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Traditional, Indigenous and Local Knowledge Systems: A Bibliometric Analysis Interfacing Response to Climate Action (SDG13)

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Abstract: Indigenous peoples and local communities (IPLCs) have long relied on traditional, indigenous, and local knowledge (TILK) systems to respond to the significant challenges they face. Various international protocols have acknowledged the relevance of TILK in promoting climate action. Although the contributions of TILK to climate action have been documented over the past 10 to 15 years, this body of work has not yet been comprehensively mapped. Therefore, this study conducted a bibliometric analysis to map research on TILK and climate change (TILK-CC). The findings reveal substantial growth in publications on TILK-CC, particularly since 2007; however, leading authors, research institutions, and funding bodies are predominantly based in the Global North. While TILK-CC research is ostensibly intended to benefit the most vulnerable populations, including indigenous peoples, the underrepresentation of the voices of IPLCs and academia from the Global South points to epistemic extractivism. This study consequently identifies key research gaps, particularly in citizen science initiatives on TILK-CC and in the nexus between TILK and climate justice in urban, coastal, and marine contexts. It further underscores the need for capacity-building programmes for IPLCs to enable their active engagement in all phases of citizen science projects, thereby safeguarding against epistemic 'violence' and supporting TILK sovereignty.

Keywords: climate change; epistemic extractivism; indigenous knowledge; indigenous people; Sustainable Development Goal (SDG) 13

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Introduction

One of the most pressing challenges confronting the world in the 21st century is climate change, which poses serious threats to both the Earth and human societies and raises profound uncertainties about the future (Dorji et al., 2024; Kongnso, 2022). As firsthand observers of the adverse impacts of climate variability, many rural people and indigenous peoples, and local communities (IPLCs) possess a rich portfolio of traditional, indigenous, and local knowledge (TILK) that is critical for forecasting, managing, and adapting to climate change, building climate resilience in dynamic environments, and offering solutions to the significant challenges they face (Adero et al., 2024; Ebhuoma, 2022). TILK encompasses the total body of information on how living organisms interact with their environments that has been accumulated through adaptation processes and passed down across generations through cultural transmission (Chilunjika, 2024). It is sometimes referred to using singular terms such as "traditional knowledge", "traditional ecological knowledge", "native knowledge", "local knowledge", "indigenous technical knowledge", "folk knowledge", and "indigenous science" (Chilunjika, 2024; Rai & Mishra, 2023a).

The terms used to describe TILK systems, including labels such as "traditional", "folk", and "native", have been subject to criticism because they can be construed negatively to imply simple, regressive, savage, or static knowledge systems (Rai & Khawas, 2020; Souther et al., 2023). As a result, some scholars favour the terms "indigenous knowledge" and "local knowledge", emphasising the culturally embedded and context-specific nature of knowledge originating from indigenous or local populations. These formulations more clearly identify specific groups of people while avoiding overtly negative or demeaning connotations (Rai & Khawas, 2020), although they are not without limitations. Notably, these terms and their variants do not fully capture the diversity of knowledge systems present in contemporary, highly mobile and pluralistic societies (Souther et al., 2023). Given that no single term or definition can adequately represent the plurality of indigenous and local knowledge, there is a need for pluralistic and inclusive terminology (Souther et al., 2023). Reflecting this perspective, the Intergovernmental Panel on Climate Change (IPCC) (2014), in Section SPM 3.3, adopts the plural formulation "indigenous, local, and traditional knowledge systems", recognising them as vital resources for climate action. In this spirit, and in recognition of its inclusiveness, the term TILK is used for purposes of this study.

Social and scientific scholars in developed countries have increasingly recognised that TILK can make significant contributions to the implementation and realisation of the Sustainable Development Goals (SDGs) and related policies and initiatives (Rai & Mishra, 2023b). The relevance of this valuable knowledge reservoir is also acknowledged in the Paris Agreement, which states that climate change adaptation action should be guided by the best available science (Sharma et al. 2023). Similarly, the Sendai Framework for Disaster Risk Reduction underscores that disaster risk reduction plans and strategies are most effective when scientific knowledge is combined with TILK (Madzivhandila, 2024). Ebhuoma (2022) notes that the United Nations Educational, Scientific and Cultural Organization (UNESCO), alongside the IPCC, recognises the importance of IPLCs' participation and knowledge systems in achieving the ambitious objectives of the SDGs, particularly SDG 13. This acknowledgement reflects the understanding that, while multiple knowledge systems can support climate action and the resilience of communities, TILK plays a crucial role in enhancing the capacity of IPLCs to respond to climate change and variability (Ebhuoma, 2024). Nevertheless, some government-led adaptation interventions have proven maladaptive because of the exclusive reliance on scientific knowledge and measures at the expense of TILK (Sharma et al., 2023).

The relationship between scientific knowledge and TILK is frequently framed in dualistic terms, with scientific knowledge characterised as systematic, modern, and objective, and TILK portrayed as traditional, primitive, and based on non-intellectual systems (Rai & Mishra, 2023b). Such characterisations have been reinforced by some Western intellectuals who dismiss TILK as 'junk science' (Josef & Ben-Erik, 2021) that does not deserve preservation, intellectual property rights, or validation (Tsekea, 2016). This position has been described as hegemonic and as instrumental in perpetuating forms of 'coloniality.' (Shizha, 2016), given that scientific knowledge and TILK are grounded in distinct aims, philosophies, epistemologies, ontologies, and world views that shape how knowledge is defined and produced (Matindike & Ramdhany, 2025).

Western science is commonly characterised as analytical, reductionist, positivist, objective, and quantitative, and is primarily transmitted through formal academic and literate channels. In contrast, TILK is often described as subjective, qualitative, intuitive, holistic, spiritual, and transgenerational, and is deeply rooted in local environments (Mazzocchi, 2006). The challenges IPLCs face in protecting their knowledge systems under Eurocentric intellectual property (IP) frameworks stem from the fact that such knowledge often does not meet the requirements of these frameworks, which stipulate that a product must be new, original, innovative, or distinctive, and be individually owned (Shizha, 2016). Therefore, the perception that TILK cannot be accorded IP protection perpetuates the exploitation and misappropriation of indigenous knowledge and resources (Shizha, 2016). Although identifying a single creator of IP rights in the context of TILK is problematic given its collective nature (Kariuki, 2019), there is a need to recognise communal IP rights (Shizha, 2016). In addition, a dedicated legal instrument is required to address the unique aspects of TILK governance and to ensure effective protection against its unauthorised use within IP rights systems (Phillips, 2016). Scholars such as Dean and

Kame Parks (2024) argue that the primary function of IP rights extends beyond incentivising innovation and creativity to include the dissemination of knowledge – both new and existing – that is not widely known, particularly given that IP laws require rights holders to disclose knowledge or to relinquish exclusive rights after a defined period. Although TILK is often considered 'old', it is not widely known outside specific cultural contexts and holds value well beyond those contexts (Cross, 2010), thereby providing a strong rationale for its protection within IP rights systems. Critics of TILK nevertheless continue to characterise it as unsystematic and unintellectual, implying a lack of validation and rigour when compared with formal academic methodologies. Given that scientific knowledge and TILK are underpinned by distinct epistemologies, each with its own strengths, limitations, methods, and perspectives, it is essential to validate TILK not solely through scientific frameworks but also through approaches that acknowledge and respect its unique contributions (Ijatuyi et al., 2025). Josef and Ben-Erik (2021) argue that TILK should not be evaluated or validated against Western scientific standards, as this reinforces the perceived superiority of Western science. Both knowledge systems rely on distinct methods of observation, hypothesis testing, experimentation, and validation (Filho et al., 2022); hence, their shared commitment to addressing environmental and community challenges provides a robust foundation for collaboration (Ijatuyi et al., 2025). In this regard, Zent (2025) recommends integrating TILK into climate action, ensuring IPLCs' inclusion in climate action initiatives, and incorporating collaborative action or citizen science into TILK and climate change (TILK-CC) research.

Although the contributions of TILK to climate change have been extensively articulated and documented over the past 10 to 15 years (Sharma et al. 2023), this body of work has not yet been fully appraised (Chilunjika, 2024) and mapped at the global level. Existing bibliometric studies on TILK-CC have largely focused on specific countries or regions, such as Taiwan (Bayrak et al., 2021) and Africa (Filho et al., 2022). Other studies have concentrated on systematic reviews of TILK-CC research (Chanza et al., 2024; Petzold et al., 2020). Therefore, this study undertakes a bibliometric analysis to map publication trends, actors, themes, emerging issues, and research gaps in TILK-CC research.

Theoretical framework

This study is guided by the social-ecological systems framework (SESF), a theoretical approach for understanding the complex interplay between natural and human systems and integrating the natural and social sciences to address sustainable development challenges, including climate change (Virapongse et al., 2016; Wang et al., 2025). In this context, the SESF is used to examine how ecological components and social systems, including cultural practices and knowledge, influence humanity's capacity to adapt to, mitigate, and build resilience against contemporary environmental challenges (Rana & Singh, 2025). Hossain et al. (2024) emphasise that the SESF is crucial for designing and implementing climate actions that align with the unique realities of diverse communities and ecosystems. Consequently, the SESF facilitates a holistic understanding of how the TILK of diverse communities can inform climate governance and action.

Methodology

For this study, a bibliometric analysis of TILK-CC research at the global level was conducted using VOSviewer. Bibliometric analysis is considered a valuable approach for providing insights into how scientific knowledge and scholarship have evolved over time (Sahid et al., 2025). Given the strong conclusion of the Intergovernmental Panel on Climate Change (2014) report that global warming and related extreme events are expected to increase significantly in the near to long term, examining bibliometric trends is essential for understanding TILK research and advancing climate action.

Keywords and database

Lindez-Macarro et al. (2025) note that a bibliometric analysis should include journals from the Web of Science (WoS) or Scopus, among the many existing databases, to avoid inaccurate results. Accordingly, a bibliometric analysis was performed using peer-reviewed articles from the Scopus database. Scopus is widely recognised in the scientific community as multidisciplinary and is currently considered the most extensive repository of scientific literature, containing over 27 million abstracts (Sahid et al., 2025). In addition, Scopus provides user-friendly preliminary data analysis tools that allow data to be presented in various formats (Afinowi & Nhamo, 2025). Supporting this observation, Dorji et al. (2024) state that Scopus is recognised as one of the most widely used, popular, and reliable bibliographic databases and is noted for being the largest single abstract and indexing database ever created. Sánchez et al. (2017) point out that WoS accounts for 54% of the journal titles found in Scopus, whereas 84% of the titles listed in WoS are included in Scopus. Scopus includes a larger number of journals and articles compared to WoS, features a variety of document types (such as conference proceedings and books), and offers superior coverage of publications from developing countries (Sahid et al., 2025). Since TILK primarily serves as social capital for the poor and IPLCs, especially in developing countries, Scopus was selected for this bibliometric study. The keywords used to search for abstracts are presented in the search string in the following section.

Inclusion and exclusion criteria

Generic and refined searches of published literature in the Scopus database were conducted on 15 January 2026. These searches yielded 4,574 and 4,371 articles, respectively (Figure 1).

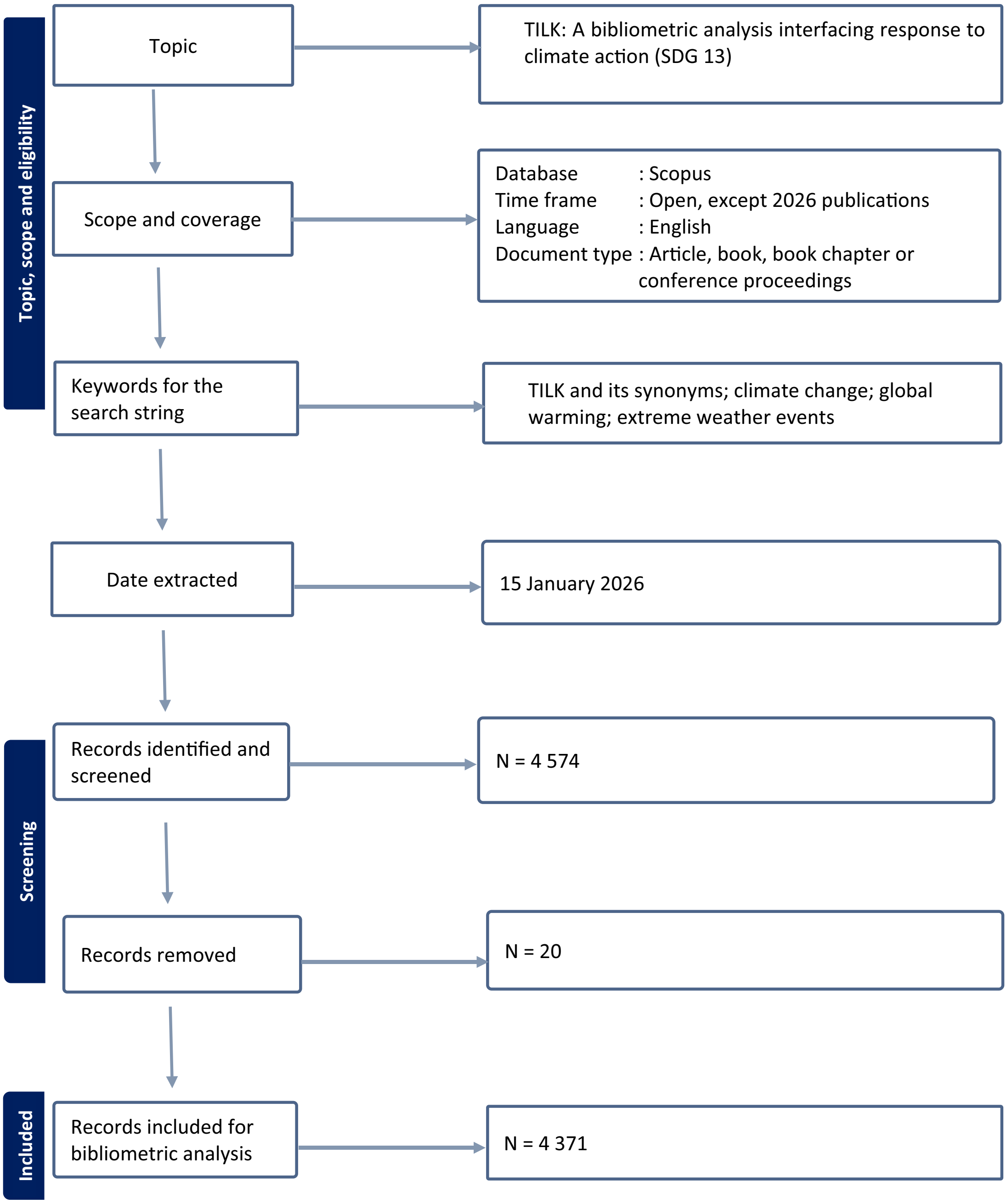

Figure 1. Bibliometric flow diagram

The search queries entered into the Scopus database are presented below. Search strings provide more details about the inclusion and exclusion criteria, complementing the information in Table 1.

Table 1. Inclusion and exclusion criteria

Inclusion criteria	**Exclusion criteria**
Articles available from the Scopus database	Articles outside the Scopus database
Publications up to 2025	Articles for 2026
Articles written in English	Articles written in other languages
Articles that focus on the intersection of TILK with climate change, climate adaptation, mitigation, resilience strategies, climate justice, and climate governance	Articles that focus solely on climate change without incorporating TILK or IPLCs' perspectives

(i) Scopus generic search

TITLE-ABS-KEY ("indigenous knowledge" OR {IKS} OR "local knowledge" OR "traditional knowledge" OR "ecological knowledge" OR "traditional ecological knowledge" OR "indigenous climate knowledge" OR "community-based knowledge" OR "folk knowledge" OR "native knowledge" OR "indigenous technical knowledge" OR "indigenous science" AND "climate change" OR "global warming" OR "extreme weather event*" OR "climate variability" OR "climate resilience" OR "climate adaptation" OR "climate mitigation" OR "climate justice").

(ii) Scopus refined search

TITLE-ABS-KEY ("indigenous knowledge" OR {IKS} OR "local knowledge" OR "traditional knowledge" OR "ecological knowledge" OR "traditional ecological knowledge" OR "indigenous climate knowledge" OR "community-based knowledge" OR "folk knowledge" OR "native knowledge" OR "indigenous technical knowledge" OR "indigenous science" AND "climate change" OR "global warming" OR "extreme weather event*" OR "climate variability" OR "climate resilience" OR "climate adaptation" OR "climate mitigation" OR "climate justice") AND PUBYEAR > 1,994 AND PUBYEAR < 2,026 AND (LIMIT-TO (DOCTYPE , "ar") OR LIMIT-TO (DOCTYPE , "ch") OR LIMIT-TO (DOCTYPE , "re") OR LIMIT-TO (DOCTYPE , "cp") OR LIMIT-TO (DOCTYPE , "bk")) AND (LIMIT-TO (LANGUAGE , "English")).

A total of 4,371 bibliographic records were used for performance data analysis and scientific mapping in VOSviewer.

Data analysis

A preliminary data analysis was performed in Scopus, which provides user-friendly tools for this purpose (Afinowi & Nhamo, 2025). CSV files were subsequently exported from Scopus and converted into an Excel spreadsheet to facilitate a performance analysis of publication trends and the distribution of publications by country, institution, author, and funding organisation. A scientific mapping of bibliometric information on TILK-CC research was conducted using VOSviewer software. Scientific mapping focuses on the structural relationships and intellectual exchanges between research elements, including co-citation, co-word analysis, and citation (Lindez-Macarro et al., 2025). VOSviewer was selected due to its widespread acceptance and credibility within the scientific community, its robust handling of large datasets, and its capacity to visualise complex bibliometric relationships effectively (Gencer & Gencer, 2025; Lindez-Macarro et al., 2025). In addition, VOSviewer is open-source software, further enhancing its accessibility for bibliometric research.

Results and discussion

Temporal trends in publications on TILK-CC research

Figure 2 shows that research on TILK-CC began with three publications in 1995. Although the start was slow, it reflected the response to the 1992 Earth Summit, which recognised the rights of IPLCs as crucial for the future of the environment (Malapane et al., 2022). Notably, 1995 coincided with the first Conference of the Parties (CoP) to the United Nations Framework Convention on Climate Change (UNFCCC) and the release of the second IPCC report, which explicitly acknowledged a definite human influence on the climate. This report initiated present-day efforts to mobilise international collaboration to promote climate policies, highlighting the severity

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of climate change. As a result, some institutions, such as the Potsdam Institute for Climate Impact Research (PIK), sponsored scholars to attend CoPs and to engage in discussions at various UNFCCC meetings.

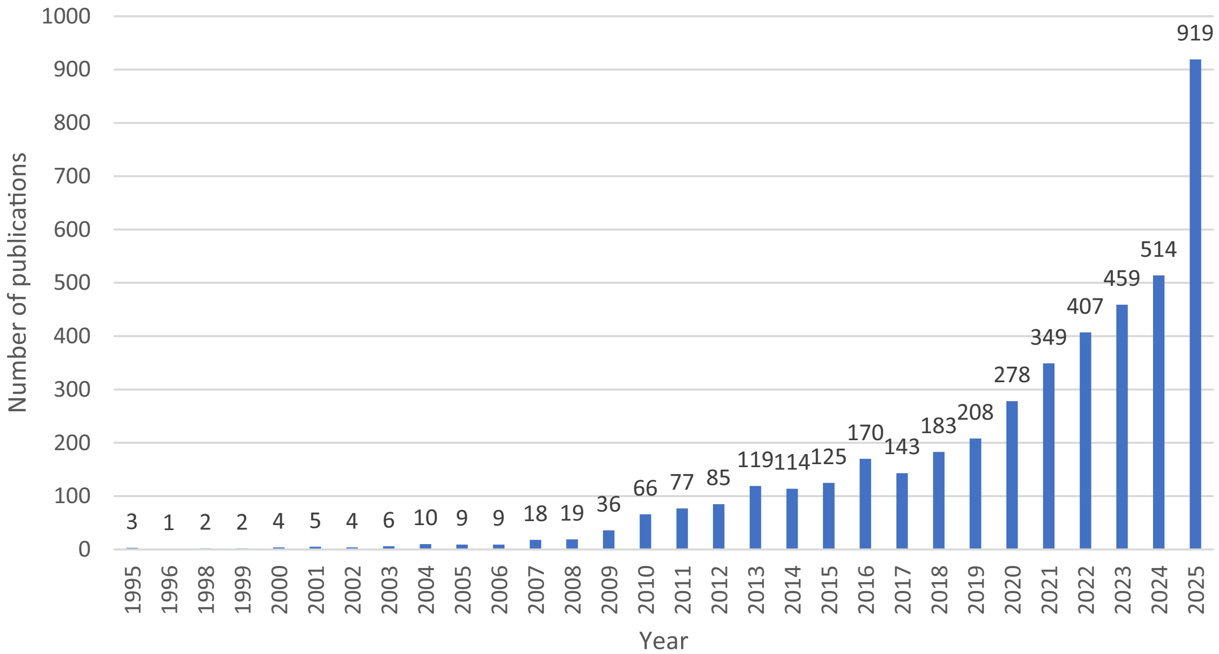

Figure 2. Temporal trends in publications on TILK-CC research

Figure 2 illustrates a steady increase in publications until 2003. Although slight temporal variations exist, these results are broadly consistent with Gondo's (2025) findings showing a gradual increase in publications on TILK-CC research from 1993 to 2003. From 2007 to 2025, there was a sharp rise in publications on TILK-CC research. However, these results differ from Gondo 2025 observation that publications peaked in 2013, plateaued from 2013 to 2019,, and then slightly declined from 2019 onward, suggesting a shift in research focus or a decline in interest in the subject.

The sharp increase after 2007 coincides with the release of the IPCC Fourth Assessment Report (AR4), which provided a comprehensive evaluation of climate change, its causes, and its impacts. Consequently, finding methods, instruments, and systems that improve insight into both immediate and potential climate concerns, such as global warming, became a top priority for analysts, policymakers, and scientists worldwide Ajibade et al., 2023). Gondo (2025) and Madzivhandila (2024) report that growing awareness of the impacts of climate change on vulnerable groups, including IPLCs, has prompted practitioners and researchers to recognise TILK as a key solution to the urgent challenge of climate change, thereby driving increased research and attention to their needs. Governments' reliance on the most recent global data on climate change (Madzivhandila, 2024) has also contributed to the surge in research publications since 2007. Einecker and Kirby (2020) note that scholarly output on climate action rose sharply from 2007 to 2019 due to factors such as the growth of the Chinese academic sector, the launch of new journals, and the rise of digital publication, which increased annual research output. Moreover, international organisations and funding agencies have prioritised studies and initiatives that incorporate TILK-based adaptation strategies for climate change, further contributing to the growth of publications in this field (Gondo, 2025).

Distribution of publications by document type

Journal articles were the most common medium for disseminating TILK-CC information, followed by book chapters, review papers, and conference proceedings. The number of peer-reviewed journal articles was nearly four times greater than that of book chapters, while systematic review papers were almost double the number of conference papers over the same period. (Refer to Figure 3.) Scholars and decision-makers recognize the crucial role of TILK in climate action; hence, they disseminate this information through various publication channels and platforms. However, Nyadzi et al. (2021) highlight that IPLCs face multiple barriers, such as illiteracy and poverty, which may limit their participation in the knowledge economy and restrict their access to published data.

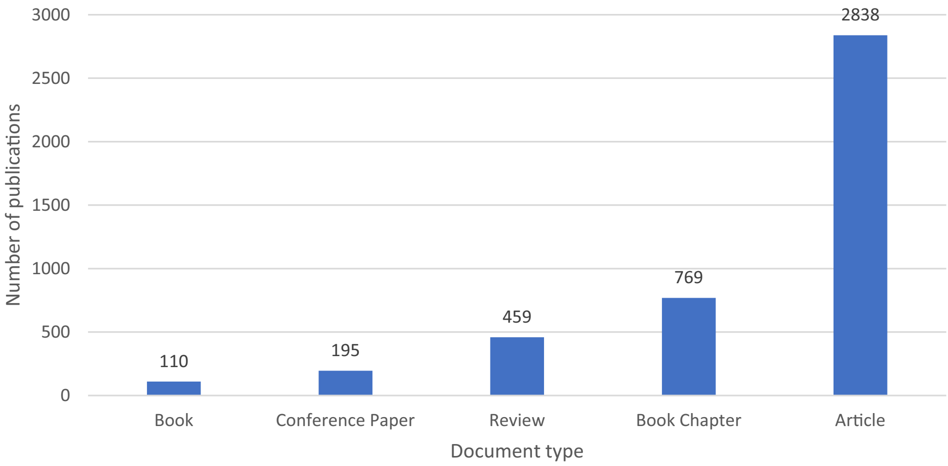

Figure 3. Distribution of publications by document type

Distribution of publications by discipline

Table 2 shows the contribution of various disciplines to TILK-CC research. Environmental science emerged as the leading contributor, followed by social sciences and agricultural and biological sciences. Other disciplines each contributed less than 4% of publications over the period 1995 to 2024. Petzold et al. (2020) similarly found that environmental science journals accounted for 35% of TILK-CC adaptation publications, followed by social sciences (26%), earth and planetary sciences (13%), and, lastly, agricultural and biological sciences (10%). These results corroborate the findings of Ajibade et al. (2023), which indicate that environmental science and earth and planetary sciences are among the most prominent disciplines contributing to publications on climate change. Furthermore, the complex nature of climate change has prompted multidisciplinary studies on TILK-CC (Ajibade et al., 2023). Consequently, government planners and scientific experts rely extensively on this body of knowledge and its applications when addressing pressing climate change issues (Madzivhandila, 2024).

Table 2. Distribution of publications by discipline

Discipline	Articles	% (N/5806)
Environmental science	2 546	29,1
Social sciences	1 900	21,7
Agricultural and biological sciences	1 170	13,4
Earth and planetary sciences	833	9,5
Engineering	387	4,4
Arts and humanities	296	3,4
Energy	291	3,3
Medicine	233	2,7
Economics, econometrics and finance	211	2,4
Accounting, business and management	191	2,1
Computer science	147	1,7
Multidisciplinary	140	1,6
Biochemistry, genetics and molecular biology	126	1,4
Psychology	45	0,5
Decision sciences	37	0,4
Health professions	34	0,4
Mathematics	25	0,3
Chemistry	24	0,3
Immunology and microbiology	22	0,3
Pharmacology, toxicology and pharmaceutics	19	0,2
Veterinary science	18	0,2
Chemical engineering	18	0,2
Materials science	15	0,2
Physics and astronomy	14	0,2

(*Continued*)

Table 2. (Continued)

Discipline	**Articles**	**% (N/5806)**
Nursing	12	0,1
Neuroscience	6	0,06
Dentistry	1	0,001

The most prominent authors in the field

Figure 4 presents the top 17 authors with eight publications or more on TILK-CC between 1995 and 2024. Reyes-Garcia leads with 27 articles, followed by Ford (23 articles), Peace (19 articles), McNamara (13 articles), Parsons (12 articles), Derbile (11 articles) and Mustonem (11 articles). The remaining authors have eight to ten articles each, which also represents a significant contribution. Since climate change is one of the greatest threats to human societies and economic systems, many analysts, policymakers and scientists have prioritised the development and dissemination of knowledge on strategies for dealing with climate change, resulting in a high volume of publications for certain authors over the years (Ajibade et al., 2023).

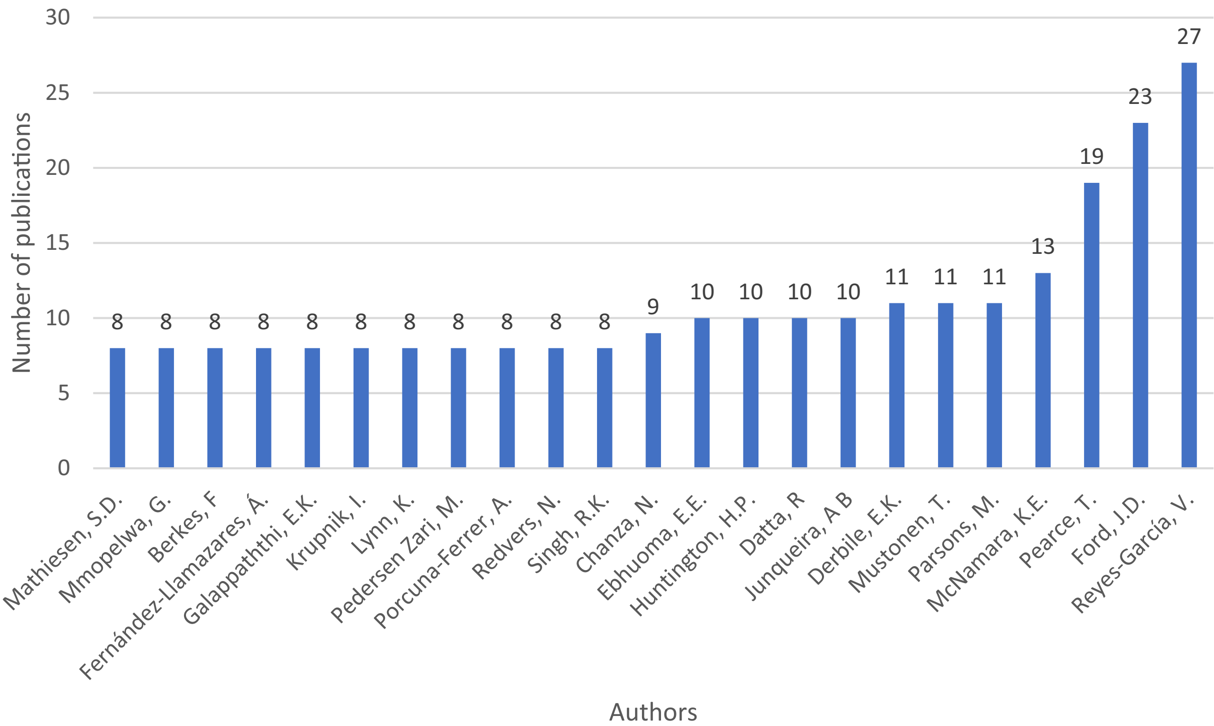

Figure 4. The most prominent authors

However, the most prolific researchers on TILK-CC are predominantly from the Global North, which raises concerns since TILK constitutes the social capital of the rural poor and IPLCs, who are primarily located in the Global South. This reflects a form of epistemic extractivism that reinforces power imbalances and perpetuates inequalities in the global knowledge economy, often driven by external entities such as academia in the Global North (Gills et al., 2023). Dean and Kame Parks (2024) argue that global climate change negotiations, such as the CoPs and their subsidiary bodies, are often inaccessible to IPLCs. Even in smaller multi-stakeholder forums, IPLCs often face challenges related to voice, representation, and influence. According to Nyadzi et al. (2021), IPLCs in the Global South encounter barriers, such as illiteracy and poverty, which hinder their participation in the knowledge economy and in decision-making processes that affect them. The under-representation of indigenous people and scholars is also linked to a disconnect between the scientific education provided in schools and the knowledge systems present in indigenous communities (Matindike & Ramdhany, 2025).

Influential research and funding institutions that support TILK-CC research

For authors, scientists, and researchers to produce impactful research, support and resources from academic and funding institutions are essential (Ajibade et al., 2023). Most of the leading academic institutions engaged in

TILK-CC research (nine of the top 23) are based in highly industrialised countries, including the United States of America (USA), Australia, China, South Africa, and Canada, at both global and continental levels (Table 3). These countries are among the major contributors to greenhouse gas emissions that drive global warming and climate change. Consequently, research conducted in these countries (many of which are signatories to the 2015 Paris Agreement) reflects a strong awareness of the effects of climate change (Ajibade et al., 2023) and the role that TILK can play in enhancing the resilience of the rural poor and IPLCs.

Table 3. The most influential educational institutions

Institution	Country	Number	% (N/941)
The University of British Columbia	Canada	57	**6,1**
University of Alaska Fairbanks	USA	54	5,7
The University of Queensland	Australia	50	5,3
Commonwealth Scientific and Industrial Research Organisation	Australia	51	5,4
Universitat Autònoma de Barcelona	Spain	49	5,2
Chinese Academy of Sciences	China	48	5,1
Centre National de la Recherche Scientifique (CNRS)	France	46	4,9
Institut de Ciència i Tecnologia Ambientals (ICTA-UAB)	Spain	43	4,6
University of KwaZulu-Natal	South Africa	42	4,5
Université McGill	Canada	42	4,5
University of South Africa	South Africa	42	4,5
University of Melbourne	Australia	41	4,4
University of Cape Town	South Africa	38	4,0
The Australian National University	Australia	37	3,9
Université de Montpellier	France	35	3,7
University of Guelph	Canada	34	3,6
Wageningen University & Research	Netherlands	34	3,6
University of Manitoba	Canada	34	3,6
Centre de Cooperation International en Recherché Agronomique pour le Development (CIRAD)	France	33	3,5
The University of Auckland	New Zealand	33	3,5
University of Oxford	UK	33	3,5
University of Leeds	UK	33	3,5
University of Victoria	Canada	32	3,4

Among the top institutions, eight are in the Global North, with China as the only exception. Canada has the highest number of institutions (5) that publish on TILK-CC, followed by France (4). South Africa is notable as the only African country represented, hosting three universities among the top 23 institutions, while China is the sole Asian country with an institution that has produced scholars in the field of TILK-CC. Institutions with high research outputs play a critical role in shaping scholarly discourse, informing policy decisions, and promoting the application of TILK in real-world climate change adaptation plans and strategies (Gondo, 2025).

Figure 5 indicates that 26 of the top 29 funding institutions supporting TILK-CC research are based in the Global North, with the remaining three in China, Brazil, and South Africa. The National Science Foundation accounts for the highest number of funded publications (153), followed by the European Union with 78. And Canada's Social Sciences and Humanities Research Council. The European Union, represented by five institutions, has the largest number of entities funding research on this subject, followed closely by Canada, with four institutions. South Africa's National Research Foundation, China's National Natural Science Foundation, and Brazil's Fundação de Amparo à Pesquisa are the only funding organisations from Africa, Asia, and South America, respectively, that support research on TILK-CC.

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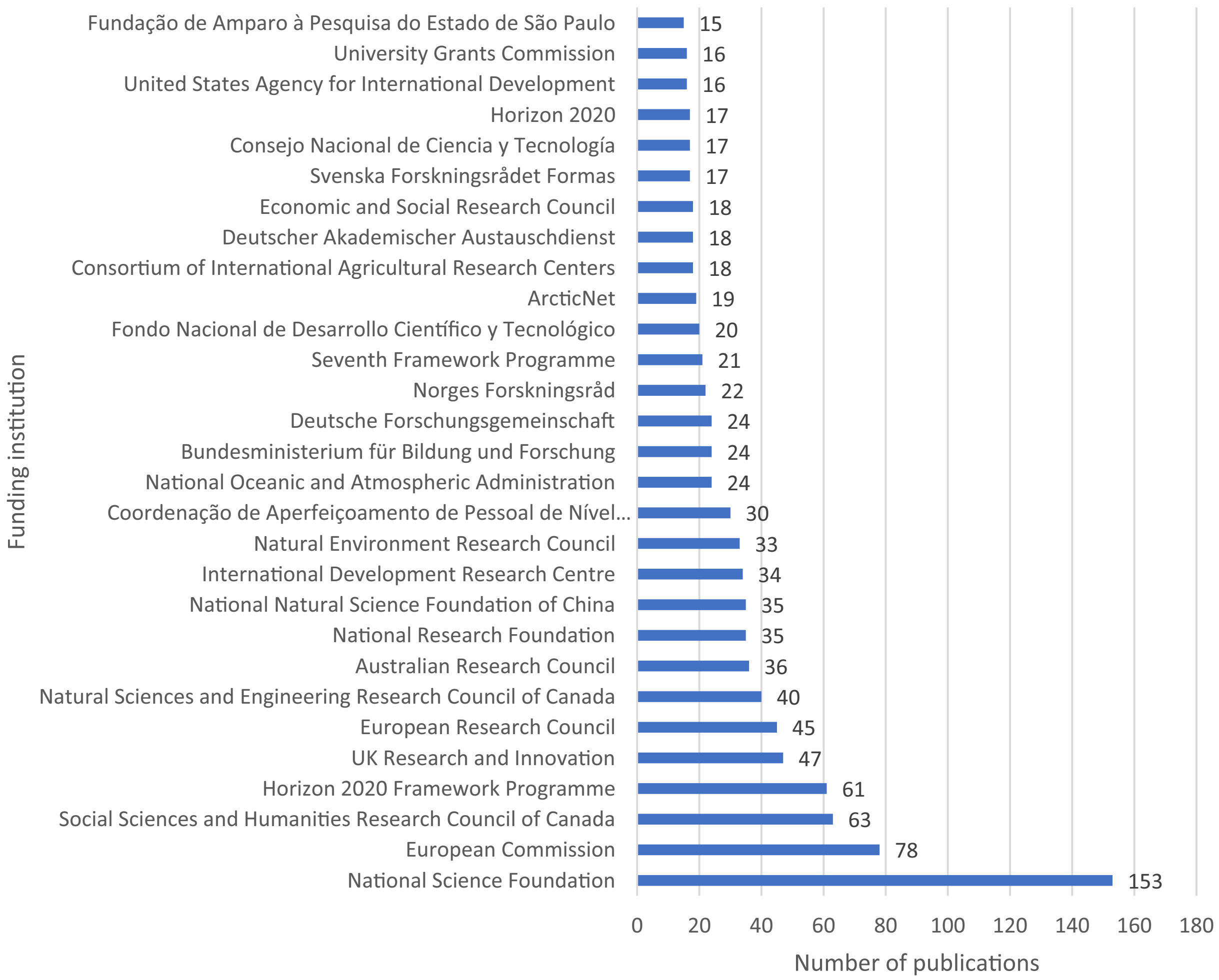

Figure 5. Institutions that fund TILK-CC research.

The dominance of academic, research, and funding institutions from the Global North in TILK-CC research raises important epistemological and ethical concerns in the global knowledge economy. It shows that the global knowledge economy often privileges Western methodologies, potentially marginalising the perspectives of indigenous scholars and IPLCs in TILK research, despite their roles as knowledge holders and custodians. This imbalance is particularly concerning given that many IPLCs who are disproportionately affected by climate change and who rely on TILK for climate resilience are in the Global South. Although TILK-CC research is ostensibly designed to benefit the most vulnerable, IPLCs remain largely underrepresented in research processes and outputs (Nyadzi et al., 2021). Matindike and Ramdhany (2025) argue that the limited representation of IPLCs in scientific professions is rooted in longstanding tensions between TILK and Western scientific knowledge. This over-representation of actors from a single region in TILK-CC research could lead to the misrepresentation of IPLCs' lived experiences and knowledge systems, as those most affected are often sidelined and excluded from discussions that affect their lives. Research on TILK-CC should therefore prioritise citizen science approaches and collaborative frameworks that respect indigenous perspectives and actively involve IPLCs as citizen scientists, ensuring their participation in the co-design, co-implementation, and co-dissemination of knowledge.

The findings also point to ongoing concerns regarding the unauthorised appropriation, exploitation, commodification, and transfer of IPLCs' knowledge systems to foreign contexts by Western actors (Tsekea, 2016). These practices are reinforced by Anglo-American intellectual property regimes that privilege individual ownership, thereby complicating the identification of rights holders in the case of intangible, collective IPLC assets such as TILK (Kariuki, 2019). Mzimela and Moyo (2024) call for the decolonisation of the mental universe to enable historically enslaved, colonised and exploited IPLCs, particularly in the Global South, to reclaim their identity, voice, knowledge and power in the global academic discourse.

Citation counts by country

Citation counts by country, based on a minimum threshold of 87 documents, indicate that among the top 20 countries, the USA accounts for the highest number of cited documents, followed by Australia, Canada, and the United Kingdom (Table 4). South Africa is the only African country represented among the top six, with a notable volume of citations in TILK and climate change research. However, it is important to recognise that the relationship between citation counts and research quality is complex. Australia has the highest average citations per country, despite having only about half the number of publications as the USA. The findings further demonstrate that citation counts are not solely determined by research output or quality since citation frequency is influenced by multiple factors. Older publications tend to attract more citations because of their longer presence in academic discourse, which provides more opportunities for referencing. In addition, freely accessible studies or those published in widely read open-access journals often accumulate citations more rapidly, whereas paywalled publications may receive fewer citations regardless of their quality. Established scholars are also cited more frequently due to their visibility and influence in their fields. Nonetheless, the high citation levels and the wide geographical distribution of publications on the application of TILK to climate action highlight its global significance for climate resilience (Gondo, 2025).

Table 4. Citation counts by country

Country	Documents	Documents (%)	Citations	Average cited documents per country
Australia	439	8,08	15 867	36,14
Bangladesh	87	1,60	2 463	28,31
Brazil	112	2,06	3 686	32,91
Canada	510	9,38	15 442	30,28
China	162	2,98	3 104	19,16
France	145	2,67	4 282	29,53
Germany	238	4,38	5 575	23,42
Ghana	99	1,82	2 589	26,15
India	477	8,77	5 207	10,92
Indonesia	146	2,69	1 480	10,14
Italy	174	3,21	3 974	22,84
Kenya	100	1,84	3 495	34,95
Netherlands	115	2,11	4 068	35,37
New Zealand	117	2,16	3 156	26,97
Norway	112	2,06	3 189	28,47
South Africa	298	5,49	6 049	20,30
Spain	142	2,61	3 696	26,03
Sweden	119	2,19	3 040	25,55
United Kingdom	479	8,81	14 325	29,91
United States	985	18,15	27 795	28,22

Citation and co-citation count per author

Table 5 shows that among the top 30 authors, Ford contributed the highest proportion of publications (8,8%), followed by Reyes-García (7,1%), Pearce (6,3%), and Parsons and Mustonen (4,6%). Since citation levels often depend on the relevance of research to the field, the findings indicate that citation weight is not always directly proportional to research output. Among the leading contributors, Pearce is the only author to rank among the top five in average citations per author. Overall, Berkes, Pearce, Fernández-Llamazares, Ford, and Parsons had the highest average citations per author, in that order. High citation counts are commonly associated with extensive partnerships or co-authorships between scholars, which are influenced by institutional affiliations, connections in global networks, the impact and visibility of the research, authors' reputations, journal prestige, and the countries in which the studies were conducted (Ajibade et al., 2023).

Table 5. Citation counts by author

Author	Documents	% documents	Citations	Average citations per author
Pedersen, Z. M.	10	4,80	200	20
Pieroni, A.	5	2,40	116	23,5
Porcuna-ferrer, A.	9	4,31	193	21,4
Prober, S. M.	6	2,88	367	61,2
Rasmus, S.	5	2,40	210	42
Redvers, N.	8	3,84	130	16,3
Reyes-garcía, V. E.	30	14,42	1 068	35,6
Roncoli, C.	6	2,88	721	120,2
Rubis, J. T.	5	2,40	543	108,6
Schlingmann, A.	8	3,84	176	22
Simpson, N. P.	5	2,40	365	73
Singh, R. K.	8	3,84	77	9,6
Smit, B. E.	6	2,88	550	91,7
Spring, A.	5	2,40	30	6
Stafford-Smith, M.	5	2,40	490	98
Ticktin, T.	6	2,88	322	53,7
Tirivangasi, H. M.	7	3,37	112	16
Titumir, R. A.	5	2,40	7	1,4
Toting, E.	5	2,40	213	42,6
Tugjamba, N.	5	2,40	75	15
Turner, N. J.	7	3,37	539	77
Turunen, M. T.	6	2,88	278	46,3
Vaast, P.	5	2,40	143	28,6
Vinyeta, K.	5	2,40	47	9,4
Wesche, S. D.	5	2,40	151	30,2
Westoby, R.	8	3,84	216	27
Whyte, K. P.	6	2,88	1 416	236
Xu, J.	5	2,40	129	25,8
Yegbemey, R. N.	5	2,40	2	0,4
Álvarez-fernández, S.	7	3,37	99	14,1

Table 6 presents co-citation patterns among authors with at least 20 citations, providing insights into the field's intellectual structure and collaborative networks. The identification of frequently co-cited authors reveals groups of researchers who are often cited together, indicating shared thematic interests within the field. These patterns also highlight influential research clusters and potential areas for future inquiry. Daniel's single cluster and relatively low total link strength (19) may reflect a more peripheral or distinct area of focus. Approximately 9 authors operate within one cluster, while 4 span two clusters, suggesting they are part of smaller but potentially more specialised research communities. Barlet and Cheryl emerge as central figures, each associated with the highest number of clusters (9), followed by Ayers and Jessica (8), indicating that they research a broader range of topics. Furthermore, Dereck's and Armitage's strong link strengths (189 and 190, respectively) suggest a high level of collaboration or thematic overlap with other authors.

Table 6. Co-citation patterns among authors

Author	Clusters	Links	Link strength
James, D.	7	6	100
Ford	7	5	99
Bardsley	4	11	184
Douglas	4	11	184
Ayers	8	9	71
Jessica	8	9	68
Barlet	9	14	63
Cheryl	9	13	53
Daniel	1	12	19

(*Continued*)

Table 6. (Continued)

Author	Clusters	Links	Link strength
Ban	2	12	104
Natilie	2	12	104
Shankar	2	13	50
Aswani	2	12	49
Bulkeley	5	8	68
Harriet	5	8	68
Anja	3	13	70
Glen	1	11	28
Bohensky	1	13	55
Adams	1	17	62
Alexander	1	18	35
Anderson	1	17	41
Bennette	1	21	96
Nathan	1	16	82
Allen	1	15	37
Dereck	6	27	189
Armitage	6	27	190

As a result of the effects of climate change and global warming worldwide, research on this topic has increasingly involved extensive collaborations, resulting in numerous publications and co-citations (Ajibade et al., 2023). In addition, IPLCs, researchers, and policymakers are increasingly working together as the rights of indigenous communities and the value of their knowledge systems gain recognition in global discourse and climate change conventions (Gondo, 2025). Partnerships between organisations with diverse expertise, regional representation, and strong overall connections are essential to promote an all-encompassing, inclusive strategy to tackle climate change (Gondo, 2025).

Keyword co-occurrence

Analysing the co-occurrence of keywords in a specific field of study (knowledge mapping) offers important insights into how hotspots, clusters, or themes emerge in a discipline (Ajibade et al., 2023). The keywords were grouped into five clusters. In four of the five clusters (Figure 6), terms such as "local knowledge", "indigenous people", "traditional ecological knowledge", and "indigenous knowledge systems" appeared. The presence of these terms across four clusters indicates growing recognition of IPLCs and TILK in climate action (Gondo, 2025).

Red cluster: Climate change, TILK, and agriculture. The dominant and highly interconnected keywords in the red cluster are "TILK", "agricultural production", "agriculture", "farmer knowledge", and "smallholder farmers" (Figure 6). Agricultural sciences and contributing authors appear to play the most significant role in shaping the keywords in this cluster. TILK represents a key social asset for smallholder farmers in enhancing climate resilience, particularly given their limited physical and financial resources. Mbah et al. (2021) found that inadequate funding for rural smallholder farmers leads to a lack of structural and institutional adaptation strategies in response to climate change; consequently, these farmers rely heavily on social adaptation strategies.

Green cluster: Climate change, TILK, risk management, and governance. Environmental and social sciences emerge as the top contributors to publications in the green cluster, as reflected in keywords related to disaster risk assessment, participatory governance, and capacity-building advocacy. Ebhuoma (2024) identifies a related "governance" cluster, highlighting the critical role of IPLCs' governance structures in guiding the management, utilisation, and harvesting of resources.

Yellow cluster: Climate change, TILK, and disadvantaged groups. The yellow cluster focuses on the utilisation of TILK by disadvantaged groups, particularly indigenous peoples and women. Social sciences appear to make the largest contribution to publications in the yellow cluster, as reflected by the frequent occurrence of terms such as "colonialism", "environmental justice", "gender", "wellbeing", and "indigenous people".

Blue cluster: Natural resource conservation and management. Publications in the blue cluster are predominantly contributed by environmental and biological sciences, as indicated by the high occurrence of terms such as

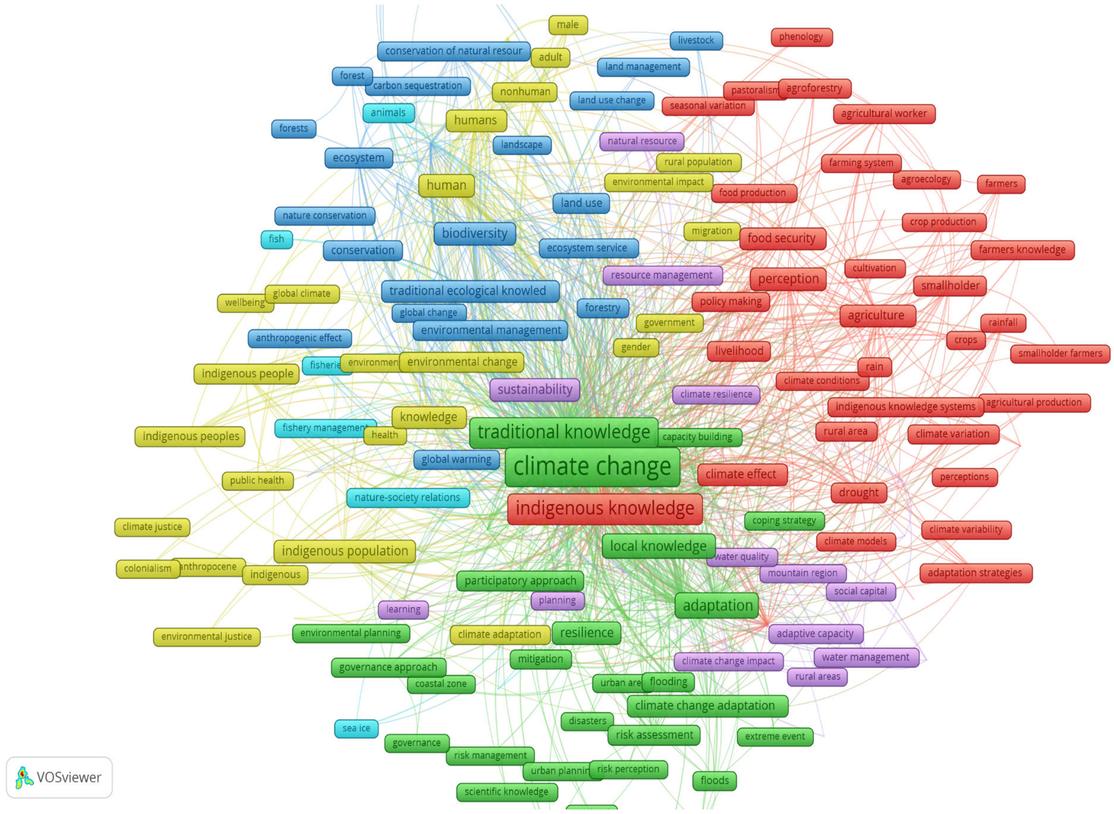

Figure 6. Keyword co-occurrence

“conservation”, “environmental management”, “fisheries management”, “biodiversity”, and “forestry”. Because IPLCs’ methods for managing and conserving natural resources are often deeply embedded in their cultural identities and spirituality, TILK – particularly traditional ecological knowledge – is crucial for natural resource conservation and sustainable land-use practices (Ebhuoma (2022).

Purple cluster: Sustainability and adaptive capacity. Keywords in this group include “adaptive capacity”, “sustainability”, and “learning and social capital”. According to (Gondo, 2025),TILK provides invaluable insights into local environmental dynamics and adaptive coping strategies.

Figure 6 further shows that the application of TILK is important in the disaster risk reduction and management sector, as reflected by keywords such as “risk assessment and management”, “disasters”, “extreme events”, “floods”, and “drought”. While broader natural disasters are represented under umbrella terms such as “risks”, “disasters”, and “extreme events”, the study explicitly highlights the use of TILK in managing specific events, particularly floods and droughts. Mbah et al. (2021) and Petzold’s et al. (2020) similarly found that, among the analysed publications, drought was the most frequently indicated reason for IK-based climate change adaptation.

The keywords identified in this study reflect global trends in TILK-CC research over the past three decades. From 1995 to 2017, the term “traditional knowledge” was most commonly used (Figure 7). Since 2018, there has been a noticeable shift towards terms such as “indigenous knowledge” (IK) and “indigenous and local knowledge” (ILK). For instance, Petzold et al. (2020) and Mbah et al. (2021) found that “IK” was the term used most often, appearing in 151 of 236 publications and 22 of 39 reviewed papers. The shift from “traditional knowledge” to “IK” may have been necessitated by the negative connotations of the word “traditional”. Souther et al. (2023) argue that no single term or definition can capture the plurality of these knowledge systems, advocating for pluralistic and inclusive terminology. Pluralistic terms, such as “ILK”, have been used by Filho et al. (2022), Chanza et al. (2024) and Zent (2025), and in the IPCC Fifth Assessment Report (IPPC, 2014); in this study, the term “TILK” is used. More recent TILK-CC research (2020 to the present) has focused on gender issues, indigenous peoples, food security, smallholder farmers, climate and environmental justice, resilience, and human well-being.

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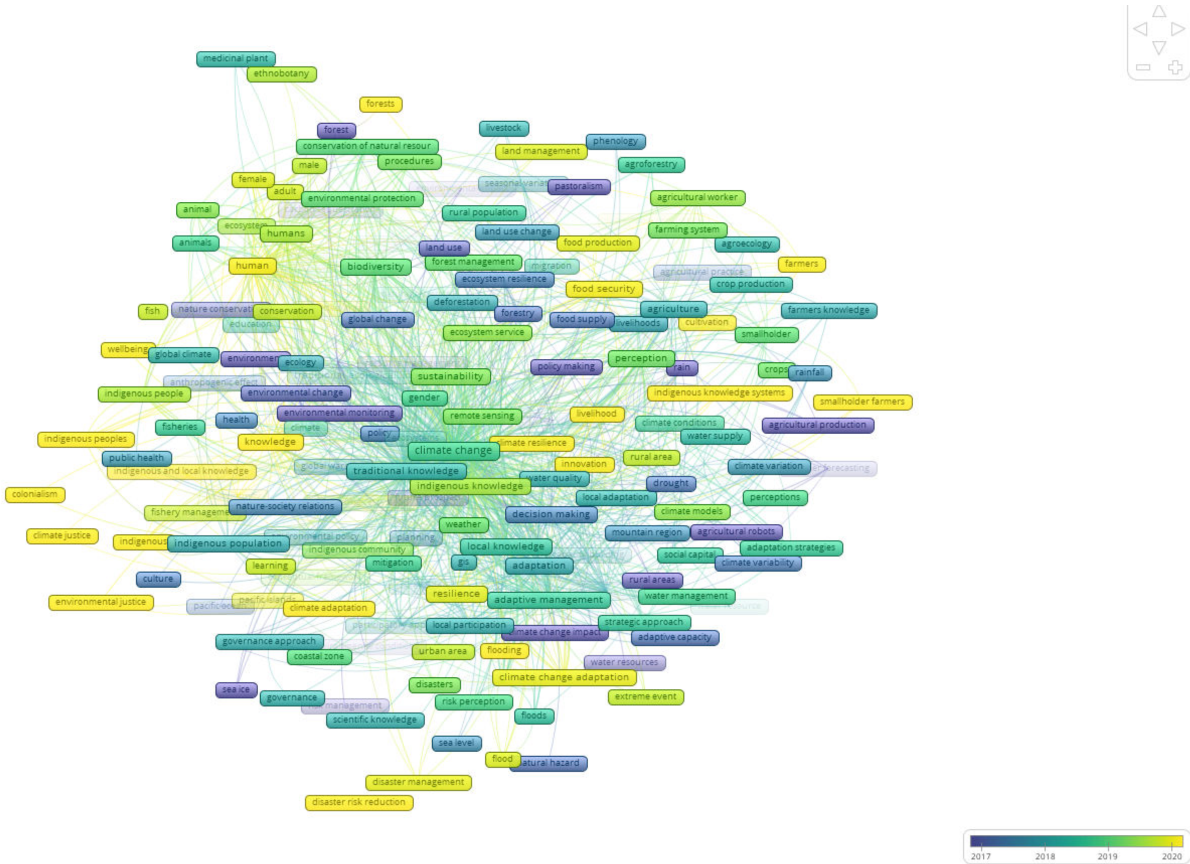

Figure 7. Research themes over time

Implications and future directions

The study highlights the growing significance of TILK in climate change research and the need for sustained interdisciplinary collaboration. To uphold TILK sovereignty, future research should apply citizen science principles, including co-design, co-implementation, and co-dissemination, to ensure shared ownership of data and findings. This should be preceded by capacity-building programmes for indigenous communities to guarantee active participation in all phases of citizen science projects. Research involving ILPCs should coincide with agreements that protect their rights and ensure they retain control over how their knowledge is generated and used. The analysis also underscores the importance of incorporating indigenous perspectives and knowledge into policymaking. Future research could explore the practical applications of TILK in areas such as loss and damage in urban and coastal settings, urban planning, fishery management, and climate justice.

Conclusions

This study highlights a gradual increase in research output on TILK and climate change since 1995, with particularly significant growth from 2007 onwards. This increase is attributed to the growing recognition of the value of integrating TILK with scientific approaches to enhance climate change action under various international protocols. The analysis also indicates that peer-reviewed journal articles are the predominant medium for disseminating research on TILK and climate change, followed by book chapters. Environmental science, social sciences, agricultural and biological sciences, earth and planetary sciences, and engineering were identified as the main contributors to TILK and climate change research. This multidisciplinary approach underscores the complexity of climate change and the need for a holistic understanding of the relationships among TILK, climate change, and sustainability.

Keyword co-occurrence analysis revealed thematic clusters within the field, including TILK and natural resource management; sustainability and adaptive capacity; climate change and agriculture; risk management and governance; and TILK and disadvantaged groups. Nonetheless, further research is required in under-explored areas, such as the application of TILK in climate justice, climate mitigation, loss and damage, and coastal and marine environments. The study also highlights research gaps that call for greater emphasis on indigenous perspectives and knowledge, the practical applications of IK in climate change policymaking and the intersections between TILK and other forms of knowledge.

Limitations of the study

A literature search was conducted in the Scopus database on 15 January 2026. This cut-off date presents limitations, as articles published late in 2025 may not have been captured. In addition, restricting the search to the Scopus database may have excluded some important publications on TILK-CC research.

Declarations

Interdisciplinary Scope: This article examines trends in research on the TILK-CC nexus at a global level.

Author Contributions: Conceptualisation (Gideon Walter Mutanda), literature review (Gideon Walter Mutanda and Godwell Nhamo), methodology (Gideon Walter Mutanda and Godwell Nhamo), analysis (Gideon Walter Mutanda), review and editing (Gideon Walter Mutanda and Godwell Nhamo). The final version of the article has been approved by all the authors.

Conflict of Interest: The authors have no conflict of interest to declare.

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Availability of Data: The article includes all the relevant data. However, more information can be obtained from the corresponding author upon reasonable request.

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