

Green Climate Fund Implementation: Bibliometric and Thematic Review

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Abstract

The goal of this research is to perform both a bibliometric analysis and a thematic analysis on the current implementation of the Green Climate Fund (GCF) and the role it is taking in the overall global climate finance governance structure from 2015 to 2026. In order to achieve this objective, the authors selected 44 peer reviewed studies published in Scopus which utilized a modified search strategy. Using Biblioshiny (RStudio), and VOSviewer, the authors developed and analyzed a set of publication trends; author collaboration; keyword co-occurrence; and thematic structures based upon these articles. The results represent the most complete bibliometric representation of the GCF's implementation in academia with its many disciplines and identified gaps. The findings offer an agenda for future research to support evidence-based decision making and processes related to more equitable and transparent governance arrangements between climate and finance.

Keywords: Green Climate Fund, Climate Finance, Regional Disparities, Environmental Economics, Stakeholder Engagement.

1. Introduction

The growing worldwide focus on Sustainable Development since 2015 has caused an explosion in Climate Finance literature that needs to be rigorously analyzed to help develop our understanding of how the major areas of concern have developed over time and the ways in which collaborative networks evolve [1], [2]. Bibliometrics are being used to visualize the structural makeup of the academic discipline of Green Finance by tracing the trajectory of publications; by geographically mapping where these publications originate and occur; and by demonstrating the patterns of co-occurrence (hot spots) among terms such as Green Bonds, Climate Policy etc. [2], [3]. These analyses provide a methodological way to analyze and understand the changes in research interest/ focus in this area of study, especially the transformation from early research focused on carbon markets to current research focused on Sustainable Development Goals and Digital Financial Solutions [1], [4]. This study utilizes a systematic bibliometric approach to comprehensively examine the structural characteristics and thematic evolution of Green Finance Research, including the identification of Main Themes/Trends and inter-cluster relationships throughout the domain [5], [6]. Leveraging large-scale datasets spanning multiple decades, researchers have effectively utilised bibliometric tools such as VOSviewer and Biblioshiny to categorise the literature into distinct thematic clusters, including responsible investment, carbon and climate financing, and green banking [6], [7].

The Green Climate Fund (GCF) was launched in 2010 during the 16th Conference of the Parties (COP16) to address the need for a significant international financing mechanism to support developing countries' efforts to address the effects of climate change (UNFCCC, 2011). It seeks to provide a new scale of financing for mitigation and adaptation in developing countries while enhancing country ownership, direct access, and targeting the most vulnerable Low-lying Small Island Developing States (SIDS) and Least Developed Countries (LDCs). From a mere emerging intergovernmental organisation, GCF has gone on to do more, developing a business model for major climate finance that blends public and private funds to have regional-scale impacts across sectors. Its efforts include low-emission improvement pathways, climate-smart infrastructure, inclusive approaches to weather adaptation, and potential construction of companions. With GCF projects approved in more than 200 locations worldwide, the GCF is a key driver of the 2015 Paris Agreement and the 17 Sustainable Development Goals (SDGs) [8], [9]. However, some scholars have criticised the GCF's functioning on the grounds of its effectiveness, equity, and efficiency. Other researchers investigated the fund's performance across governance structures [10], co-financing regimes [11], and institutional accountability [12]. This includes criticism that was made toward an omission of local actors [13], insufficient gender mainstreaming [14], as well as remaining barriers to obtaining climate funding for certain Small Island Developing States (SIDS) and Least Developed Countries (LDCs) [15]. As a whole, this research demonstrates that there are many challenges with regard to climate financing governance which include contradictions. Therefore, it emphasizes the need for long-term assessments regarding the implementation of the Green Climate Fund (GCF). In addition to being based upon 10 years of research on the topic of climate finance from an academic perspective, this study aims to demonstrate the factual basis behind the climate finance literature that has been studied, critiqued, and theoretically analyzed.

1.1 Importance of GCF in Global Climate Finance Governance

The GFC provides an important framework through which to address the financial disparity that exists between developed and developing countries with regards to their ability to adapt to and mitigate climate change impacts. It is the primary financial instrument for the United Nations Framework Convention on Climate Change (UNFCCC). Consequently, it plays a significant role within the geographical economy of climate finance mobilization, allocation and governance; this includes supporting adaptation and mitigation initiatives in vulnerable and less economically developed geographies [8], [16]. Furthermore, the GFC's remit does not stop at providing funding; it also aims to promote inclusive, equitable and transformative forms of development. Additionally, the GFC serves as a governance tool to help influence national policy-making processes, develop capacity within institutions, and establish global financing standards [17], [18].

There is an important relationship between the GCF (Global Green Fund) community and how the fund operates at each level of the analyzed evaluative framework. This is due to the fact that the GCF can have a role in influencing or contributing to larger global trends regarding governance of green finance. Specifically, the GFC has contributed to the development of new forms of innovative financing, including, but not limited to: climate bonds; blended finance approaches; and co-benefit frameworks [19], [20]. Moreover, through its emphasis on country ownership and providing for "direct access," the GFC also supports inclusive, participatory decision-making processes with regard to the allocation and monitoring of resources [13]. However, several major global issues remain unaddressed. These include the problem

of procedural complexity [21]; lack of representation of marginalized peoples, especially Indigenous peoples [22]; and political authority in permitting activities related to the GFC.

Against the backdrop of the ongoing green shift and the increasing demand for sustainable finance instruments, the GCF's part is even more significant. As governance of global climate action shifts toward a more decentralised and polycentric style, the GCF can provide an important forum for aligning global commitments with development needs on the ground [23], [24]. The GCF, through its financial, environmental, and social standards, not just mobilises funding, but also standardises the fluid governance of the emerging green finance discourse, particularly in emerging markets and high-risk geographies.

1.2 Rationale of the study

The GCF is one of the most important pillars of climate finance within the UNFCCC, established to assist developing countries in mitigation and adaptation. A decade of academic literature (2015–2026) on GCF implementation can be discussed from the perspectives of financial flows, institutional arrangements, participation, transparency, gender, private-sector engagement, and regional access. Although this academic interest is increasing, a comprehensive synthesis that encompasses the paradigm shifts and thematic trends across GCF focus areas remains missing. Indeed, studies on co-financing, project evaluation, or even the legal frameworks around the world have been fragmented; Nonetheless, mapping the field with data has been generally missing. To fill this research gap, this study conducts a bibliometric and thematic analysis of 44 peer-reviewed articles published in Scopus-indexed journals between 2015 and 2026. Through trends in publications, key authors and contributors, collaboration networks, thematic clusters, and narratives, this review reveals valuable insights about the conceptualisation, discourse and assessment of GCF implementation across disciplines and geographies. This would be of interest to scholars, as well as to practitioners and policymakers seeking to improve the governance, equity, and efficiency of the climate finance system.

1.3 Research Questions

- RQ1 What are the major publication trends in academic research on the Green Climate Fund between 2015 and 2026?
- RQ2 Who are the major contributors (authors, institutions, countries) in GCF implementation research, and how do they collaborate?
- RQ3 What are the significant themes and clusters of issues as evidenced in the literature focusing on the implementation of GCF?
- RQ4 What are the existing evaluations at the GCF project level (performance, challenges, equity issues) that take place in developing, climate-vulnerable regions?
- RQ5 Based on the scholarly literature, what would be typical policy narratives and suggestions for the enhancement of transparency, accountability, and effectiveness in GCF?

2. Methodology

The study employed structured bibliometrics and thematic analysis to explore global scholarly trends, research networks, and the thematic evolution of GCF implementation between 2015 and 2026. The methodology framework includes systematic data retrieval, selection based on eligibility criteria, and descriptive analysis visualisation using a specific tool.

2.1. Data Source and Search Strategy

2.1.1. Database and Keywords Used

Data were obtained from Scopus on 15-03-2026, which provides extensive coverage of peer-reviewed literature across the social sciences, economics, and business. The search keyword strategy was based on the combination of two main ideas. Search Query: (TITLE-ABS-KEY (Green Climate Fund) AND TITLE-ABS-KEY (implementation)). This search query ensured that articles specifically addressed the implementation aspects of the Green Climate Fund across various contexts.

2.1.2. Inclusion and Exclusion Criteria

To ensure that the data was both relevant and of high quality, several stages were undertaken to conduct the selection process (Table 1).

Table 1: Inclusion and exclusion process	
Filter Stage	Articles Remaining
Initial Search Results (All Subjects)	142
Time Range: 2015–2026	142
Subject Areas: Social Sciences; Economics; Business & Management	73
Document Type: Articles Only	48
Language: English	44
Final data set	44
Source: Author's work	

By applying these filters, the final sample comprised academic research from relevant fields that addressed the policy, institutional, financial, and implementation aspects of GCF.

Final Search String: (TITLE-ABS-KEY (Green Climate Fund) AND TITLE-ABS-KEY (implementation)) AND PUBYEAR > 2014 AND PUBYEAR < 2026 AND (LIMIT-TO (SUBJAREA , “SOCI”) OR LIMIT-TO (SUBJAREA , “ECON”) OR LIMIT-TO (SUBJAREA , “BUSI”)) AND (LIMIT-TO (DOCTYPE , “ar”)) AND (LIMIT-TO (LANGUAGE , “English”))

2.2. Tools for Analysis

2.2.1. Biblioshiny (R Studio)

A descriptive bibliometric analysis was conducted using the R-based Bibliometrix package, accessed via the Biblioshiny Web-based interface. It facilitated the identification of important publication trends (e.g., the weighted number of papers each year, the most relevant journals, productive authors, and core papers). The tool also served to further thematic development and structure conceptualisation by co-word and factorial analysis.

2.2.2. VOSviewer

VOSviewer was used to visualise and map bibliometric networks, including co-authorship (authors, countries, institutions), keyword co-occurrence, and citation networks. These visualisations enabled the recognition of patterns of collaboration and theme clusters in the field of research.

2.3. Types of Analyses Conducted

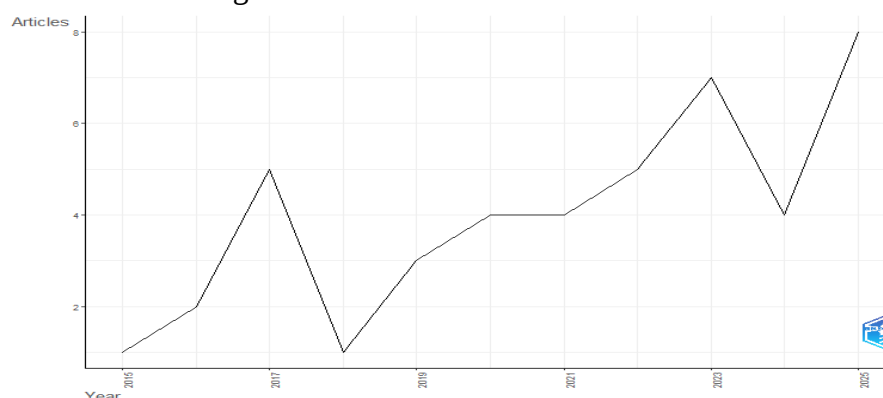
Descriptive bibliometrics were employed to assess productivity by year, source, authorship, citations, and overall impact. Network analysis was conducted to examine the collective relationships among authors, institutions, and countries. At the same time, keyword co-occurrence and thematic mapping were used to identify research hotspots, thematic clusters, and the intellectual structure of GCF implementation research. Citation analysis explored the impact and affiliations among studies and authors. Additionally, thematic evolution analysis was performed to examine the evolution and divergence of topics over the period from which the documents originated. This methodological design provides a robust and replicable investigation of the body of scholarship on the Green Climate Fund's implementation efforts.

3. Descriptive Bibliometric Analysis

3.1. Annual Publication Trends (2015–2026)

There is an upward trend in the volume of research published annually since the last decade (Fig. 1). However, this growth is slow. The volumes were quite low for the first three years (2015-2017) because it was a very new area. There was also a downward trend in 2018 but then the growth continued. The research publications have grown each year from 2019 on, which indicates that academics are becoming increasingly interested in climate financial mechanisms. This trend appears to be increasing each year since 2022 and most publications were written in 2025.

Figure 1: Annual Scientific Production

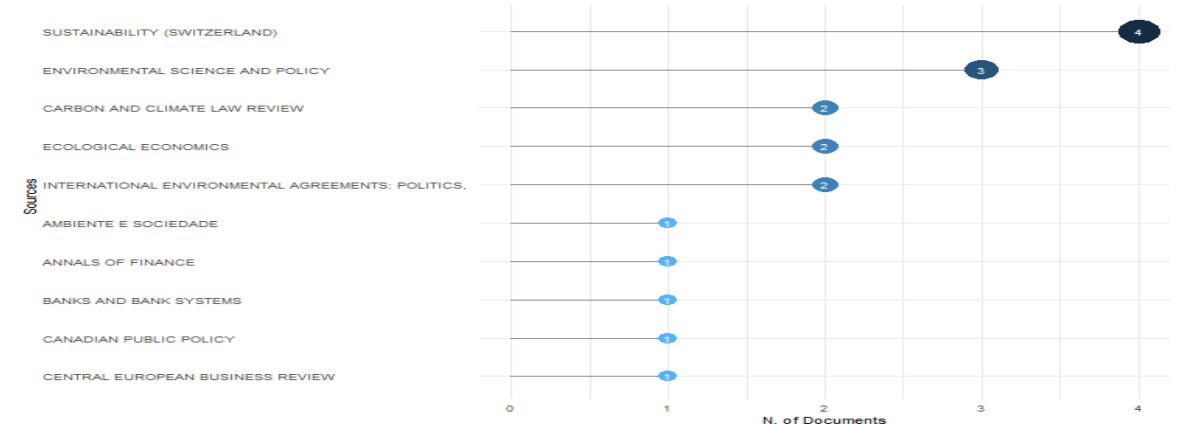


Source: Biblioshiny-R

3.2. Leading Journals, Authors, and Institutions

The distribution of all articles by source clearly shows that research on the Green Climate Fund (GCF) is published across many interdisciplinary journals, not mainly or exclusively in one journal (Figure 2). Among these journals, Sustainability (Switzerland), with the most articles published, shows the greatest interest in publishing articles on climate financing and sustainability governance. Environmental Science and Policy is second in the number of articles it publishes, and this is likely due to its policy-oriented focus in much of the discussion regarding the GCF. While there are a few additional journals that have some presence in the field, e.g., Carbon and Climate Law Review, Ecological Economics and International Environmental Agreements: Politics, Law and Economics, overall the pattern of publication indicates that the research related to the GCF is being conducted from an interdisciplinary perspective, including environmental policy, climate governance, and sustainability studies.

Figure 2: Most relevant sources



Source: Biblioshiny-R

Table 2 lists the most productive GCF authors in terms of GCF implementation. It is interesting to note how the authors' authorship was distributed as well. There were no co-authors, and each of the authors mentioned has authored only one study; therefore, their fractionalised authorship remains the same. The evidence presented above suggests that the field of GCF implementation is at an early stage of development and that it is not dominated by a few authors. Rather, it seems that many authors from various institutions and geographic locations are beginning to contribute to the literature on GCF implementation. This type of fragmentation is typically seen when new areas of study emerge among a larger number of academicians.

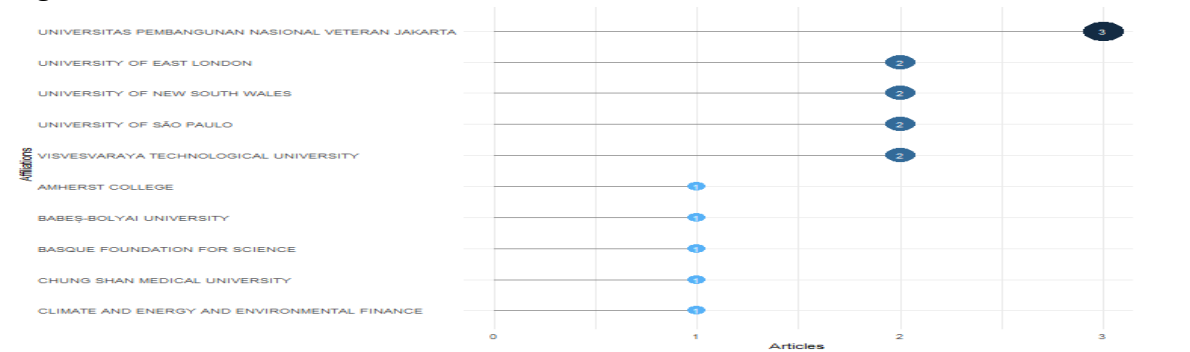
Table 2: Top ten contributing authors

Authors	Articles	Articles Fractionalised
Bowman M	1	1
Chaudhury A	1	1
Cheng W	1	1
Ciot M-G	1	1
Giacomini G	1	1
Li H	1	1
Maddahi R	1	1
Marozzi M	1	1

Owen R	1	1
Recio Me	1	1
Source: Biblioshiny-R		

The GCF implementation has been studied by a variety of Universities and Research Centres worldwide, as shown in Figure 3. With three publications, Universitas Pembangunan Nasional Veteran Jakarta produces the most studies on this topic, which can be taken as evidence of their greater involvement than others. The University of East London, the University of New South Wales, the University of São Paulo, and Visvesvaraya Technological University have also each produced two studies. Other institutions, such as Amherst College and Babes-Bolyai University, have contributed to one study. Together, these findings suggest that there is no central geographic location for research on GCF implementation. The diversity of research locations on GCF implementation reflects growing international academic interest in climate finance and sustainable development.

Figure 3: Most relevant affiliations



Source: Biblioshiny-R

3.3. Most Cited Articles and Impact Metrics

Table 3 identifies the top-cited academic papers that have contributed to Green Climate Fund (GCF) implementation and other climate finance issues. Clearly, the paper by Dafermos (2018) in Ecological Economics has had the greatest number of citations overall and therefore the most enduring influence on GCF climate finance research. Although He (2019) in Land Use Policy and Lund (2017) in World Development are among the most highly cited academic papers in terms of their influence on GCF climate finance research, they are both being surpassed by the relatively new research by Brodny (2021) and Owen (2023), with the latter two having greater Normalised Citation Rates, indicating an increasing relevance in the contemporary dialogue. The pattern of citations across all four tables indicates that the original research has remained the foundation of the existing literature, and as the body of knowledge continues to evolve, newer contributions will become increasingly recognised.

Table 3: Most Cited Articles and Impact Metrics				
Paper	DOI	Total Citations	TC per Year	Normalized TC
Dafermos Y, 2018, Ecol Econ	10.1016/j.ecolecon.2018.05.011	497	55.22	1.00
He B-J, 2019, Land Use Policy	10.1016/j.landusepol.2019.05.003	236	29.50	2.64

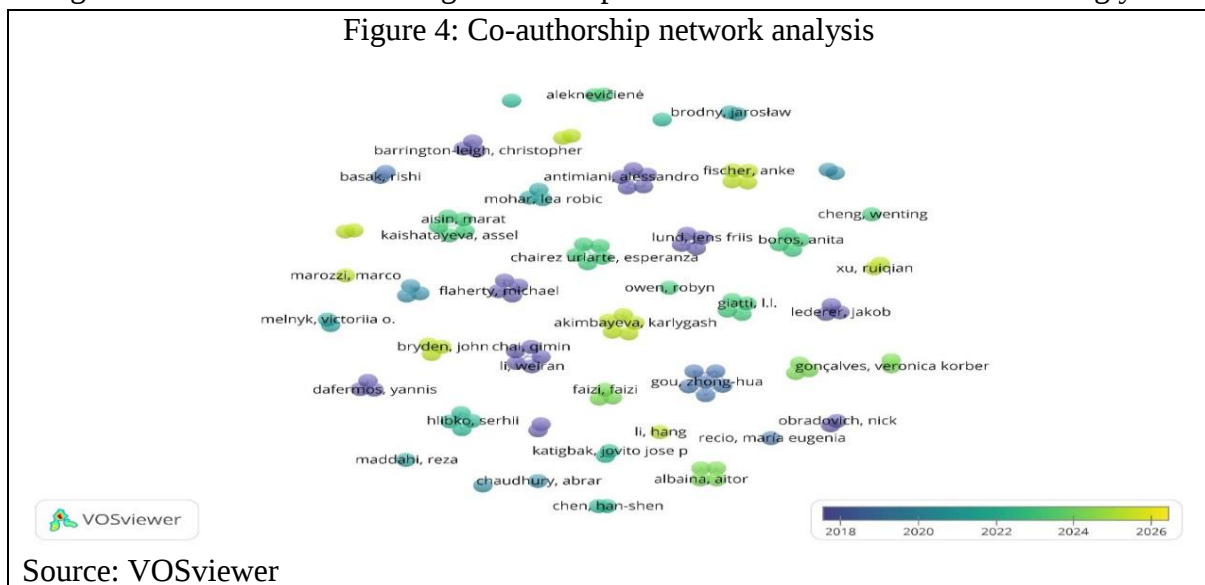
Lund JF, 2017, World Dev	10.1016/j.worlddev.2016.08.005	173	17.30	2.20
Flaherty M, 2017, Res Int Bus Financ	10.1016/j.ribaf.2016.06.001	155	15.50	1.97
Brodny J, 2021, J Clean Prod	10.1016/j.jclepro.2020.123641	48	8.00	3.76
Chaudhury A, 2020, Sustainability	10.3390/SU12145507	45	6.43	1.65
Lazaro LLB, 2023, J Climate Finance	10.1016/j.jclimf.2023.100009	40	10.00	1.89
Owen R, 2023, IEEE Trans Eng Manage	10.1109/TEM.2021.3094992	40	10.00	1.89
Antimiani A, 2017, Environ Sci Policy	10.1016/j.envsci.2017.07.015	38	3.80	0.48
Rempel A, 2020, Energy Res Soc Sci	10.1016/j.erss.2020.101736	35	5.00	1.28
Source: Biblioshiny-R				

4. Collaboration and Network Analysis

4.1. Co-authorship Patterns

Figure 4 illustrates moderate dispersion in the collaboration patterns in the co-authorship network for the GCF implementation research landscape. There are many small networks of authors rather than one large network, suggesting that many individual research teams contribute to the development of research on climate finance, governance, and sustainability. There appear to be clusters of authors forming partnerships with other researchers with similar interests in these areas of study. The colour gradient also indicates the period during which the authors collaborated. More recent authors appear towards the lightest end of the spectrum. The network shows increasing levels of scholarly interactions over time; however, continued growth in collaborative linkages could expand the field of research in the coming years.

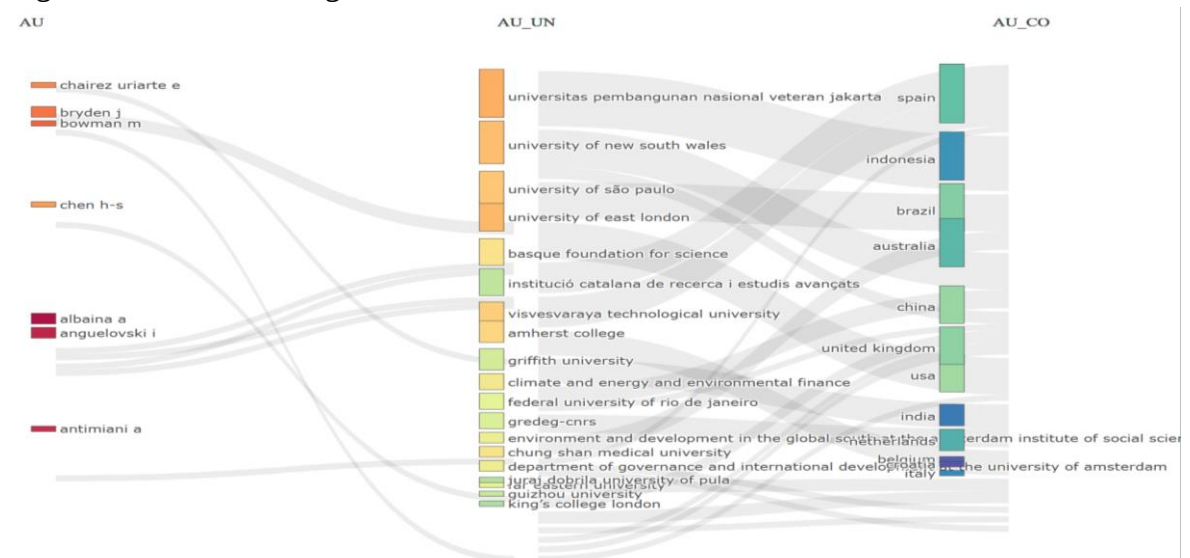
Figure 4: Co-authorship network analysis



4.2. Institutional and Country-Level Collaborations

Figure 5 depicts the three-field representation illustrating author-institution-country relationships in the area of green climate fund (GCF) implementation research. This figure provides a clearer understanding of authors' connections to institutions and of those institutions' contributions to the global research community. A number of the authors are affiliated with universities that maintain international academic partnerships, underscoring the international scope of climate finance research. Universities such as Universitas Pembangunan Nasional Veteran Jakarta, the University of New South Wales, and the University of São Paulo were noted for their prominence and ties to countries such as Indonesia, Australia, and Brazil. In total, the figure represents the geographically diverse base of knowledge in this field and indicates that research on the GCF's implementation is supported by a wide-ranging international academic network.

Figure 5: Three-field diagram



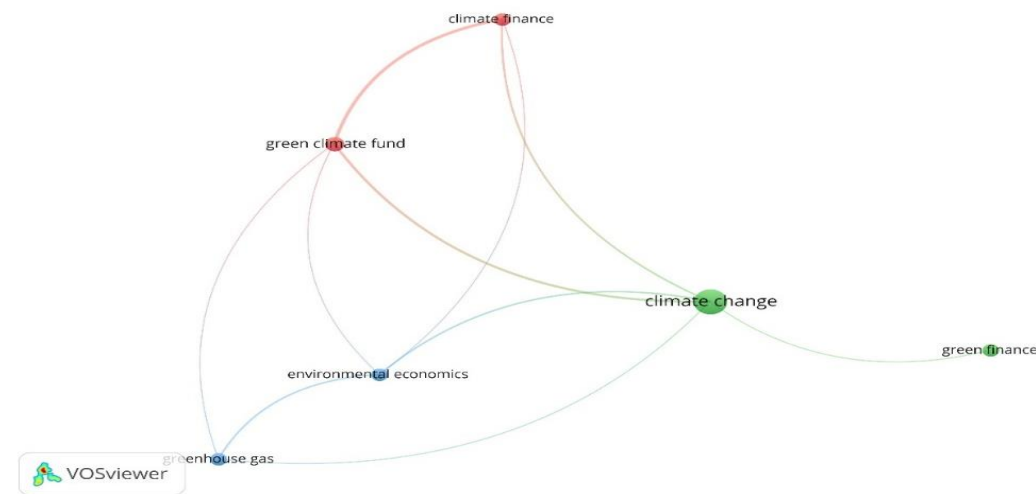
Source: Biblioshiny-R

5. Thematic and Keyword Analysis

5.1. Keyword Co-occurrence Mapping

Figure 6 shows how keywords relate to one another, illustrating key relationships and themes in the literature regarding the Green Climate Fund (GCF). Keywords, notably climate change, are at the centre of this co-occurrence network and represent a common thread across all other research areas. The second-largest group of connected keywords includes climate finance and the Green Climate Fund. This indicates an emphasis on financial and institutional aspects of global climate governance. The third set of connected keywords includes environmental economics and greenhouse gas. These show how the discussion connects with broader environmental policy and economic issues. In total, it appears the literature is primarily centred on climate change, yet has begun to consider additional topics, including financial mechanisms, environmental policies, etc.

Figure 6: Keyword Co-occurrence Mapping



Source: VOSviewer

5.2 Word Cloud

Figure 7 shows the word cloud generated by using all the keywords found in the selected articles and provides an immediate impression of the main topics and issues discussed in the literature about the GCF's implementation. The frequency with which the term 'climate change' is present at the top of the word cloud confirms that it has been the dominant factor for researchers when defining their agenda. The frequent presence of other keywords such as "green climate fund", "climate finance", "environmental economics", and "green finance" reinforces the fact that the financing and policy dimensions are the two key areas of the climate governance framework that have driven the focus of researchers. Finally, the presence of words related to "sustainable development", "emission control", and "environmental policy" shows the broad environmental management context in which the discussions have taken place.

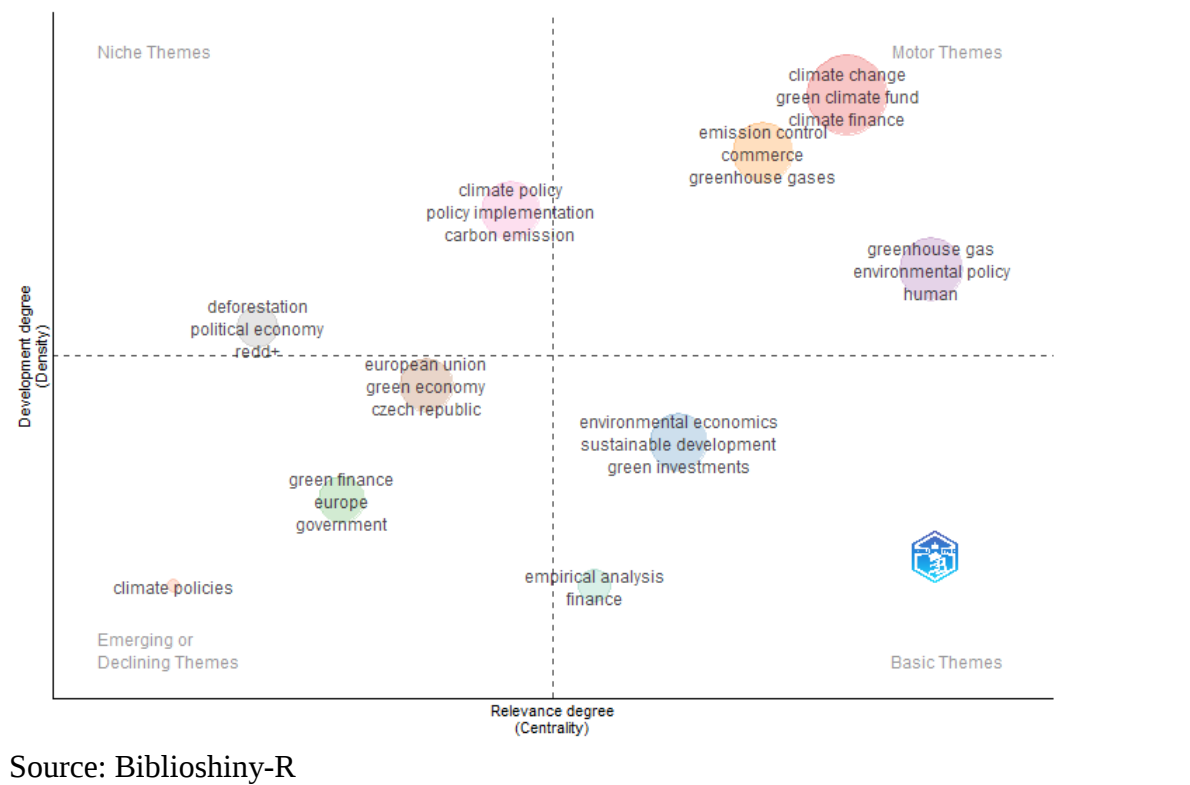
Figure 7: Word Cloud



Source: Biblioshiny-R

such as climate policy, policy implementation, carbon emissions, etc., show significant development but little interconnection with each other. The emerging or declining areas of the thematic map include climate policies and governments, indicating areas that will be the focus of new research and/or are likely to decline in importance based on trends in the literature.

Figure 9: Thematic Map



Source: Biblioshiny-R

5.4.1. Organisational Structures and Distribution Issues

The Global Climate Fund successfully transferred funds to their recipients based on a horizontal organizational design that is able to transfer funding horizontally across different regions and industries. However, the funding mechanism has also been criticized as being overly complex and layered. In addition to this complexity, there have been issues related to the ability of the funds to be disbursed quickly and equitably among different resources [8]. Although the purpose of the Global Climate Fund was to support "the most vulnerable" countries such as least developed countries (LDCs), small island developing states (SIDS), etc., these countries have had difficulty accessing the funding due to bureaucratic barriers and donor driven priorities [15]. Furthermore, National Designated Authorities (NDAs) and Accredited Entities must navigate complex approval processes, which can be challenging to do regardless of whether they come from countries with strong or weak institutional systems. Countries with weak institutional practices are placed at an even greater disadvantage by virtue of these approval processes [16]. This demonstrates the need for a clear and transparent framework that removes redundant complexity while still providing enough rigor to govern efficiently and equitably.

5.4.2. Monitoring, Evaluation, and Capacity Building

The monitoring and evaluation (M&E) functional area plays a key role in ensuring the GCF projects are effective, accountable and adaptable. However, ODS has repeatedly noted that M&E frameworks for funds lack consistency and transparency, thus undermining the potential for learning and accountability [25], [26]. Self-reported data constitute a major source for tracking projects. Yet reliability across regions and project types remains a concern [27]. Many recipient countries cannot perform strong evaluations or change implementation based on evidence, making this problem even harder to tackle. Even when GCF-specific capacity-building initiatives occur, they often operate in isolation or are poorly aligned with local institutional contexts [28]. Long-term investments in local knowledge and skills should be complemented by strengthening systems for monitoring and evaluation (M&E) to ensure transparency, impact assessment, and adaptive governance informed by the fund's knowledge.

6. Challenges in GCF Implementation

Although GCF is the most important institution in international climate finance today and was designed to overcome many implementation barriers, it is facing severe challenges. The crux of the issue lies in the bureaucratic and procedural complexities where disbursement of funds and projects may take longer, especially in low-capacity and high-risk regions [13], [23]. At the same time, GCF approval and accreditation processes remain widely seen as extremely technical and resource-intensive in their implementation, with a disproportionate impact on small countries or local actions that cannot maintain the level of in-organisational administrative structure needed to meet very rigid requirements [15]. It should be noted that the political relationships and power disparities between board member countries and contributor countries often result in inequitable allocations of funding, which further exacerbate the inequality in the governance of climate finance and create an issue of fairness relative to the scale and accessibility of climate finance [8], [9], [18].

Another key problem is that GFCF approaches do not generally address the requirements of local societies. Even though the Fund promotes country ownership in its approach, such a model is rarely implemented on the ground by means of an adequate participatory development process with local stakeholders, particularly indigenous peoples, local communities and civil society via small-scale non-governmental organisations [22], [28]. The gap mentioned above can lead to inadequate and ineffective participatory governance processes and expose the global community to the risk of an external priority setting as regards the type of support to be given. Additionally, monitoring, evaluation and accountability mechanisms are not typically included in funded activities; therefore, assessing the long-term sustainability and transformative effects (as opposed to short-term results) of financed activities is extremely difficult [10], [29]. However, blended financing models have other problems with co-funding. Their design provides incentives for banks to prioritize 'bankable' versus 'socially beneficial' projects; therefore, it may redirect focus away from less commercially attractive yet socially important initiatives [11], [16].

6.1. Transparency and Accountability Concerns

Transparency and accountability remain crucial but difficult drivers of the Green Climate Fund's (GCF) functioning and are frequently identified as key elements underpinning its credibility and long-term success. Although the GCF was designed to function in a transparent manner, especially in financial flows,

project selection, and governing structures, case studies have found differences between this goal and reality [12], [30]. The complex, multi-layered architecture of the fund and the fact that access is usually indirect through intermediaries are also barriers to determining clear lines of responsibility and hinder effective civil society and recipient country monitoring of fund flows and project outcomes [28], [31]. Reporting guidelines are also inconsistent, and regulatory structures and enforcement of fiduciary and environmental safeguards are weak and have failed to scale up accountability, particularly in countries with weak institutional oversight [13], [32].

Concern that decision-making is not done inclusively, nor in a transparent manner, down to the level of project appraisals and the board, where the interests of donor countries may silence the voices of vulnerable yet affected communities [9], [16]. In others, self-reported project effects are not cross-checked, and inflated narratives about the transformative effects on the Transmission System Operators (TSOs) or the project's success are presented [27]. These failures not only erode stakeholders' confidence but also weaken the GCF's ability to become a strong instrument of climate justice. To restore trust in third-party appraisals, establish an overarching set of performance standards, and strengthen public notice, these are key components of a new fund model in government [23], [25].

6.2. Regional Disparities and Access in Developing Countries

One of the biggest problems that the Green Climate Fund (GCF) is dealing with today is unequal use of its resources around the world; specifically among developing nations, this unequal use goes against what the GCF was established upon as an equitable and just foundation for addressing climate issues. Although the GCF did establish a priority based on the needs of the least developed countries, small island developing states, and African countries (countries facing the highest GHG emissions growth rate), there remains large inequities in terms of approved funding and project implementations at the regional level [29], [33]. In many cases, the lack of institutional capacity or technical know-how results in poor timing and complexity from the funding process itself, including funding tied to accredited entities. The global intermediary system used to manage funds in developing countries has replaced local institutions and undermined country ownership and relevance [34].

In low-income areas, particularly in Africa and some parts of Asia, where human and financial capital are already stretched, the procedural and administrative costs of GCF accreditation and proposal development are disproportionately high [16], [35]. Once again, based on an aspect of dissymmetry, this development effect resembles the splitting of funds: a small number of large developing countries capture the majority of project approvals. Where smaller and/or more vulnerable nations are concerned, however, the approvals are more limited [18]. Compounding this issue is the absence of strong data and surveillance systems in these regions to demonstrate preparedness [36].

As a strategy to remedy these inequities, readiness enhancement and capacity-building grants have been utilised, but scaled impact has been limited [31]. To ensure this equitable distribution, the GCF requires a much more robust program to simplify the credentialing process, bolster regional technical support centres, and provide direct access to local institutions, returning to the basics of fairness and fulfilling the GCF's global mandate.

6.3. Institutional Bottlenecks

The GCF is operational; however, it has been experiencing some institutional hurdles in the developing world, including bureaucratic inefficiencies, multiple or overlapping responsibilities, and a lack of absorptive capacity to channel funds to developing countries. The GCF intends to increase developing countries' access to funding by strengthening their national institutions' capacities and processes through participation in direct access modalities. Still, procedural issues and fiduciary, environmental and social safeguards requirements, among other factors, have made it difficult for many developing countries to become accredited [8], [37]. These procedures are commonly lengthy and inefficient; they create a time lag and waste resources at the start of the project, and they prevent national actors from applying for accreditation. Moreover, poor inter-ministerial coordination and a lack of clarity among agencies during implementation led to fragmented project designs and duplicated efforts, thereby undermining not only the effectiveness but also the efficiency of climate interventions [9], [23].

Moreover, unpreparedness within institutions to process large-scale international climate finance leads to differences between countries in the absorption and oversight of these funds. This has been particularly noticeable in low-capacity settings where administrative structures have not been fully harmonised with GCF norms, leading to encoding problems and low utilisation of funds [16], [35]. In addition, the power realised by multilateral implementation agencies compared to national ones is part and parcel of a broader asymmetry in institutional power, which frequently leads to dependency and undercuts rather than strengthens indigenous capacity [34]. However, this could be speedier if donors seek a way to channel all funds through international organisations, but it could erode local ownership and alignment with countries' priorities too [29].

Bridge the institutional gap between capacity-building workshops and the people responsible for mid-level roles solely through capacity-building courses. To realise replicable and scalable models, a sustained investment in institutional reform will be required, along with enhanced accreditation pathways for smaller agencies, strengthened multi-agency engagement protocols, and the development of a project pipeline [27], [31]. Without these systematic fixes, the GCF will only ever progress towards an inclusive and process-based climate finance window.

7. Emerging Issues and Future Research Directions

Several emerging challenges related to the GCF demand systematic research and policy-oriented analysis as shifts are occurring within the broader architecture of global climate finance. An example of this is the increasing complexity of the potential for private sector actor engagement towards equity and sustainability in the developing world, where development may not 'interface' with market mechanisms [16]. In contrast, the increasing frequency of climate crises necessitates new, flexible funding mechanisms focused on adaptation rather than solely on mitigation, including both anticipatory financing for climate-related risks and damage financing [15]. Blockchain technology to trace funding flows and AI to model climate risks offer promising new tools but raise ethical questions needing further exploration [38]. However, future comparative studies on regional modelling options for connectivity will be even more important for concluding the scalability of inclusive connectivity, particularly in SIDS and LDCs [13], [18]. The need for longer-term monitoring of the impact of GCF-financed projects and the implementation of sustainable system changes has also been absent, thereby creating an opportunity to develop new

evidence-based policy transitions [27], [34]. Only by considering an interdisciplinary perspective that combines the analytical examination of governance, finance, and development will begin to unravel the enigmatic structure of climate finance governance and generate more equitable and inclusive climate preparedness and development pathways through instruments such as the GCF.

7.1. Innovations in Climate Finance Delivery

The ways in which climate finance is being provided are changing how funds are allocated, tracked, and scaled, helping meet global sustainable development goals, creating a confusing mix of hope and confusion. The variety of means to fund climate activities, including the use of green bonds, climate impact auctions, and blended finance mechanisms, is increasing the capital available for climate investment and decreasing the perceived risk of investing in climate [19], [39], primarily through the private sector, in the developing world. There have been a few recent conversations about the potential for using digital technologies (such as blockchain) to enhance transparency and traceability in the climate finance flow to help resolve misallocation, build trust/confidence in stakeholders [38], and to serve as decision support tools for climate risk modeling and project evaluations in fragile ecosystems where traditional metrics may fall short [17]. However, new technologies and innovations require favourable regulatory environments and technical capacities that vary greatly from country to country and institution to institution. Additionally, it remains unclear whether the growing role of the private sector has led to a decrease in focus on equity, adaptation, and local agendas [16]. Therefore, longitudinal studies are needed to examine the continued efficacy, accessibility, and implications for social justice of the new means of delivering climate finance in areas of traditionally underdeveloped or low capital/trust traditional financial services. However, to make the innovations in climate finance available for both mitigation/adaptations, as well as development and resilience, they need to be buttressed by inclusive governance structures.

7.2. Importance of digital and data-driven platforms

These technologies are increasingly being applied to the design, delivery, and assessment of climate finance's impact, as well as to the institutions that manage climate-related policy programs, such as the Green Climate Fund. These technologies allow for better tracking of fund disbursements at lower cost, and for monitoring project implementation and the achievement of performance indicators from the project down to the implementation level and across jurisdictions and implementing agencies. Blockchain-enabled tools can provide real-time, tamper-proof proof of funds flows and compliance obligations and therefore represent an effective solution to long-standing problems with climate finance platforms in terms of corruption, leakage and inefficiency [38]. In addition, geospatial analytics, satellite imagery, and AI models are being used to assess climate impacts, measure project outcomes, and inform data-driven policy decisions, particularly in areas where traditional monitoring infrastructure is nonexistent [16], [17]. The application of these technologies may support the use of early warning systems, risk mapping to guide targeted adaptation investments and the identification of climate vulnerability indices to prioritise interventions. Additionally, digital platforms such as climate financing dashboards open to all and project transparency portals can be used by civil society organisations, academics, and local communities to engage with funding data and contribute to participatory governance and public accountability [15]. However, despite their enormous potential, there is still a significant need for extensive capacity development and infrastructure investment in the low- and middle-income world to implement digital tools; if these needs are not addressed, it could prevent equitable access to these innovations. Research on

the future of these technologies is required, particularly with respect to their continued mainstreaming in GCF implementation and their use to protect privacy, data sovereignty and the ethical concerns regarding the algorithmic decision-making processes of climate finance governance.

7.3. Integrating Local Stakeholder Perspectives

Local stakeholders' views are increasingly seen as essential for developing and implementing Green Climate Fund (GCF) projects to achieve high-impact, high-quality, and long-lasting climate finance results. Although the GCF has expressed rhetoric of inclusive governance, multiple studies show continued shortcomings in the participation and representation of local communities, in particular Indigenous peoples, women, and disadvantaged groups [13], [28]. These gaps have been attributed to top-down and project-based processes of project development that do not sufficiently incorporate local knowledge, cultural context, and adaptive paradigms, leading to a gap between objectives and implementation resources [37], [40]. Involving all stakeholders in REDD+ (reducing emissions from deforestation and forest degradation), as well as in ecosystem based adaptation initiatives, have demonstrated that a lack of participation will reduce community members' confidence in projects, increase resistance, and reduce long term viability of these projects [22], [41]. There is a growing body of evidence regarding the participatory and FPIC (free prior and informed consent) practices that are being used by some GCF funded projects, however the extent to which these practices are implemented vary greatly among regions [28]. While this appears to be a shift in efforts to revise existing laws to encourage earlier and more honest inclusion of stakeholders in the development and oversight of projects may be viewed as a matter of political justice or legitimacy, it has significant implications in regards to the flexibility and efficiency of climate actions. Additionally future research could examine collaborative strategies for designing under varying conditions; evaluating climate project using participatory methods; and using participatory methods to identify communities perspectives on increasing voice and promoting environmental and social transformation through climate financing.

8. Policy Recommendations

8.1. Enhancing Transparency and Efficiency

Improving the transparency and efficiency of the GCF is imperative for preserving the stakeholders' confidence and maximising the effectiveness of climate finance. Several studies suggest that GCF operations, especially in developing countries, are characterised by delays in funding release, ambiguous reporting channels, and limited public access to information [13], [16]. To overcome this, the GCF should institutionalise real-time tracking systems backed by digital footprints, including blockchain and open, accessible dashboards. They may provide an irreversible trail of fund transfers and project accomplishments that serve to minimise corruption risks and enhance accountability [38]. In addition, standardising the set of impact assessment indicators and reporting periodic (independently audited) performance and impact statements also improves the comparability between the different geographical regions and projects. It would not only make decision-making more accountable but would also focus resource distribution on actions that are more effective and better aligned with climate priorities.

8.2. Improving Capacity Building and Knowledge Sharing

Strengthening institutional and technical capacity in recipient countries is a precondition for enhancing GCF implementation results. However, even though GCF provides resources for scaling up gender-

responsive climate measures, several developing countries continue to have weak capacities to develop project pipelines, lack effective monitoring mechanisms, and have limited knowledge of GCF processes and eligibility criteria [29], [37]. Providing targeted training to NDAs and DAEs (Direct Access Entities), offering peer-learning programs for them, and establishing South-South collaboration initiatives can help address those gaps. In addition, establishing centralised, multi-lingual platforms for knowledge-sharing that collate examples of best practice, policy toolkits and successful case studies from GCF projects can facilitate adaptive learning across different socio-political contexts [18]. Capacity-building has mainly focused on bureaucratic institutions throughout the global South; there is also a need to expand climate finance deployment in less traditional actors, especially local civil society and Indigenous organisations, which can provide inclusive solutions and perspectives and ensure climate finance aligns with local contexts.

8.3. Strengthening Multilateral Governance of GCF

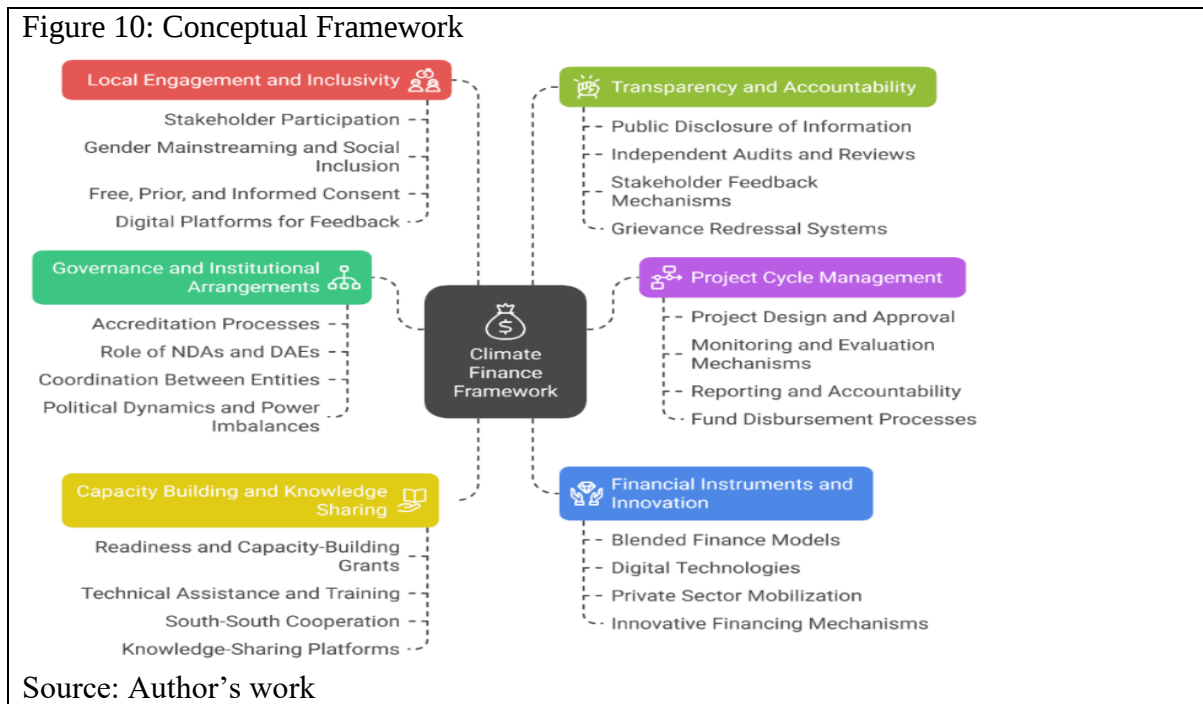
One leading notion is that effective multilateral good governance remains the foundation of GCF legitimacy, equity, and reactivity. This fund offered an innovative governance structure to balance donor and recipient interests. Yet, research framed by the same geopolitical, accountability, and stakeholder representational tensions which plagued global governance prior to the pandemic suggests this vision has not been realised in practice [9], [23]. Strengthened Governance of GCF: strengthening the GCF political neutrality, clarifying roles & responsibilities of key institutional actors, and ensuring greater representation from LDCs, SIDS and Indigenous peoples. More explicit rules about appointments, more demanding conflict-of-interest standards, and mechanisms for participatory decision-making can restore legitimacy. GCF governance should also be more consistent with the Paris Agreement and recommend further links to the Sustainable Development Goals to facilitate coherence and coordination among climate finance mechanisms. The study's conceptual framework is presented in Figure 10, and the further research directions are shown in Table 4.

Table 4: Further Research Directions	
Research Direction	Research Questions
Transparency and Accountability Mechanisms	To what extent is there transparency in GCF projects? Why don't more GCF projects disclose budget allocations for each component?
	How can independent third-party audits contribute to blood system accountability?
	How do recipient countries disseminate information and communicate the use of funds to stakeholders?
	What digital tools are available to monitor Spooner Fund disbursements and results in real time?
Regional Disparities in Access	What are the principal obstacles encountered by LDCs and SIDS in accessing GCF resources?
	What is the efficacy of existing regional allocation mechanisms in addressing climate vulnerability?
	How are the disparities perpetuated/ resolved by national designated authorities (NDAs)?

	What are the ways that regional cooperation platforms can help enhance equal access to GCF resources?
Institutional Bottlenecks	What are the biggest bureaucratic bottlenecks in GCF's process of approving and disbursing proposals?
	How do cross-agency coordination challenges influence the schedule of project implementation?
	What are the capacity gaps of the implementing agents?
	How can institutionally embedded learning loops be made compatible with GCF governance?
Innovations in Finance Delivery	How does blockchain help to make climate finance more traceable and less open to corruption?
	What are the benefits of applying AI to select and monitor GCF projects?
	To what extent can mobile-based platforms support micro-level climate finance allocation?
	What role can green bonds and blended finance play in complementing GCF support?
Stakeholder Integration	How can GCF-funded project planning incorporate Indigenous ways of knowing?
	Which participatory models can guarantee an inclusive stakeholder participation?
	What are the implications of power differentials between donors and local actors on participation?
	What is the impact of co-designing climate adaptation projects in practice?
Capacity Building and Knowledge Sharing	What gaps exist in technical knowledge among project implementers in developing countries?
	What is the impact of GCF's readiness activities on institutional capacity?
	What can South-South and triangular cooperation contribute to climate finance learning?
	What can digital platforms do to enable continued knowledge transfer?
Monitoring and Evaluation Reforms	To what extent can existing M&E frameworks track the long-term impact of GCF-funded projects?
	Which indicators can measure the result of mitigation and adaptation?
	What role can real-time data systems play in improving GCF monitoring workflows?
	What feedback loops exist to ensure lessons learned are integrated into the next cycle of funding?
Multilateral Governance	How will GCF relate to and work with other climate finance mechanisms, such as the Adaptation Fund or Global Environment Facility (GEF)?
	What governance challenges emerge from GCF's multi-stakeholder structure?
	How can fair one-on-one representation be ensured in GCF decision-making?
	What coordination models increase alignment between donor philosophical visions and recipient realities?
	In what ways does GCF funding affect national climate strategy development?

Impact of GCF on National Policy Coherence	What processes have been put in place to ensure that GCF-supported projects, in dollar value, are consistent with national development plans?
	How are domestic institutions integrating GCF mandates into their climate governance frameworks?
	Which national priorities are (not) compatible with international obligations?
Long-Term Sustainability of GCF Projects	What are the critical success factors for the sustainable after-care of GCF-funded projects?
	What does it take for countries to move from GCF dependence to being self-sustaining in terms of climate finance?
	What exit strategies should be integrated into project design?
	In what ways can locally projected ownership and financing mechanisms scale and sustain impact over time?
Source: Author's work	

Figure 10: Conceptual Framework



9. Conclusion

The bibliometric analysis was conducted to present an integrated evidence base on the research landscape of Green Climate Fund (GCF) implementation, governance, and its role in driving global climate finance. Through a review of 44 major articles published between 2015 and 2025, the study identifies key themes centred on transparency, accountability, regional variations, institutional obstacles, and stakeholder inclusivity. The results show growing academic interest in GCF research, particularly after 2020, and that this interest is universal across countries. There have been improvements, but concerns continue about the lack of equal access to funds, deficiencies in accountability and narrow inclusion. The analysis underscores the importance of additional studies on data-driven decision-making, gender-responsive financing, and equitable governance, providing valuable insights for those working to enhance climate finance deployed through the GCF.

The second part is a bibliometric and thematic analysis that complements the study on GCF implementation and addresses all five research questions. (1) The first 2 are a combination of the total number of publications from 2015 to 2025, and the second is a record-breaking five articles published in 2023. The literature on climate finance has grown rapidly, in line with the growing urgency of climate change worldwide. (2) The second aspect is the plurality of authorship: utilising the contributors from numerous institutions (e.g. New School for Social Research and University of New South Wales) and journals (e.g. Climate Policy), and the emergence of CGIAR international networks of collaborators. (3) GCF thematic cluster concentrates on the challenges that GCF offers, GCF policy instruments, market-based instruments, mitigation and sustainable development, land-use and the Global South, and national climate finance systems. (4) Project equity assessments in climate-vulnerable regions identify bureaucratic barriers and unequal natural access and recommend adjusting project implementation and local ownership. (5) Climate justice cannot be achieved without proper delivery of climate policies, which require simpler governance and more intensive monitoring mechanisms.

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