domains of climate finance, global sustainability, and governance. The reliance on a small set of seminal works, combined with the persistent concentration of scholarship in high-income countries, limits both the inclusiveness and adaptability of the literature. For researchers and policymakers alike, this represents a dual challenge: advancing DFNS conceptually to align with contemporary debates while ensuring that governance, equity, and local participation move from peripheral concerns to central analytical dimensions. Addressing these gaps will be crucial for DFNS to evolve from a fragmented academic niche into a coherent and policy-relevant field within the broader sustainability agenda.

Despite offering novel insights, this study is subject to several methodological and scope-related limitations. First, the dataset is restricted to publications indexed in Scopus, which may exclude

relevant works available in other databases such as Web of Science or Google Scholar. The findings, therefore, reflect only the Scopus corpus.

Second, bibliometric methods cannot fully capture the qualitative dimensions of DFNS, such as local community engagement, governance effectiveness, or project-level environmental outcomes. These aspects would require in-depth case studies or mixed-method approaches to complement the quantitative mapping.

Third, the findings reflect geographical imbalances in research production. The dominance of high-income countries and the underrepresentation of Africa, Latin America, and the Asia-Pacific limit the global generalizability of the results.

Lastly, there are limitations in measuring the environmental and macroeconomic impacts of DFNS due to data gaps and transparency issues in project implementation. The lack of standardized reporting mechanisms constrains the ability to assess long-term effectiveness across different contexts.

Nevertheless, these limitations also highlight important opportunities for future research. Expanding the dataset to include multiple databases, integrating bibliometric results with case-based and qualitative analyses, and prioritizing Global South perspectives would significantly enrich the literature. Furthermore, improving transparency and reporting mechanisms in DFNS practice would allow scholars to more rigorously evaluate its ecological and financial impacts. By addressing these challenges, future research can build on the foundation established here and contribute to the development of a more coherent, inclusive, and policy-relevant DFNS scholarship.

CONCLUSION

The aim of this study was to conduct a systematic bibliometric analysis of the debt-for-nature swap (DFNS) literature to identify its conceptual evolution, thematic orientations, and global collaboration patterns. This study systematically examined 117 publications produced between 1988 and 2025, mapping the structural evolution, thematic orientations, and geographical distribution of the debt-for-nature swap (DFNS) literature. The main contribution of the study lies in consolidating a fragmented body of research through bibliometric methods and thereby making the academic development dynamics of the field more visible.

The analysis demonstrates that DFNS has evolved from a mechanism primarily focused on conservation and debt relief into a multidimensional policy instrument. Its integration with climate finance, green and blue bonds, and the sustainable development agenda highlights the growing strategic role of DFNS in global debates on the environment and the economy. However, the concentration of research in high-income countries, the limited level of international collaboration, and the weak representation of the Global South emerge as significant imbalances within the literature.

For policymakers, these findings suggest that DFNS should not be regarded solely as an environmental financing mechanism but also as a strategic tool for debt management and financial innovation. Addressing challenges related to transparency, accountability, and local participation is therefore crucial to ensure that DFNS agreements achieve both ecological and socio-economic impact. Moreover, enhancing the engagement of Global South institutions and stakeholders would strengthen inclusiveness and policy effectiveness, particularly in contexts where DFNS is directly implemented.

For future research, this study highlights several promising directions. First, complementing bibliometric evidence with in-depth case studies can capture the qualitative dimensions of DFNS, such as governance practices and community-level outcomes. Second, underexplored areas such as the blue economy, debt transparency, and nature-based solutions offer fertile ground for conceptual expansion. Finally, strengthening collaboration networks between scholars in the Global North and Global South will be essential to generate more balanced and globally relevant knowledge. By advancing in these directions, DFNS scholarship can evolve into a coherent and policy-relevant field within the broader sustainability agenda.

These conclusions resonate with the imbalances and emerging themes identified in this paper, particularly the limited internationalization of DFNS scholarship and the peripheral status of innovative financial instruments such as blue bonds. Addressing these gaps will not only enhance the inclusiveness and policy relevance of the field but also ensure its alignment with global debates on climate finance, sustainable development, and governance.

AUTHOR CONTRIBUTIONS

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Funding acquisition: Cansel Oskay.

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Supervision: Cansel Oskay.

Validation: Cansel Oskay.

Visualization: Cansel Oskay.

Writing – original draft: Cansel Oskay.

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ETHICAL STATEMENT

This article does not involve human or animal participants.

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