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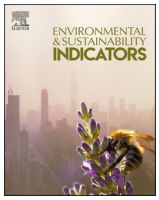

Bridging global evidence with local needs: A systematic review to inform climate and biodiversity strategies in Malawi

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ABSTRACT

This systematic review synthesised global scientific evidence (n = 54 studies) to extract potentially transferable strategies for addressing climate change and biodiversity loss in Malawi. Guided by the Protocol, Search, Appraisal, Synthesis, Analysis, and Reporting (PSALSAR) framework, this review analysed research published between 2014 and 2024, with a focus on identifying interventions from socio-ecological contexts comparable to Malawi. Despite the global nature of the literature, only 7 % of the studies focused on Africa, and none specifically on Malawi, revealing a significant geographic evidence gap. Through contextual mapping, the review highlights promising approaches, including community-based adaptation, integrated governance, and renewable energy transitions. While the insights are preliminary, they offer a foundation for future empirical validation in Malawi and similar low-income, biodiversity-rich countries. The study contributes to knowledge localisation and identifies priorities for interdisciplinary research, community engagement, and policy alignment. Future research should refine these strategies and evaluate their applicability across diverse contexts to support global efforts in combating climate change and preserving biodiversity.

1. Introduction

Climate change and biodiversity loss are complex, multidimensional challenges that affect the world (The Royal Society, 2021). These pressing issues are driven by anthropogenic activities, including deforestation, industrial pollution, and greenhouse gas emissions (Miles and Kapos, 2008). Their impacts are far-reaching and disrupt ecosystems, economies, and human wellbeing (Arneth et al., 2020). Changes in temperature and precipitation can cause crop failure and water scarcity, whereas biodiversity loss weakens ecosystem resilience and increases disease vulnerability (Aytenew, 2021).

Malawi provides a microcosm for these global environmental threats, where local and international drivers intersect. Located in south-eastern Africa, Malawi faces recurrent droughts, floods, and food insecurity, which are exacerbated by high population pressure and dependence on biomass energy (US Agency for International Development [USAID], 2023). Over 95 % of households use firewood or charcoal, which accelerates deforestation and biodiversity loss, despite legal prohibitions (National Statistical Office [NSO], 2019; Gayen et al., 2024). Each year, approximately 33,000 ha of forest are lost, compounding climate vulnerability (Ngwira and Watanabe, 2019).

Although the Malawian government has introduced forest and energy policies, their implementation has been fragmented and underresourced. Current strategies often overlook the socio-economic realities of rural communities, which lack viable energy alternatives (Parkinson, 2022). Given these constraints, a shift towards integrated, evidence-based solutions is needed, linking climate adaptation, biodiversity protection, and local development goals.

This study responds to this need by systematically reviewing international research to identify scalable strategies for Malawi. While focusing on global literature, this study uses a structured methodology to assess its relevance and applicability to Malawi's ecological and socioeconomic context. Simultaneously, the Malawian case generates evidence that can inform other African Countries facing similar challenges of deforestation, biomass dependence, and vulnerability to climate shocks. By treating Malawi as a representative entry point, this review highlights how global lessons can be contextualised for Malawi and other biodiversity-rich, low-income countries.

By bridging the gap between global knowledge and local needs, this study contributes to the development of integrated interdisciplinary frameworks for sustainable policy and practice in Malawi and comparable countries. This review also aims to identify key research gaps,

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support the localisation of global best practices, and inform multi-sectoral interventions in Malawi. The methodology and results presented here can be adapted for use in other low-income, biodiversity-rich contexts where data scarcity and capacity constraints hinder evidence-based policymaking. To guide the review, Fig. 1 presents an integrative framework that links research inputs, thematic clusters, and the resulting academic, policy and practice implications with alignment to the Sustainable Development Goals (SDGs).

2. Methodology

This study employed a systematic review methodology to examine the global literature on climate change and biodiversity conservation and extract transferable insights for policy and practice in Malawi. The review process adopted the Protocol, Search, Appraisal, Synthesis, Analysis, and Reporting (PSALSAR) framework, adapted from Mengist et al. (2020a), who customised the Search, Appraisal, Synthesis, and Analysis (SALSA) model for environmental research. The PSALSAR framework was chosen because of its emphasis on transparency, reproducibility, and relevance to interdisciplinary environmental enquiries (Mengist et al., 2020b). Table 1 outlines the six PSALSAR stages considered in this study.

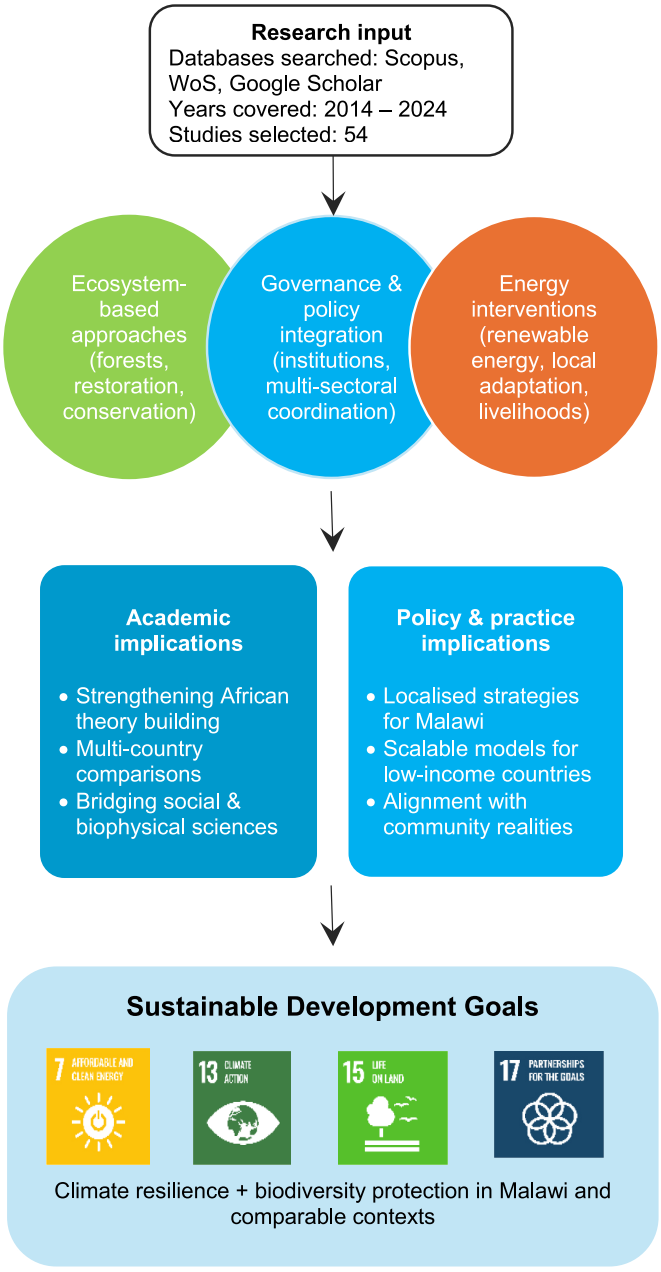

Fig. 1. Conceptual framework of the study, illustrating the linkages between research inputs (databases searched: Scopus, Web of Science [WoS], and Google Scholar), thematic clusters (ecosystem-based approaches, governance, and energy interventions), and their academic and policy implications, aligned with the SDGs.

2.1. Protocol

During the protocol stage, the review scope was refined to focus on studies with applicable insights for Malawi, particularly in tropical, resource-constrained, or biodiversity-rich contexts. This focus on 'transferability' rather than strict geographical inclusion allowed for greater relevance to Malawi's challenges, despite a lack of direct local studies. The following research questions guided the review.

i. What are the global research trends in climate change and biodiversity conservation relevant to the challenges faced by Malawi?
ii. What are the global research hotspots and emerging themes with practical applicability to Malawi?
iii. What interventions and strategies can be adapted to Malawi's socio-ecological system?
iv. What lessons can be drawn to inform future interdisciplinary environmental planning in Malawi?

2.2. Search

To capture peer-reviewed interdisciplinary research, three databases were selected: Scopus, Web of Science (WoS), and Google Scholar. A systematic search was conducted across these platforms using terms designed to reflect themes related to climate change and biodiversity, as well as integrated or multidisciplinary approaches. The search was limited to English-language sources published between 2014 and 2024, a period chosen to align with key global milestones such as the 2015 Paris Agreement and the Sustainable Development Goals (2015–2030). This timeframe reflects the most active phase of international climate action, ensuring contemporary relevance and avoiding overlap with pre-

Table 1
Framework for systematic review and meta-analysis (adapted from Fernández Del Amo et al., 2018).

PSALSAR Framework	Phase	Outcome	Method
	Protocol	Define scope	Only climate change and biodiversity
	Search	Define the search strategy	Search strings
		Search studies	Search databases
	Appraisal	Select studies	Define inclusion & exclusion criteria
		Assess the quality of studies.	Quality criteria
	Synthesis	Extract data	Extraction sheet
		Categorise extracted data	Define themes & iterative categories.
	Analysis	Analyse data	Quantitative description and narratives
		Results & discussion	Identify trends, gaps, & compare results
		Conclusion	Conclude and make recommendations
	Report	Written report	PRISMA methodology (Page et al., 2021)
		Journal article	Follow journal guidelines

Notes: PRISMA stands for Preferred Reporting Items for Systematic Reviews and Meta-Analyses. It was created to help ensure transparent and comprehensive reporting of systematic reviews.

Paris frameworks.

Two Boolean-based search strings were developed for Scopus and WoS (Table 2), while Google Scholar used an advanced query to extract grey literature. This multimodal approach enabled the inclusion of underrepresented but methodologically sound studies from developing regions. To mitigate the risk of including non-peer-reviewed or low-quality sources from Google Scholar, strict screening was applied: (i) only studies published in peer-reviewed journals were included, (ii) conference papers, theses, and reports were excluded, and (iii) quality appraisal was conducted using the Critical Appraisal Skills Programme (CASP) to ensure methodological rigour. The search results were consolidated in Microsoft Excel, yielding 305 unique articles after the deduplication process.

2.3. Appraisal

The appraisal phase followed a three-step screening process: title screening, abstract screening, and full-text analysis using the predetermined inclusion/exclusion criteria (Table 3). The criteria emphasised studies with methodological rigour, relevance to developing countries, and alignment with climate-biodiversity linkages. Quality assessment was conducted using the CASP checklist, which evaluates study validity, methodological transparency, and relevance of findings. To enhance reliability, two reviewers independently applied the CASP criteria to all studies. Discrepancies in judgement were resolved through discussion, and where necessary, a third reviewer was consulted to reach a consensus. Only studies that demonstrated robust methodologies and policy relevance were included in this review. Ultimately, 54 studies met the inclusion criteria. The overall selection and screening process is summarised in Fig. 2, which illustrates the flow of records through each review stage using a PRISMA-style diagram.

2.4. Synthesis

The selected studies were coded and categorised in a structured spreadsheet based on the following.

- Geographic region
- Type of ecosystem studied

Table 2
Search queries used to retrieve literature from Scopus, Web of Science (WoS) and Google Scholar.

Database	Search string	Hits
Scopus	TITLE-ABS-KEY (("systems approach" OR "interdisciplinary collaboration" OR "holistic approach" OR "integrated approach" OR "cross-disciplinary approach" OR "sustainability strategies" OR "ecosystem-based management") AND ("biodiversity conservation" OR "ecosystem management" OR "conservation strategies" OR "biodiversity preservation" OR "habitat protection" OR "habitat restoration" OR "habitat conservation" OR "ecological restoration") AND ("climate change impacts" OR "climate change adaptation" OR "climate change mitigation" OR "climate resilience strategies" OR "climate action plans" OR "global warming solutions" OR "environmental resilience" OR "climate change resilience") OR ("Malawi" OR "Sub-Saharan Africa" OR Africa)) AND (LIMIT-TO (LANGUAGE, "English"))	117
WoS	(TS=(Interdisciplinary) AND TI= (Climate change) AND TS= (Biodiversity)) AND (LA = =("ENGLISH"))	51
Google Scholar	"Integrated approach" AND intitle:"Climate Change" AND intitle:"Biodiversity" NOT Citations	137

Notes: Quotation marks ("") indicate an exact word or phrase search. Field tag descriptions: TITLE-ABS-KEY refers to title, abstract, author, and index keywords; KEY refers to author and index keywords; TS refers to topic (title, abstract, keyword plus, and author keywords); TI refers to article titles; and LA refers to the language of the article.

Table 3
Criteria used for inclusion and exclusion of literature in the study.

Reason for inclusion or exclusion	Decision
If any of the keywords or a combination exists within the title or abstract	Include
The paper underwent peer review and has been published in a scientific journal.	Include
The article was accessible for review or download	Include
The paper has been published in English	Include
The article was published within the last 10 years, specifically from 2014 to 2024	Include
Articles not meeting the inclusion criteria above	Exclude
Duplicate articles found in the search documents	Exclude
Articles about coastal, ocean, marine, and sea topics irrelevant to Malawi	Exclude
Articles on climate change with application in epidemiology	Exclude

- Type of intervention or policy proposed
- Relevance to Malawi's context

Special attention was given to strategies from countries with comparable socio-economic and ecological settings, such as those in sub-Saharan Africa, South Asia, and Latin America. Studies from developed countries were included only if they provided adaptable insights.

2.5. Analysis

A mixed-methods analysis was conducted to identify trends and gaps across the 54 studies. The Voyant tool was used for text mining and keyword analysis to visualise the dominant themes (Sinclair and Rockwell, 2024). The analysis phase also involved mapping each study's relevance to Malawi's National Biodiversity Strategy and Action Plan (NBSAP II) and climate commitments under the Paris Agreement. Given the absence of Malawi-specific studies, the analysis also prioritised identifying studies from socio-ecologically comparable regions and assessing their transferability. The PSALSAR framework facilitated this contextual alignment by allowing a structured interpretation of externally generated evidence, ensuring their relevance to Malawi's national frameworks and development goals.

2.6. Reporting

The discussion expands the scope of references to include relevant reports and papers identified during the literature review that were not included in the systematic review. This expansion incorporates works published outside the chosen timeframe.

The findings are presented in narrative and visual formats. The figures illustrate trends in publication, regional contributions, and thematic clustering. The tables summarise key studies and categorise strategies with potential application to Malawi. The final reporting phase also links the findings to SDGs, demonstrating their broader global relevance.

3. Results

This section presents the findings of the 54 studies included in this systematic review. The results are organised into five subsections covering global research trends, thematic hotspots, interventions relevant to Malawi, key lessons learned, and a synthesis of the implications.

3.1. Global research trends

3.1.1. Geographic distribution of research

The analysed studies reveal a significant imbalance in regional research output. As illustrated in Fig. 3, approximately 72 % of the papers were authored by researchers affiliated with institutions in Europe and North America, particularly the United Kingdom and the United States. This dominance mirrors the global disparities in nature-based

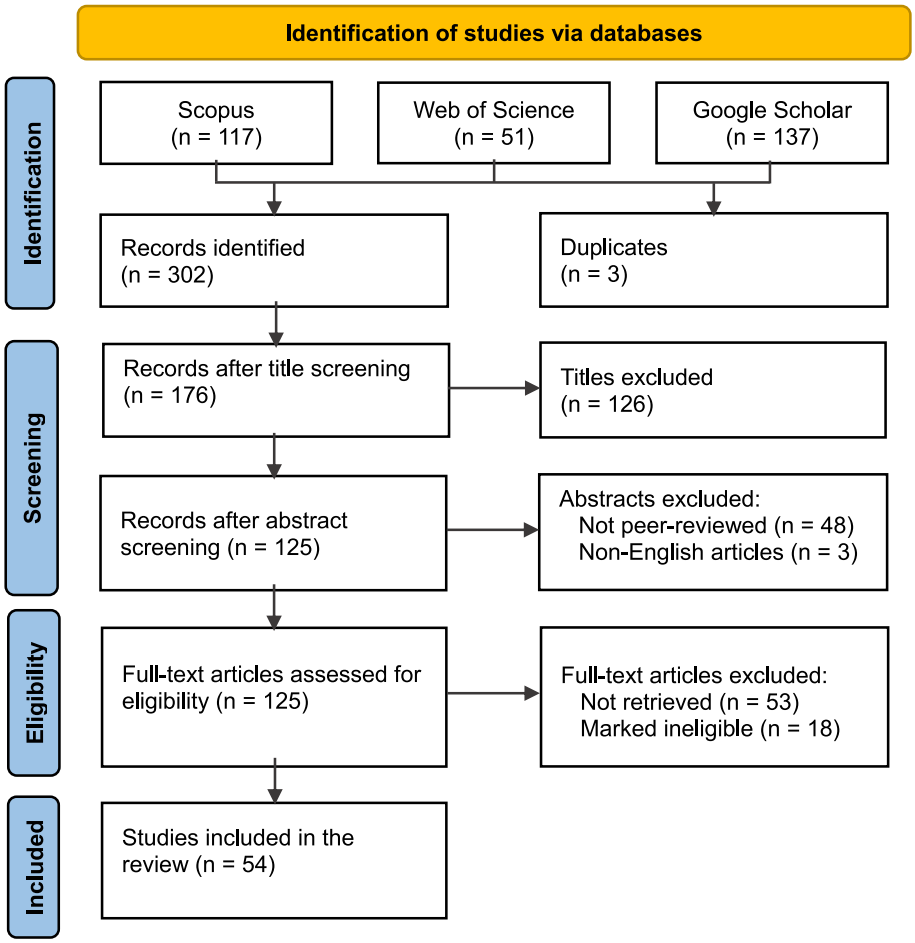

Fig. 2. Sequential method followed to synthesise the existing literature on global climate change and biodiversity, utilising the PRISMA methodology flowchart (Page et al., 2021). The relatively small number of duplicate records (n = 3) reflects the differing coverage and indexing practices of Scopus, Web of Science, and Google Scholar, as well as the use of tailored search strings across databases.

and interdisciplinary climate research, as observed by Su et al. (2023) and Wang et al. (2023). Such a concentration limits the transferability of evidence to sub-Saharan Africa and highlights the need for context-specific research to inform Malawi's climate and biodiversity strategies.

3.1.2. Temporal trends

Fig. 4 illustrates the publication timeline from 2014 to May 2024, indicating a generally low frequency of research. Publications peaked in 2019, with 10 studies, possibly due to increased global interest in climate–biodiversity connections leading up to the United Nations 2020 Biodiversity Framework. There was a decline in 2020, likely related to the COVID-19 pandemic's disruption of academic activities. This temporal trend reinforces the need for sustained investment in research ecosystems in the Global South.

3.2. Research hotspots and emerging trends

3.2.1. Dominant themes

The evaluated dataset encompasses a broad spectrum of approaches to climate change and biodiversity, revealing three dominant thematic clusters across 54 studies. First, ecosystem-based approaches (n = 20; 37 % of studies) were prominent, featuring interventions such as forest conservation, habitat restoration, and sustainable land-use planning. Several studies have focused on specific ecosystems, such as forests and freshwater environments, whereas others have adopted a holistic perspective on biodiversity and climate interactions (Choi et al., 2021; Mucova et al., 2018; Ortolano et al., 2017). To provide a visual overview of these recurring themes, Fig. 5 presents a word cloud generated from the dataset keywords.

This thematic diversity enhances our understanding of the varied impacts of climate change on different biodiversity hotspots and ecosystem types (Trew and Maclean, 2021). Second, energy and emissions strategies (n = 15; 28 %) have emerged as a major focus, including renewable energy transitions, biogas system deployment, and off-grid solar projects. These strategies have been frequently discussed as co-benefit interventions, aiming to reduce emissions and alleviate deforestation and indoor air pollution, which are issues highly relevant to Malawi. Third, governance and stakeholder models (n = 19; 35 %) were recurring themes. These studies emphasised community-led conservation, adaptive co-management, and multi-sectoral coordination mechanisms to address complex socio-ecological challenges. Many proposed integrated or systems-based frameworks seek to align ecological goals with governance innovation.

While thematic diversity reflects methodological and conceptual sophistication, a critical limitation is that most studies, particularly those from high-income countries, have not engaged deeply with local socio-political constraints or implementation barriers in low-income settings. For instance, Soto-Navarro et al. (2020) offered high-resolution global maps of carbon storage and biodiversity to guide conservation planning; however, their use presupposes technical infrastructure and institutional coordination that may not be available in countries such as Malawi and Mozambique.

Nonetheless, the overall quality of the reviewed studies was high,

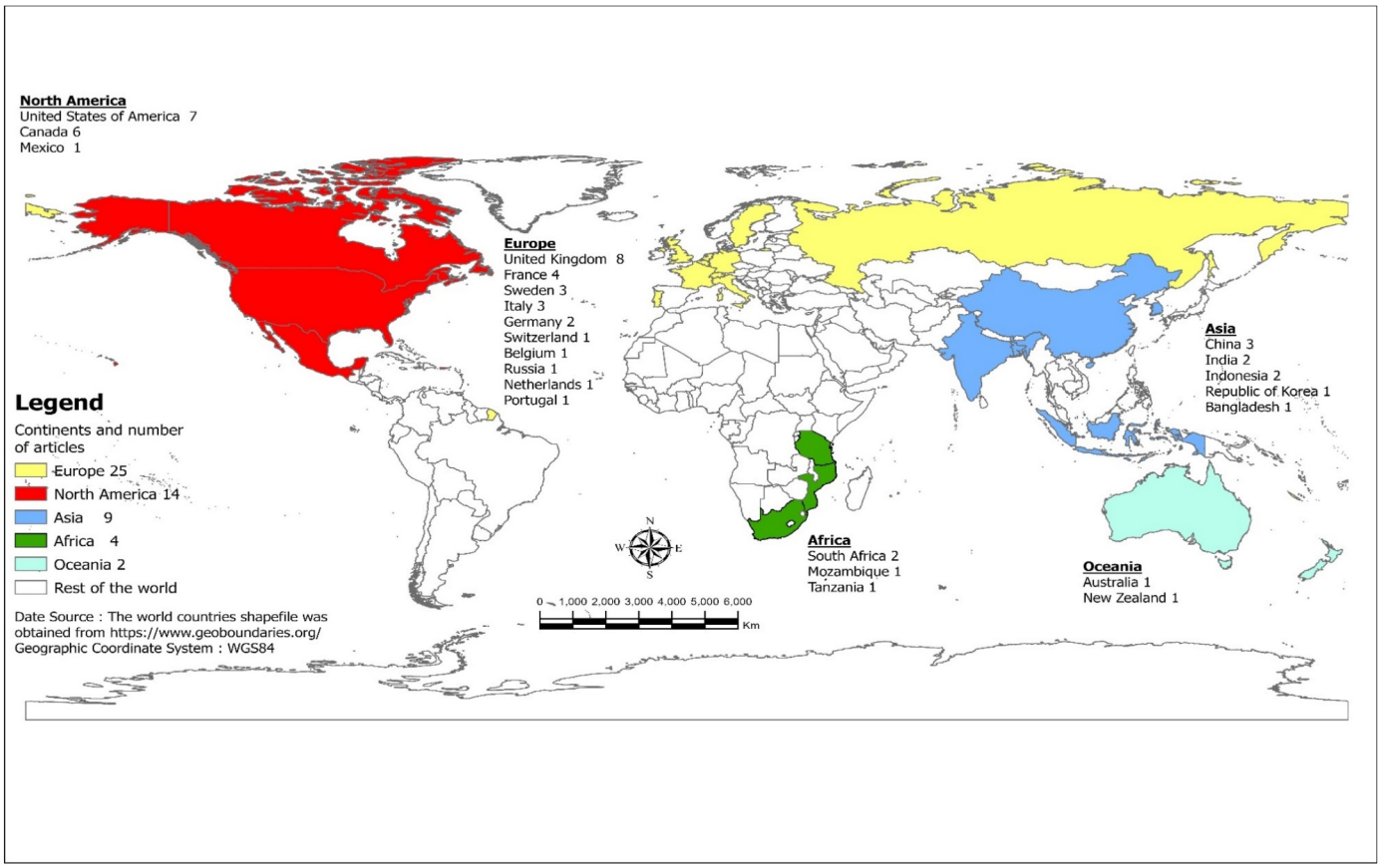

Fig. 3. Global distribution of climate change and biodiversity research output from studies included in the review. The numbers represent papers authored by researchers affiliated with each continent and country after applying the exclusion criteria (Data source: Runfola et al., 2020.

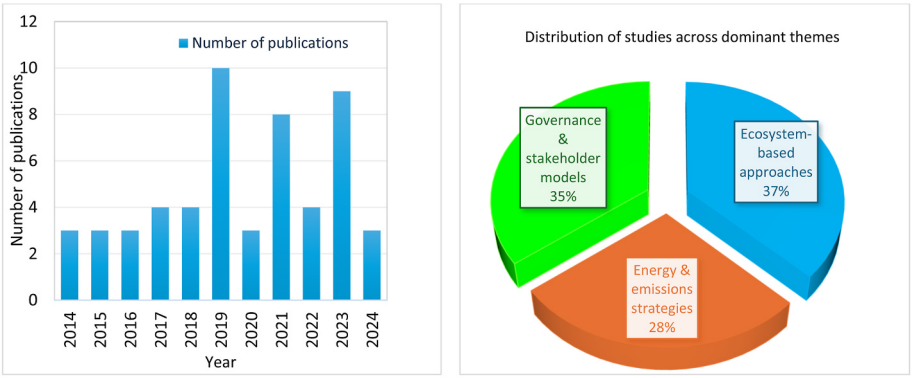

Fig. 4. Trends and thematic distribution of the reviewed studies. The bar chart shows the number of publications per year (January 2014–May 2024), highlighting the variation in research output over time. The pie chart classifies the 54 studies into three dominant themes: ecosystem-based approaches, energy and emission strategies, and governance and stakeholder models.

with most being published in reputable peer-reviewed journals that adhere to rigorous research standards. This strengthens the credibility of the identified thematic clusters and reinforces the need to interpret them through the lenses of local feasibility, equity, and institutional capacity.

3.2.2. Selection criteria and key studies

Table 4 summarises ten key studies selected from the 54 reviewed articles to illustrate methodological diversity, publication quality, and contextual relevance. The selection criteria included empirical and review studies published in peer-reviewed journals such as Nature Climate Change and Conservation Biology. These studies emphasise transferable strategies applicable to developing countries with similar socio-ecological challenges.

3.3. Patterns in transferable strategies

Drawing on 54 reviewed studies referencing Malawi's developmental context, three broad categories of potentially transferable strategies were identified: community-based adaptation (CBA), renewable energy transitions, and integrated forest governance. While these strategies show strong potential, their applicability is conditional; they must be locally adapted, validated, and often downscaled to suit Malawi's socio-political, ecological, and economic landscape.

Community-based adaptation strategies, which are widely

Fig. 5. Word cloud generated from a dataset of research papers highlighting key environmental themes such as climate change, biodiversity, conservation, and ecosystem management. The prominence of these terms reflects their frequency in the selected literature and aligns with the initial search criteria. Created using Voyant tools (Sinclair and Rockwell, 2024)

Table 4
Summary of ten key studies covering climate change and biodiversity aspects, geographical focus, study type, and significant findings.

#	Title of the Paper	Authors	Journal Name	Country of Affiliation	Study Location	Study Type	Study Findings
1	Climate change, biodiversity, and tipping points	Urich et al. (2021)	Springer Nature	New Zealand	Botswana	Case study	Highlights comprehensive frameworks for assessing tipping points in biodiversity due to climate change.
2	Climate change and biodiversity	Maljean-Dubois and Wemaere (2017)	Encyclopaedia of Environmental Law	France	Not site-specific	Review article	Discusses policy-making and integrated approaches to enhance biodiversity conservation.
3	Sustainable integrative framework for biodiversity conservation	Joseph (2022)	East African Journal of Interdisciplinary Studies	Tanzania	Tanzania	Empirical study	Emphasises adaptive strategies for sustainable biodiversity conservation in East Africa.
4	Mapping co-benefits for carbon storage and biodiversity	Soto-Navarro et al. (2020)	Philosophical Transactions of the Royal Society B	Switzerland	Global	Mapping analysis	Provides global maps that highlight the co-benefits of carbon storage and biodiversity conservation.
5	Global progress in climate change and biodiversity conservation	Farooqi et al. (2022)	Global Ecology and Conservation	China	Global	Review article	Reviews global climate change and biodiversity research progress, identifying key trends and gaps.
6	Climate change impacts on Himalayan biodiversity	Dahal et al. (2021)	Indian Institute of Science	India	Himalayan region	Integrative approach	Examines the impacts of climate change on Himalayan biodiversity, suggesting adaptive strategies for conservation.
7	An integrated framework to identify wildlife populations under threat from climate change	Razgour et al. (2018)	Molecular Ecology Resources	UK	UK and Spain	Observational	Provides a framework to assess wildlife vulnerability to climate change, emphasising genomic data in conjunction with ecological models.
8	Using the conservation standards framework to address climate change and biodiversity	Brown et al. (2022)	Climate	USA	Central Asia, Canada, Chile, and Alaska	Integrated conservation	Applies the Conservation Standards framework to integrate climate change adaptation and biodiversity goals.
9	The EU policy on climate change, biodiversity conservation, and sustainable development	Paleari (2024)	Environmental Science and Policy	Italy	European Union	Policy analysis	Analyses the EU's approach to integrating climate change, biodiversity, and ecosystem services into policy.
10	Integrating issues of biodiversity and climate change	Wang et al. (2021)	Earth and Environmental Science	Indonesia	Indonesia	Conceptual framework	Highlights the need for integrated conservation strategies to address biodiversity loss and climate change.

implemented in South Asia and Latin America, have become particularly relevant to Malawi's predominantly rural population. Their success depends on the alignment of the community knowledge systems, governance mechanisms, and incentive structures (Jihan et al., 2023). Effective implementation in Malawi requires robust local institutions, trust in the state, traditional leadership, and mechanisms for inclusive participation.

Renewable energy transitions are another frequently proposed

solution, particularly in the form of solar micro-grids, biogas digesters, and improved cooking stoves (Zalengera et al., 2014; Chikumbanje et al., 2022). These technologies are technically feasible in Malawi, but their uptake remains constrained by affordability, access to finance, and behavioural barriers. Targeted subsidies, community-led solar co-operatives, and gender-inclusive training models such as those piloted in Nepal and Kenya offer promising adaptation pathways.

Integrated forest governance and strategies, including participatory forest management, enforcement reforms, and agroforestry models, have demonstrated notable success in Brazil and Indonesia. These models emphasise community monitoring, strengthened enforcement, and incentive-based conservation (López and Mulero-Pázmány, 2019). In Malawi, applying these approaches requires reconciling customary land tenure with state policy, strengthening inter-agency coordination, and strengthening the capacity of district-level forest offices. These three strategic categories are summarised in Table 5, which maps their global application, relevance to Malawi, and key implementation considerations.

These three strategic categories were not isolated in the literature but were closely interlinked in high-impact interventions. For example, forest governance efforts often fail without parallel improvements in household energy alternatives. Similarly, renewable energy projects are more sustainable when embedded within broader community development frameworks.

Promising strategies for Malawi include deploying renewable energy through micro grids and biogas, promoting the adoption of improved cooking stoves, and integrating reforestation efforts with agroforestry and public-private partnerships (Choi et al., 2021). Educational campaigns, particularly those embedded in school curricula and disseminated via radio and mobile platforms, were also found to support long-term ecological literacy and behavioural change (Ninsiana et al., 2024).

Sustainable livelihood programs, such as beekeeping, eco-tourism, and microenterprise support, have emerged as cross-cutting enablers that reinforce environmental outcomes by enhancing local economic resilience (Djordjević-Milošević and Milovanović, 2020). Finally, this review emphasises the importance of investing in research and development, particularly in locally led studies on land management, biodiversity monitoring, and renewable technologies to address data gaps and support adaptive policymaking (Cowell et al., 2020; Wang et al., 2021; Gasser et al., 2022). While global strategies can inform national responses, their effectiveness in Malawi hinges on localisation, community participation, institutional reform, and sustained financial and political commitments.

3.4. Lessons learned from integrated studies

Achieving sustainability in the context of climate change and biodiversity loss requires holistic approaches that integrate ecological preservation, economic resilience, and social equity (Cabezas et al., 2004). Drawing on the synthesis of 54 peer-reviewed studies, four core insights emerge: three thematic lessons and one set of critical contradictions that inform the potential localisation of global strategies in Malawi.

Table 5
Mapping of transferable strategies from global studies to local contexts.

Strategy type	Global application	Malawi relevance	Implementation notes
Community-based adaptation	Highly present in South Asia and Latin America	Highly relevant due to Malawi's rural demographics	Needs local capacity, trust-building, and aligned incentives
Renewable energy transition	Solar micro grids and biogas systems in India, Kenya and Nepal	Technically feasible, but cost is a barrier	Requires targeted subsidies, inclusive implementation, and gender-sensitive approaches
Integrated forest governance	Participatory models in Brazil and Indonesia	Highly relevant for reducing deforestation and promoting equity	Customary land rights must be respected; enforcement must pair with energy access reforms

3.4.1. Integrated and holistic approaches

Many studies have highlighted the need for integrated systems-based frameworks that combine climate resilience, biodiversity protection, and developmental objectives. For instance, ecosystem-based Adaptation (EbA) enhances resilience by utilising natural processes to mitigate vulnerability to climate shocks (Brink et al., 2016). Integrated Landscape Initiatives (ILIs) also offer multi-functional land use models that can support conservation and livelihoods when sustained by long-term institutional commitment and adaptive governance (Zanzanaini et al., 2017).

Although these models provide useful conceptual tools, their success elsewhere does not guarantee their relevance in a local setting. Without clear local governance structures, reliable financing, and cross-sectoral policy alignment, the operationalisation of such approaches may remain out of reach. Therefore, they are best treated as frameworks for exploration rather than immediate blueprints for action.

3.4.2. Community involvement and stakeholder engagement

Recurring evidence across the literature highlight the pivotal role of local communities in the design, implementation, and long-term success of environmental interventions. Decentralised management and iterative stakeholder learning have been consistently linked to improved landscape resilience and social legitimacy (Jihan et al., 2023). Importantly, studies have emphasised the concept of "stakeholder capital", which refers to the trust, capacity, and embedded knowledge that local actors bring to natural resource governance.

These findings underscore the importance of integrating interventions into existing governance systems in Malawi, where informal institutions and customary authorities play a pivotal role. However, this requires more than just rhetorical support for participation; it demands concrete investments in capacity building, transparency, and inclusive engagement mechanisms, particularly for women and youth, who are often marginalised in environmental decision-making.

3.4.3. Interdisciplinary research and appropriate technologies

The most important strategies identified in this review are based on interdisciplinary approaches. Studies that combined ecological, technological, and socio-political data were more likely to design feasible and context-aware interventions. For example, the integration of genomic data with spatial analysis and participatory methods has yielded more targeted biodiversity planning (Razgour et al., 2018). Agro-ecological innovations and Green Infrastructure (GI) are also more effective when informed by local knowledge and supported by enabling policies (Balzter et al., 2023; Sussams et al., 2015). For Malawi, the lesson is not just the value of interdisciplinarity, but also the importance of locally led knowledge production. Imported technologies must be adapted to the specific needs and constraints of the rural population. Without attention to affordability, accessibility, and cultural compatibility, even well-intentioned innovations risk limited uptake and outright rejection.

3.4.4. Contradictions and gaps across contexts

Despite these lessons, the literature has also revealed contradictions that constrain the direct transferability of global findings to local settings. These gaps underscore the importance of contextualisation over replication.

A key concern is technological determinism found in many energy studies. Interventions such as improved cooking stoves or solar systems were frequently promoted based solely on engineering performance.

However, they failed to achieve a scale that also considered behavioural, gender, and affordability factors. In Malawi, where household energy decisions are shaped by cultural norms, economic vulnerability, and trust in institutions, technology-only solutions are inadequate.

Similarly, forest governance models that have proven effective in countries with strong enforcement institutions such as Brazil and Indonesia often fail in regions with weak governance and unclear land rights. In Malawi, where customary tenure dominates and enforcement resources are limited, top-down forest protection can erode trust and trigger resistance, unless paired with viable livelihood alternatives and co-management structures.

Finally, many studies have exhibited an urban or Global North bias, proposing integrated policy frameworks that presume access to infrastructure, financing, and data resources, often lacking in rural Malawi. Although theoretically sound, these strategies may be unworkable without significant adaptation. These contradictions highlight a core principle: intervention success is less about technical merit and more about political feasibility, social ownership, and institutional fit.

3.5. Summary of synthesis

This review shows that most climate-biodiversity research has been externally generated, with limited empirical grounding in African contexts, and none has focused specifically on Malawi. Nonetheless, the literature offers conceptual frameworks and transferable lessons that can inform national dialogue and support exploratory adaptation. Integrated, community-led strategies hold particular promise but require careful contextualisation and governance reform. Similarly, technological solutions, such as renewable energy systems or agroecological practices, are only effective when delivered through socially informed, inclusive mechanisms that address access, affordability, and cultural relevance. While global models offer useful reference points, they must be interpreted through the lens of local governance structures, rural livelihoods, and resource constraints. Rather than prescribing solutions, this review provides a foundation for locally driven experimentation, knowledge coproduction, and adaptive policy development.

4. Discussion

4.1. Academic implications and interpretation of findings

Despite the growing global body of research on climate change and biodiversity conservation, this review confirms a significant geographic imbalance, with only four of the 54 studies focusing on Africa and none specifically on Malawi. This highlights a critical gap in locally relevant knowledge, which limits the availability of context-specific evidence that can directly inform policy and practice. The concentration of research in Europe and North America underscores the need to build local research capacity and funding in the country. At the same time, this imbalance is not unique to Malawi; similar gaps exist across many low-income African countries. From an academic standpoint, this highlights the importance of addressing the geographic skew in research outputs, broadening comparative studies across underrepresented contexts, and incorporating African case studies into global climate-biodiversity analyses. Thus, lessons drawn from this review, such as renewable energy transitions, agroforestry interventions, and integrated governance, provide evidence that may be transferable to comparable socio-ecological contexts across the continent and beyond.

Malawi faces a dual challenge of global climate drivers, such as the accumulation of greenhouse gases, and local pressures, including a heavy reliance on biomass energy, which accounts for approximately 25 % of the national greenhouse gas emissions (USAID, 2023). Although locally specific studies are scarce, international evidence, when contextualised using frameworks such as PSALSAR, can inform local strategies. For instance, effective agroforestry programs provide promising models for restoring degraded landscapes and reducing emissions through biomass substitution (Chazdon et al., 2016). Similarly, renewable energy transitions on a global scale, such as solar and biogas production, are feasible and relevant to rural energy poverty challenges in low-income countries. Theoretically, these findings reinforce the value of interdisciplinary frameworks such as PSALSAR for contextualising international evidence in resource-constrained environments. These strategies also provide reference points for other African nations grappling with similar energy-poverty-deforestation dynamics, thereby enhancing the applicability of this study's findings.

Integrated community-driven strategies that combine interdisciplinary research and adaptive governance are essential for building climate and biodiversity resilience in the region. For research, this highlights the need to test models of knowledge co-production that combine scientific and indigenous systems of knowledge and measure the long-term outcomes of community engagement. For policy and practice, the implication is to ensure that such strategies translate into locally owned interventions that can withstand donor and political cycles.

4.2. Integrated strategies for Malawi

The following subsections translate academic findings into practical strategies for Malawi's context, offering policy and practice implications derived from the review.

4.2.1. Sustainable energy transitions

Promoting renewable energy is a cornerstone of sustainable development, particularly in low-income countries, where dependence on traditional biomass poses environmental and health hazards. Malawi's energy sector is characterised by low electricity access (15 %) and a high reliance on traditional biomass (80 %) (Chaima et al., 2023; NSO, 2019). Transitioning to renewable energy sources such as solar energy, biogas, and improved cooking stoves can mitigate environmental degradation, reduce indoor pollution, and support economic development (Sovacool, 2012). Financing tools such as results-based subsidies or micro-loans can enhance the affordability and uptake of these renewable solutions, particularly among low-income households (Su et al., 2024).

a) Solar power

Solar energy offers a scalable off-grid solution for Malawi. Jacobson et al. (2017) found that renewable energy can meet global energy needs in a sustainable and economically viable way. Programs such as the World Bank's *Lighting Global* and SolarAid's *Mayi Walas* demonstrate that solar initiatives can succeed when coupled with community engagement and financing. In these models, women entrepreneurs were trained to sell solar lights and create income opportunities while expanding access to energy (World Bank, 2020a, 2020b). The lessons include fostering local entrepreneurship, subsidising costs, and offering support.

b) Biogas

Biogas systems convert agricultural waste into clean energy, thereby reducing deforestation and promoting the circular use of waste. Lessons from India have shown that household and community digesters are feasible (Minde et al., 2013). In Malawi, success depends on technical training, monitoring systems, and alignment with reforestation and soil health policies (Ngwira and Watanabe, 2019).

c) Improved cooking stoves

Improved cooking stoves can reduce wood consumption by up to 50 % and can drastically reduce indoor air pollution (Smith et al., 2014). However, adoption is limited by costs and behaviour. Strategies must integrate affordability, user-centric design, and behaviour change

campaigns to enhance uptake and sustainability.

4.2.2. Integrated forest governance

An effective forest governance model must address energy poverty while reinforcing conservation efforts. A three-phase approach is proposed.

Phase 1: Expand energy access

The widespread reliance on firewood and charcoal drives forest degradation. Scaling up affordable clean energy solutions, such as solar cookers, biogas systems, and improved cooking stoves, can reduce this dependency, lower indoor air pollution, and alleviate the burden of firewood collection, particularly for women and children.

Phase 2: Enable community-based monitoring

Once viable energy alternatives are established, communities become more willing to participate in conservation efforts. Establishing and training inclusive forest committees that feature women, youth, and traditional leaders can promote local stewardship and accountability. Participatory monitoring enhances legitimacy and compliance (Agrawal and Ostrom, 2001).

Phase 3: Strengthen enforcement against commercial exploitation

With foundational systems in place, enforcement should focus on commercial deforestation, including illegal logging and the charcoal trade. By first addressing household-level fuelwood needs, enforcement avoids penalising energy-poor households and targets systemic drivers (Su et al., 2024). Forestry authorities require better training, mobility, and access to technologies such as drones, satellite imagery, and Geographic Information Systems (GIS) for effective surveillance and enforcement (Tacconi et al., 2019).

This phased model will ensure that enforcement efforts do not unfairly penalise energy-poor households but instead target the systemic drivers. Evidence from Brazil and Indonesia shows that inclusive governance can reduce deforestation by more than 30 % (Tacconi et al., 2019). Incentive-based approaches that reward community-led conservation can further reinforce sustainable forest management (Pattanayak et al., 2010).

4.2.3. Cross-sectoral coordination

Effective climate and biodiversity governance in Malawi requires coordinated efforts from the ministries and local authorities. Historically, fragmented initiatives have led to conflicting mandates and underfunded implementation. For example, land allocation for agricultural expansion frequently clashes with reforestation goals due to poor coordination between the Ministry of Agriculture and the Department of Forestry (Ministry of Natural Resources: Energy & Mining, 2017).

The energy ministry plays a crucial role in the deployment of energy systems. Their responsibilities include increasing access to clean energy sources, such as solar and mini-hydropower, to reduce the pressure on forest resources (Ministry of Natural Resources: Energy and Mining, 2019). However, aligning rural electrification strategies with biodiversity conservation efforts remains a challenge.

Environmental agencies, such as the Department of Environmental Affairs and the Department of Forestry, are responsible for protecting biodiversity, promoting forest governance, and planning climate resilience. These agencies must work closely with energy and agricultural institutions to ensure that mainstream environmental sustainability is incorporated into the development policies. Evidence from eight studies shows that inter-ministerial task forces can improve policy coherence by 40–65 % (Paleari, 2024), suggesting their potential value in Malawi.

Agricultural departments play a crucial role in integrating agroforestry and sustainable land management practices to promote biodiversity and improve food security. Past initiatives such as the Sustainable Agricultural Production Programme (SAPP), have been successful when implemented in coordination with forestry extension officers.

Such coordination should also be extended to district-level planning processes to ensure alignment with local development needs and customary land use practices. District environmental committees and traditional authorities must be engaged early to ensure coherence between national strategies and grassroots implementation.

However, efforts to institutionalise such coordination in Malawi have been challenged by overlapping mandates, donor-driven planning cycles, and budgetary constraints. Addressing these barriers requires a robust institutional framework, a clear delineation of roles, and sustained political commitment.

4.3. Policy implications

The policy recommendations below synthesise findings from the systematic review and broader literature, presenting a clear agenda for building climate resilience and conserving biodiversity in Malawi.

a) Strengthen local research ecosystems

To address this significant research gap, Malawi must prioritise investments in research funding, technical training, and institutional partnerships (Farooqi et al., 2022). Regional research hubs equipped with geospatial, ecological, and climate analysis tools should be established in the region. Enhancing digital infrastructure and enabling open-access knowledge platforms will accelerate data-sharing and cross-border collaboration.

b) Deploy renewable energy strategically

Energy interventions should be guided by spatial equity and resource mapping to ensure the effective allocation of resources. Solar subsidies should prioritise high-solar, low-grid regions. Biogas initiatives must target agricultural zones with organic waste sources (Bond and Templeton, 2011). Improved cooking stoves should be distributed in areas that rely heavily on biomass to curb deforestation and reduce indoor air pollution. Micro-grids can sustainably power remote communities, thereby complementing national grid expansion (Eales et al., 2022).

c) Empower communities in forest Governance

Local communities must be at the centre of conservation strategies in the future. Policies should combine support for community-led reforestation, agroforestry, and sustainable livelihoods with strong regulatory enforcement (Garrity, 2004). School-based environmental education and widespread media campaigns can foster long-term ecological stewardship (Saiti et al., 2014).

Collectively, these measures reinforce Malawi's Vision 2063 and its commitments under the Sustainable Development Goals, particularly SDG 7 (Affordable and Clean Energy), SDG 13 (Climate Action), SDG 15 (Life on Land), and SDG 17 (Partnerships for the Goals), and the Paris Agreement. A multisectoral, inclusive, and adaptive governance model offers a viable pathway for achieving sustainable development outcomes.

4.4. Limitations of the study

This review faced limitations, including a disproportionate concentration of literature outside Malawi, which reduced the contextual specificity. Evidence from other regions may not fully align with Malawi's socio-environmental realities. Second, the review was restricted to English-language publications, which may have introduced selection bias and excluded relevant studies published in other languages from

consideration. Limited access to regional data and the underrepresentation of local knowledge systems constrain the evidence base. These structural gaps, combined with minimal integration from political or behavioural sciences, have restricted the development of holistic insights into this subject. Future studies should expand interdisciplinary collaborations and invest in regional research ecosystems to achieve this goal.

4.5. Recommendations for future studies

To address the global consequences of climate change on biodiversity loss and its impact on humans, further research is needed in African countries and other less-explored regions. This aligns with the World Climate Research Programme's declaration: climate science for a sustainable future for all (2024), which emphasises the need to focus on Africa as a key area affected by climate change, biodiversity loss, and environmental degradation. Therefore, policy decisions based on scientific research are crucial for addressing region-specific challenges in Malawi and Africa. Future research should focus on the following.

- Understanding local barriers to energy adoption.
- Evaluating community-based conservation models.
- Building Malawi-led research networks.
- Integrating social science perspectives into environmental decision-making

5. Conclusion

This systematic review explored global literature on climate change and biodiversity to extract insights applicable to Malawi. Using the PSALSAR framework and analysing 54 studies, this research identified transferable interventions, emerging themes, and interdisciplinary strategies suited to Malawi's development context.

Although none of the selected studies were specific to Malawi, the review demonstrated how international evidence can be contextualised to inform Malawi's national priorities. The key findings highlight the importance of integrating community engagement, renewable energy access, forest governance reforms, and multisector coordination into climate and biodiversity action. This study makes the following recommendations to move from insights to action.

1. Investing in context-appropriate renewable energy technologies such as solar micro-grids and biogas systems is essential.
2. Reforming forest governance by combining enforcement with alternative livelihood promotion.
3. Establishing cross-sectoral platforms that unify environmental, agricultural, and energy policies under a common vision.
4. Embedding environmental education and eco-literacy into school curricula and community initiatives is essential to achieving this goal.
5. Strengthening local research capacity through academic partnerships and funding mechanisms is essential.

These recommendations aim to operationalise sustainable development pathways in Malawi, while offering insights for other low-income, biodiversity-rich nations. Addressing data gaps, institutional fragmentation, and energy poverty through interdisciplinary approaches can significantly accelerate progress toward SDGs, particularly SDGs 7, 13, 15, and 17, and enhance climate resilience. Ultimately, this study highlights the importance of knowledge translation in transitioning from a global to a local scale. Malawi's future lies in integrated, inclusive, and evidence-based environmental governance.

CRediT authorship contribution statement

Lusungu Ngwira: Writing – original draft, Visualization, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Neil Harris:** Writing – review & editing, Validation, Supervision.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Data availability

Data will be made available on request.

References

Agrawal, A., Ostrom, E., 2001. Collective action, property rights, and decentralisation in resource use in India and Nepal. Polit. Soc. 29 (4), 485–514. https://doi.org/10.1177/0032329201029004002.

Arneth, A., Shin, Y.J., Leadley, P., Rondinini, C., Bukvareva, E., Kolb, M., Midgley, G.F., Oberdorff, T., Palomo, I., Saito, O., 2020. Post-2020 biodiversity targets need to embrace climate change. Proceedings of the National Academy of Sciences of the United States of America 117 (49), 30882–30891. https://www.pnas.org/doi/full/10.1073/pnas.2009584117.

Aytenew, M., 2021. Soil biodiversity as a key sponsor of regenerative agriculture. In: Hufnagel, L. (Ed.), *Biodiversity of Ecosystems*. IntechOpen. https://doi.org/10.5772/INTECHOPEN.99716.

Balzter, H., Macul, M., Delaney, B., Tansey, K., Espirito-Santo, F., Ofoegbu, C., Petrovskii, S., Forchtner, B., Nicholes, N., Payo, E., Heslop-Harrison, P., Burns, M., Basell, L., Egberts, E., Stockley, E., Desorgher, M., Upton, C., Whelan, M., Yildiz, A., 2023. Loss and damage from climate change: knowledge gaps and interdisciplinary approaches. Sustainability 15 (15), 11864. https://doi.org/10.3390/SU151511864.

Bond, T., Templeton, M.R., 2011. History and future of domestic biogas plants in the developing world. Energy Sustain. Dev. 15 (4), 347–354. https://doi.org/10.1016/J.ESD.2011.09.003.

Brink, E., Aalders, T., Ádám, D., Feller, R., Henselek, Y., Hoffmann, A., Ibe, K., Matthey-Doret, A., Meyer, M., Negrut, N.L., Rau, A.L., Riewerts, B., von Schuckmann, L., Törnros, S., von Wehrden, H., Abson, D.J., Wamsler, C., 2016. Cascades of green: a review of ecosystem-based adaptation in urban areas. Glob. Environ. Change 36, 111–123. https://doi.org/10.1016/J.GLOENVCHA.2015.11.003.

Brown, M.B., Morrison, J.C., Schulz, T.T., Cross, M.S., Püschel-Hoeneisen, N., Suresh, V., Eguren, A., 2022. Using the conservation standards framework to address the effects of climate change on biodiversity and ecosystem services. Climate 10 (2), 13. https://doi.org/10.3390/CLI10020013/S1.

Cabezas, H., Pawlowski, C.W., Mayer, A.L., Hoagland, N.T., 2004. Sustainability: ecological, social, economic, technological, and systems perspectives. Technological Choices for Sustainability 37–64. https://doi.org/10.1007/978-3-662-10270-1_3.

Chaima, E., Lian, J., Ma, C., Kaunda, S., Kavwenje, S., Nkhata, M., Phiri, S., Kumambala, P., 2023. Long-term electricity demand scenarios for Malawi's electric power system. Energy Sustain. Dev. 73, 23–38. https://doi.org/10.1016/J.ESD.2023.01.012.

Chazdon, R.L., Brancalion, P.H.S., Laestadius, L., Bennett-Curry, A., Buckingham, K., Kumar, C., Moll-Rocek, J., Vieira, I.C.G., Wilson, S.J., 2016. When is a forest a forest? Forest concepts and definitions in the era of forest and landscape restoration. Ambio 45 (5), 538–550. https://doi.org/10.1007/S13280-016-0772-Y/FIGURES/3.

Chikumbanje, M., Frame, D., Galloway, S., 2022. Minigrid integration planning (MGIP) for loss reduction and voltage profile improvement beyond energy access in developing countries. Energy Strategy Rev. 44, 100974. https://doi.org/10.1016/J.ESR.2022.100974.

Choi, Y., Lim, C.H., Chung, H.I., Kim, Y., Cho, H.J., Hwang, J., Kraxner, F., Biging, G.S., Lee, W.K., Chon, J., Jeon, S.W., 2021. Forest management can mitigate negative impacts of climate and land-use change on plant biodiversity: insights from the Republic of Korea. J. Environ. Manag. 288, 112400. https://doi.org/10.1016/J.JENVMAN.2021.112400.

Cowell, C., Bissett, C., Ferreira, S.M., 2020. Top-down and bottom-up processes to implement biological monitoring in protected areas. J. Environ. Manag. 257, 109998. https://doi.org/10.1016/J.JENVMAN.2019.109998.

Critical Appraisal Skills Programme. (n.d.). CASP checklists. Retrieved June 30, 2024, from https://casp-uk.net/casp-tools-checklists/.

Dahal, N., Lamichhaney, S., Kumar, S., 2021. Climate change impacts on himalayan biodiversity: evidence-based perception and current approaches to evaluate threats

under climate change. J. Indian Institute. Sci. 2021 101 (2), 195–210. https://doi.org/10.1007/S41745-021-00237-1, 101(2).
Djordjević-Milošević, S., Milovanović, J., 2020. Alternative livelihoods framework: beyond the risks and stress relief. Zero Hunger. 1–12. https://doi.org/10.1007/978-3-319-69626-3_8-1.
Eales, A., Banda, E., Coley, W., Frame, D., 2022. Deploying Solar Microgrids in Malawi Lessons Learned and Implications for the Malawian Microgrid Ecosystem. University of Strathclyde. https://strathprints.strath.ac.uk/90082/.
Farooqi, T.J.A., Irfan, M., Portela, R., Zhou, X., Shulin, P., Ali, A., 2022. Global progress in climate change and biodiversity conservation research. Glob. Ecol. Conserv. 38, e02272. https://doi.org/10.1016/J.GECCO.2022.E02272.
Fernández Del Amo, I., Erkoyuncu, J.A., Roy, R., Palmarini, R., Onoufriou, D., 2018. A systematic review of augmented reality content-related techniques for knowledge transfer in maintenance applications. Comput. Ind. 103, 47–71. https://doi.org/10.1016/J.COMPIND.2018.08.007.
Garrity, D.P., 2004. Agroforestry and the achievement of the millennium development goals. Agrofor. Syst. 61–62 (1–3), 5–17. https://doi.org/10.1023/B:AGFO.0000028986.37502.7C/METRICS.
Gasser, M., Pezzutto, S., Sparber, W., Wilczynski, E., 2022. Public research and development funding for renewable energy technologies in Europe: a cross-country analysis. Sustainability. 14 (9), 5557. https://doi.org/10.3390/SU14095557.
Gayen, D., Chatterjee, R., Roy, S., 2024. A review on environmental impacts of renewable energy for sustainable development. Int. J. Environ. Sci. Technol. 21 (5), 5285–5310. https://doi.org/10.1007/S13762-023-05380-Z/TABLES/2.
Jacobson, M.Z., Delucchi, M.A., Bauer, Z.A.F., Goodman, S.C., Chapman, W.E., Cameron, M.A., Bozonnat, C., Chobadi, L., Clonts, H.A., Enevoldsen, P., Erwin, J.R., Fobi, S.N., Goldstrom, O.K., Hennessy, E.M., Liu, J., Lo, J., Meyer, C.B., Morris, S.B., Moy, K.R., et al., 2017. 100% clean and renewable wind, water, and sunlight all-sector energy roadmaps for 139 countries of the world. Joule 1 (1), 108–121. https://doi.org/10.1016/j.joule.2017.07.005.
Jihan, Md A.T., Islam, R., Hossain, Md R., Hossain, S., Islam, R., Jahan, T., Jahan, R., Rahman, Md M., Islam, Md M., Jihan, Md A.T., Islam, R., Hossain, Md R., Hossain, S., Islam, R., Jahan, T., Jahan, R., Rahman, Md M., Islam, Md M., 2023. Assessing the ecological consequences: biodiversity decline in Gopalganj, Bangladesh, under climate change. J. Geosci. Environ. Protect. 11 (9), 297–316. https://doi.org/10.4236/GEP.2023.119019.
Joseph, L., 2022. Sustainable integrative framework for biodiversity conservation and pastoralists' resilience to impact of climate change in northern Tanzania rangelands. East African J. Inter. Stud. 5 (1), 50–71. https://doi.org/10.37284/EAJIS.5.1.597.
López, J.J., Mulero-Pázmány, M., 2019. Drones for conservation in protected areas: present and future. Drones. 3 (1), 10. https://doi.org/10.3390/drones3010010.
Maljean-Dubois, S., Wemaere, M., 2017. Climate change and biodiversity. In: Morgera, E., Razzaque, J. (Eds.), Biodiversity and Nature Protection Law, 3. Edward Elgar Publishing. https://www.e-elgar.com/shop/gbp/biodiversity-and-nature-protection-law-9781783474240.html.
Mengist, W., Soromessa, T., Legese, G., 2020a. Ecosystem services research in mountainous regions: a systematic literature review on current knowledge and research gaps. Sci. Total Environ. 702, 134581. https://doi.org/10.1016/J.SCITOTENV.2019.134581.
Mengist, W., Soromessa, T., Legese, G., 2020b. Method for conducting systematic literature review and meta-analysis for environmental science research. MethodsX. 7, 100777. https://doi.org/10.1016/J.MEX.2019.100777.
Miles, L., Kapos, V., 2008. Reducing greenhouse gas emissions from deforestation and forest degradation: global land-use implications. Science 320 (5882), 1454–1455. https://www.science.org/doi/10.1126/science.1155358.
Minde, G.P., Magdum, S.S., Kalyanraman, V., 2013. Biogas as a sustainable alternative for current energy need of India. J. Sust. Energy. Environ. 4, 121–132. https://ssrn.com/abstract=2431236.
Ministry of Natural Resources: Energy & Mining, 2017. Malawi National Charcoal Strategy 2017-2027. Government of Malawi. https://cepa.rmportal.net/Library/government-publications/national-charcoal-strategy-2017-2027/view.
Ministry of Natural Resources: Energy & Mining - Department of Forestry, 2019. Deforestation in Malawi. Government of Malawi. https://cepa.org.mw/Library/inbox/deforestation-in-malawi-fact-sheet/view.
Mucova, S.A.R., Filho, W.L., Azeiteiro, U.M., Pereira, M.J., 2018. Assessment of land use and land cover changes from 1979 to 2017 and biodiversity & land management approach in quirimbas national park, northern Mozambique, Africa. Glob. Ecol. Conserv. 16, e00447. https://doi.org/10.1016/J.GECCO.2018.E00447.
National Statistical Office [NSO], 2019. Malawi 2018 population and housing census. https://malawi.unfpa.org/en/publications/malawi-2018-population-and-housing-census-main-report.
Ngwira, S., Watanabe, T., 2019. An analysis of the causes of deforestation in Malawi: a case of mwazisi. Land. 8 (3), 1–15. https://doi.org/10.3390/land8030048.
Ninsiana, W., Septiyana, L., Suprihatin, Y., 2024. Introducing eco-literacy to early childhood students through digital learning. J. Educ. Learn. 18 (1), 89–96. https://doi.org/10.11591/edulearn.v18i1.20678.
Ortolano, L., Sánchez-Triana, E., Ferdausi, S.A., 2017. Strategy for adapting to climate change and conserving biodiversity in the Bangladesh sundarbans. Clim. Dev. 9 (4), 325–336. https://doi.org/10.1080/17565529.2016.1167660.
Page, M.J., Mckenzie, J.E., Bossuyt, P.M., Boutron, I., Hoffmann, T.C., Mulrow, C.D., Shamseer, L., Tetzlaff, J.M., Akl, E.A., Brennan, S.E., Chou, R., Glanville, J., Grimshaw, J.M., Hróbjartsson, A., Lalu, M.M., Li, T., Loder, E.W., Mayo-Wilson, E., Mcdonald, S., et al., 2021. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. Br. Med. J. 1–9. https://doi.org/10.1136/bmj.n71.
Paleari, S., 2024. The EU policy on climate change, biodiversity and circular economy: moving towards a nexus approach. Environ. Sci. Pol. 151, 103603. https://doi.org/10.1016/J.ENVSCI.2023.103603.
Parkinson, N.J., 2022. Malawi Steps up Action Against Illegal Charcoal Trade (Analysis). US Agency for International Development. https://www.climatelinks.org/blog/malawi-steps-action-against-illegal-charcoal-trade-analysis.
Pattanayak, S.K., Wunder, S., Ferraro, P.J., 2010. Show me the money: do payments supply environmental services in developing countries? Rev. Environ. Econ. Pol. 4 (2), 254–274. https://doi.org/10.1093/REEP/REQ006.
Razgour, O., Taggart, J.B., Manel, S., Juste, J., Ibáñez, C., Rebelo, H., Alberdi, A., Jones, G., Park, K., 2018. An integrated framework to identify wildlife populations under threat from climate change. Molecular Ecology Resources 18 (1), 18–31. https://doi.org/10.1111/1755-0998.12694.
Runfola, D., Anderson, A., Baier, H., Crittenden, M., Dowker, E., Fuhrig, S., Goodman, S., Grimsley, G., Layko, R., Melville, G., Mulder, M., Oberman, R., Panganiban, J., Peck, A., Seitz, L., Shea, S., Slevin, H., Youngerman, R., Hobbs, L., 2020. Geoboundaries: a global database of political administrative boundaries. PLoS One. 15 (4), 1–9. https://doi.org/10.1371/journal.pone.0231866.
Saiti, A., Kyle, W.C., Sinnes, A., Nampota, D., Kazima, M., 2014. Developing relevant environmental education in a rural community in Malawi. Revista. Brasileira. Pesquisa Em Educação Em Ciências. 14 (2), 185–198. https://periodicos.ufmg.br/index.php/rbpec/article/view/4360.
Sinclair, S., Rockwell, G., 2024. Voyant tools (v2.6.14). https://voyant-tools.org/?corpus=715b125b34cfcf22113c681d8d74f0c0&stopList=keywords-66a5a6172229fdf2c7a6e0c1c685d02a&whiteList=&view=Cirrus.
Smith, K.R., Bruce, N., Balakrishnan, K., Adair-Rohani, H., Balmes, J., Chafe, Z., Dherani, M., Hosgood, H.D., Mehta, S., Pope, D., Rehfuess, E., 2014. Millions dead: how do we know and what does it mean? Methods used in the comparative risk assessment of household air pollution. Annu. Rev. Publ. Health 35, 185–206. https://doi.org/10.1146/ANNUREV-PUBLHEALTH-032013-182356.
Soto-Navarro, C., Ravilious, C., Arnell, A., De Lamo, X., Harfoot, M., Hill, S.L.L., Wearn, O.R., Santoro, M., Bouvet, A., Mermoz, S., Le Toan, T., Xia, J., Liu, S., Yuan, W., Spawn, S.A., Gibbs, H.K., Ferrier, S., Harwood, T., Alkemade, R., et al., 2020. Mapping co-benefits for carbon storage and biodiversity to inform conservation policy and action. Philos. Trans. R. Soc. B 375 (1794), 1–13. https://doi.org/10.1098/RSTB.2019.0128.
Sovacool, B.K., 2012. Deploying off-grid technology to eradicate energy poverty. Science 338 (6103), 47–48. https://www.science.org/doi/10.1126/science.1222307.
Sussams, L.W., Sheate, W.R., Eales, R.P., 2015. Green infrastructure as a climate change adaptation policy intervention: muddying the waters or clearing a path to a more secure future? J. Environ. Manag. 147, 184–193. https://doi.org/10.1016/J.JENVMAN.2014.09.003.
Su, J., Wang, M., Razi, M.A.M., Dom, N.M., Sulaiman, N., Tan, L.W., 2023. A bibliometric review of nature-based solutions on urban stormwater management. Sustainability. 15 (9), 7281. https://doi.org/10.3390/SU15097281, 2023, Vol. 15, Page 7281.
Su, J., Wang, M., Zhang, D., Yuan, H., Zhou, S., Wang, Y., Adib Mohammad Razi, M., 2024. Integrating technical and societal strategies in Nature-based solutions for urban flood mitigation in guangzhou, a heritage city. Ecol. Indic. 162, 112030. https://doi.org/10.1016/J.ECOLIND.2024.112030.
Tacconi, L., Rodrigues, R.J., Maryudi, A., 2019. Law enforcement and deforestation: lessons for Indonesia from Brazil. For. Pol. Econ. 108, 101943. https://doi.org/10.1016/J.FORPOL.2019.05.029.
The Royal Society, 2021. Climate change and biodiversity: interlinkages and policy options. https://royalsociety.org/news-resources/projects/biodiversity-climate-change-interlinkages/.
Trew, B.T., Maclean, I.M.D., 2021. Vulnerability of global biodiversity hotspots to climate change. Global Ecol. Biogeogr. 30 (4), 768–783. https://doi.org/10.1111/GEB.13272.
Urich, P., Li, Y., Masike, S., 2021. Climate change, biodiversity, and tipping points in Botswana. In: Oguge, N., Ayal, D., Adeleke, L., da Silva, I. (Eds.), African Handbook of Climate Change Adaptation. Springer, pp. 1193–1226. https://doi.org/10.1007/978-3-030-45106-6_161.
US Agency for International Development [USAID], 2023. Malawi Climate Change Country Profile. US Agency for International Development. https://www.usaid.gov/climate/country-profiles/malawi.
Wang, L., Zheng, H., Polasky, S., al Li, X., Yang, W., Sun, T., Sun, C., Xu, S., Qi, W., Adinugroho, W.C., Krisnawati, H., Imanuddin, R., Ayat, A., Wirastami, L.A., Kusmana, C., 2021. Integrating issues of biodiversity and climate change to achieve sustainable forest management: a case of mbeliling landscape, flores. IOP Conf. Ser. Earth Environ. Sci. 914 (1), 012012. https://doi.org/10.1088/1755-1315/914/1/012012.
Wang, M., Sun, C., Zhang, D., 2023. Opportunities and challenges in green stormwater infrastructure (GSI): a comprehensive and bibliometric review of ecosystem services from 2000 to 2021. Environ. Res. 236, 116701. https://doi.org/10.1016/J.ENVRES.2023.116701.
World Bank, 2020a. Energy subsidy reform facility: generates knowledge to support governments to design and implement sustainable energy subsidy reforms while safeguarding the welfare of the poor. https://www.worldbank.org/en/results/2020/11/12/energy-subsidy-reform-facility-generates-knowledge-to-support-governments-to-design-and-implement-sustainable-energy-subsidy-reforms-while-safeguarding-the-welfare-of-the-poor.
World Bank, 2020b. Off-grid solar electricity is key to achieving universal electricity access: the lighting global story. https://www.worldbank.org/en/results/2020/11/10/off-grid-solar-electricity-is-key-to-achieving-universal-electricity-access-the-lighting-global-story.

World Climate Research Programme. (n.d.). Kigali declaration: climate science for a sustainable future for all. Retrieved July 18, 2024, from www.wmo.int.

Zalengera, C., Blanchard, R.E., Eames, P.C., Juma, A.M., Chitawo, M.L., Gondwe, K.T., 2014. Overview of the Malawi energy situation and A PESTLE analysis for sustainable development of renewable energy. Renew. Sustain. Energy Rev. 38, 335–347. https://doi.org/10.1016/J.RSER.2014.05.050.

Zanzanaini, C., Trần, B.T., Singh, C., Hart, A., Milder, J., DeClerck, F., 2017. Integrated landscape initiatives for agriculture, livelihoods and ecosystem conservation: an assessment of experiences from south and southeast Asia. Landsc. Urban Plann. 165, 11–21. https://doi.org/10.1016/J.LANDURBPLAN.2017.03.010.

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