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Mapping the evidence of climate change and biodiversity interventions on environmental and human outcomes in low- and middle-income countries

An evidence gap map

December 2024

Evidence
Gap Map
Report 34

Energy and extractives



International
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About this evidence gap map

This report presents the findings of a systematic search to identify and map the evidence base of impact evaluations and systematic reviews of climate change and biodiversity interventions. The online EGM is available [here](#). All content in this report is the sole responsibility of the authors and does not represent the opinions of 3ie, including its donors or its Board of Commissioners. This report is being published as received from the authors, it has not been professionally copyedited. Any errors and omissions are the sole responsibility of the authors. Please direct any comments or queries to the corresponding author, Pierre Marion, at pmarion@3ieimpact.org.

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Summary of key findings

Climate change and biodiversity loss are two of the most pressing and interrelated environmental challenges of our time. Slow pace to meet international commitments to limit global warming to 1.5°C above pre-industrial levels may increase the likelihood of species extinctions and of irreversible damage to terrestrial, marine and coastal ecosystems. Repeated exposure to severe climate shocks and biodiversity loss can result in long-lasting poverty. Action is urgently needed to address climate change and biodiversity loss as they both represent major threats to human livelihoods and wellbeing (Armand and Kim Taveras, 2022).

An Evidence Gap Map (EGM) provides a systematic and visual overview of the existing evidence, highlighting areas where research is needed and where sufficient evidence already exists. This EGM organises and describes the available rigorous evidence on the effects of climate change and biodiversity interventions on environmental and human wellbeing outcomes in low- and middle-income countries (L&MICs).

The framework for this EGM was developed in collaboration with stakeholders in the conservation and development fields (Gonzalez Parrao et al., 2024a). The scope of the EGM extends across four natural systems and productive activities: i) *land and forests*; ii) *agriculture and livestock*; iii) *aquaculture and fisheries*; and iv) *coasts and oceans*. Interventions covered by the EGM include regulatory frameworks and policies that are designed to limit harmful behaviours and promote incentives and innovations that support efforts to tackle climate change and biodiversity loss. We also consider decentralisation interventions that transfer the management and decision-making authority over natural resources from national to local actors. Our framework also includes interventions providing information and knowledge to promote and disseminate climate and biodiversity innovations. We are also interested in market integration interventions that address barriers and market failures in L&MICs that hinder the dissemination and adoption of climate mitigation, adaptation, and biodiversity-enhancing technologies and practices. The map covers both environmental and human wellbeing outcomes, focusing on biodiversity, climate mitigation measures and on adaptive capacities of individuals and communities in the face of these two crises.

The aim of this EGM is to identify studies evaluating the effects of climate change and biodiversity interventions. Impact evaluations (IEs) provide rigorous quantitative evidence, apt to identify changes attributable to interventions. We included IEs, using experimental or quasi-experimental methods, and systematic reviews (SRs) published in 2000 or after. We follow strict inclusion criteria linked to the studies' methods but also consider studies' participants, interventions, comparison, and outcomes while screening studies. This EGM identifies the extent of the evidence (clusters and gaps in the research) and summarises high-level findings of high and medium confidence SRs but it does not interrogate and draw out the findings of the included IEs.

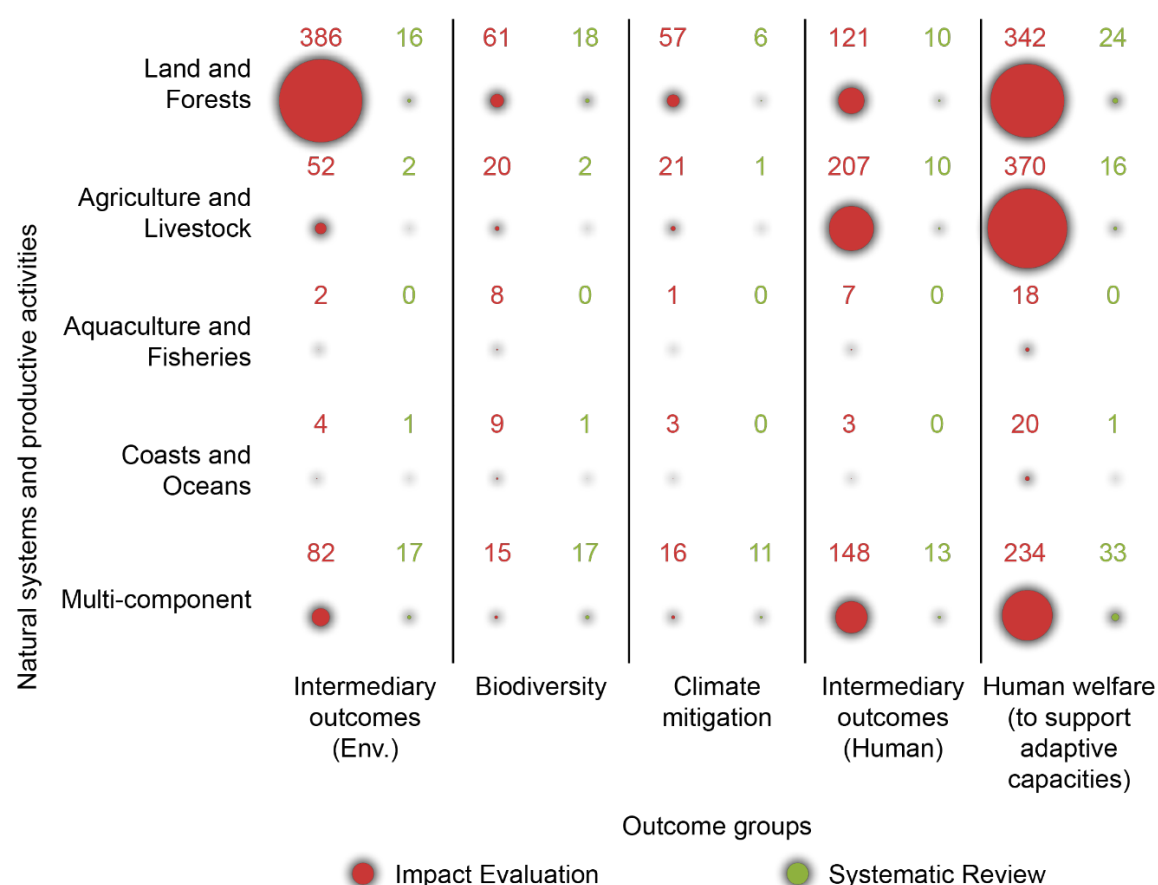
Based on a search for relevant studies in 16 academic databases and 27 grey literature sources, this EGM contains 1,512 IEs and 93 SRs. This literature has significantly expanded over the last decade indicating increased research interest on these topics as well as skills to develop this type of analyses. The number of published IEs has increased year by year, peaking at 192 IEs in 2023. Almost 85% of all IEs emerged after

2014. Extensive evidence is available in a few countries such as China, Ethiopia, Brazil, India and Indonesia but the number of IEs remains limited in many of the countries most exposed and/or vulnerable to climate change.

Clusters of evidence exist within specific *land and forests* and *agriculture and livestock* intervention categories such as *protected areas*, *other land conservation policy*, *land rights*, *community-based or decentralised land management and monitoring*, and *payments for ecosystem services*. Mostly, IEs evaluated the effects of interventions on short-term environmental outcomes and livelihood-related outcomes. In terms of SRs, 10% of the reviews received a confidence rating of high or medium. These studies were concentrated within *land and forests* and *agriculture and livestock* intervention categories. However, significant gaps in the primary research and synthesis analysis are also evident.

Figure 1 summarises at a higher level the distribution of IEs and SRs by combinations of natural system and productive activities and outcome groups. The size of each bubble reflects the number of studies in each pairing and the values next to each bubble report the number of IEs and SRs. For example, 342 IEs and 24 SR's looked at human welfare outcomes relating to interventions in *land and forests* natural systems and productive activities.

Figure 1: Summary distribution of the evidence by intervention-outcome groups



Notes: The size of each bubble reflects the number of studies in each intervention-outcome group. The values represent the number of IEs and SRs in each cell. The total of the values displayed will be larger than the number of studies in the map, as one study may report multiple outcomes.

Policy-makers can use this EGM to identify whether rigorous evidence is available for programme design specific to the context, targeted population and regions of interest:

- Clusters of research exist for a few *land and forests* and *agriculture and livestock* intervention categories, but findings from individual IEs should be interpreted with caution due to possible biases in the reported effects or to local and time-specific factors.
- All high/medium confidence SRs were published at least five years ago. The findings from these reviews may not reflect the most recent climate change or biodiversity evidence and trends related to intervention and implementation advancements. These SRs suggest that specific interventions, such as protected areas, payments for ecosystem services, decentralised land management and farmer field schools may lead to positive effects, but these effects vary extensively across contexts and other factors.

Future research opportunities for IEs and SRs exist in this field. These include conducting rigorous studies within the gaps identified by the EGM:

- All intervention categories, even where there are clusters of primary research, lack a recent high/medium confidence SR.
- Gaps in IEs relate to geographic regional contexts (such as Europe and Central Asia and in the Middle East and North Africa), to ecosystems (*aquaculture and fisheries* and *coasts and oceans*) and specific intervention types (for example, *weather forecasts and environmental disaster alerts*; and *wildlife conservation policy*).
- Other gaps in the evidence include limited reporting of intervention costs, reporting of effects on longer-term environmental outcomes and analyses incorporating equity dimensions.

Contents

Acknowledgements.....	i
Summary of key findings.....	ii
List of figures and tables	vi
Acronyms	vii
1. Background: The climate change and biodiversity crises require immediate and urgent action	1
2. Why this EGM is needed.....	3
3. What are the objectives of this EGM?.....	4
4. Conceptual approach for the EGM.....	4
4.1 Intervention instruments.....	5
4.2 Outcome domains.....	6
5. Methods	7
5.1 Inclusion criteria for studies in the EGM	7
5.2 How we searched for evidence	8
5.3 How we screened and extracted study characteristics	8
6. What we found.....	9
6.1 Search results.....	9
6.2 Characteristics of the evidence base	10
6.3 Appraisal and findings of systematic reviews	20
7. Conclusions.....	23
7.1 Implications for policy-makers.....	25
7.2 Implications for future research.....	26
Online appendix	27
References.....	28

List of figures and tables

Figure 1: Summary distribution of the evidence by intervention-outcome groups	iii
Figure 2: Conceptual framework.....	5
Figure 3: PRISMA flowchart of the systematic search and screening	10
Figure 4: Distribution of studies by publication year and study type.....	11
Figure 5: Geographic distribution of IEs.....	12
Figure 6: World Risk Index 2023	12
Figure 7: Biodiversity Intactness Index 2020	13
Figure 8: Distribution of IEs by study design.....	14
Figure 9: Distribution of IEs by intervention categories and study design (for land and forests; agriculture and livestock)	15
Figure 10: Distribution of IEs by intervention categories and study design (for aquaculture and fisheries; coasts and oceans).....	16
Figure 11: Distribution of IEs by outcome categories.....	17
Figure 12: Distribution of SRs by intervention categories and confidence rate (all natural systems and productive activities)	22
Table 1: Summary of inclusion criteria.....	7
Table 2: Distribution of IEs across natural systems and productive activities.....	15
Table 3: Distribution of SRs by the critical appraisal confidence rate.....	21
Table 4: Evidence synthesis gaps	24

Acronyms

CGIAR	Consultative Group on International Agricultural Research
COP	Conference of Parties
DEP	Development Evidence Portal
EGM	Evidence Gap Map
FCDO/DFID	Foreign, Commonwealth & Development Office of the UK, formerly DFID
GHG	Greenhouse gas emissions
HICs	High-income Countries
IE	Impact Evaluation
IPCC	Inter-governmental Panel on Climate Change
L&MICs	Low- and Middle-Income Countries
PES	Payments for ecosystem services
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
RCT	Randomised Controlled Trial
SDGs	Sustainable Development Goals
SR	Systematic Review
USAID	United States Agency for International Development
WRI	World Risk Index

1. Background: The climate change and biodiversity crises require immediate and urgent action

The Sixth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) highlights the current and rapidly deepening existential crisis of climate change, driven by anthropogenic greenhouse gas emissions (GHG; IPCC, 2023). The rate of climate warming from human activities is unprecedented in the past 2,000 years, and atmospheric concentrations of carbon dioxide have risen by almost 50% since 1750 (Friedlingstein et al., 2019). The past decade was likely the hottest on record, with global surface temperature increasing by 1.09°C since the pre-industrial period (IPCC, 2023). The Conference of Parties (COP) held in Paris in 2015 established a legally binding treaty aiming to limit global warming to well below 2°C, ideally targeting 1.5°C, by the year 2100 compared to pre-industrial levels (UNFCCC, 2023). However, given current emission trends, the world is on a trajectory towards a 3-4°C increase in temperature by the end of the century.

Biodiversity loss is also widespread, accelerating and highly consequential. The rate of species extinction has significantly increased in the last hundred years with an estimated one million animal and plant species currently threatened and at risk of extinction (IPCC, 2023; Dasgupta, 2021; Secretariat of the Convention on Biological Diversity, 2020). Almost half of the natural ecosystems are deteriorating and, specifically, half of coastal wetlands have been lost over the last century (IPCC, 2023). The overexploitation of forests, oceans, and fisheries, and a decline of ecosystem services such as animal pollination and air purification are occurring at an unprecedented rate (IPBES, 2019). These losses are driven by a range of factors, including habitat destruction, pollution, and climate change (IPCC, 2023). The Kunming-Montreal Global Biodiversity Framework (KMGBF) in 2022 set global targets for the preservation, protection and restoration of ecosystems and animal species (Secretariat of the Convention on Biological Diversity, 2022).

Biodiversity losses and climate change are interconnected, with feedback loops that can exacerbate both issues (Secretariat of the Convention on Biological Diversity, 2020). Climate change is affecting every region on Earth, with vast and rapid changes across all natural systems and productive activities. It translates into many extreme weather events, including heatwaves, wildfires, heavy precipitation, droughts, and tropical cyclones with significant immediate impacts on species and ecosystems.

In the longer term, climate change can also exacerbate biodiversity losses by altering ecosystems, reducing the ability of species to adapt (Dasgupta, 2021; IPBES, 2019), and leading to other changes such as the spread of non-native invasive species (Weiskopf et al., 2020). For example, ocean warming and ocean acidification, caused by climate change, have contributed to depleting fish stocks, aquaculture and fisheries (Vollset et al., 2022; Rogers-Bennett and Catton, 2022; World Bank, 2012). The likelihood of species extinction grows with each additional degree of warming. In the ocean, increasing temperatures heighten the risk of irreversible damage to marine and coastal ecosystems. For example, live coral reefs have diminished by nearly half over the past 150 years, and further warming threatens to eradicate almost all remaining reefs (Dasgupta, 2021; WMO, 2021; IPBES, 2019). On coasts, rising sea levels eliminate plant and animal ecosystems (Weiskopf et al., 2020). On land, rising temperatures force

animals and plants to migrate to higher elevations or latitudes, often moving towards the poles, affecting ecosystems (UN, 2024). Biodiversity loss can also result in climate change. For example, deforestation and land use change can contribute to climate change by releasing carbon into the atmosphere, while also reducing the ability of ecosystems to sequester carbon through persisting degradation (Dasgupta, 2021; IPBES, 2019).

The consequences of climate change and biodiversity loss are diverse and deep. Progressive disturbance in the local climatic environment and decline in local biodiversity can significantly harm households' livelihood activities. For example, global food crop production is dependent on animal pollination but continues to decline (IPBES, 2019), and growing seasons are rapidly changing cultivation practices (Minoli et al., 2022). Climate shocks from extreme weather and natural disasters can also result in loss of productive assets or sales of these assets to compensate for income loss. Exposure to severe and frequent shocks progressively reduces households' income-generating capacities, impacting livelihoods and welfare, possibly even leading to poverty-traps (Carter and Barrett, 2006).

Similarly, biodiversity loss represents substantial negative shocks to livelihoods. It is estimated that 20% of the world's population is reliant on wildlife for income and food (IPBES, 2019). Vulnerable populations, including Indigenous Peoples, marginalised communities, and those living in poverty, often rely directly on ecosystems for their livelihoods and are particularly susceptible to disruptions in ecosystem services (IPCC, 2023). Likewise, biodiversity loss may also affect access to traditional medicines and nutritional resources, further impacting the health and wellbeing of these communities (IPCC, 2023; OECD, 2023). All these changes mean that the likelihood of competition for access to resources increases, resulting in greater social tensions (Armand et al., 2019).

Together, climate change and biodiversity loss represent a threat to human livelihoods and wellbeing (Armand and Kim Taveras, 2022). Food security, access to freshwater systems and human health are all affected, with a higher burden on vulnerable populations. Urgent and ambitious actions are needed to limit global warming to 1.5°C above pre-industrial levels. Global climate investment in 2023 was insufficient based on the amounts needed, especially in L&MICs (Oxford Analytica, 2024; OECD, 2023), which are the countries most at risk from these crisis (Bündnis Entwicklung Hilft / IFHV, 2023). Mitigation efforts to reduce GHG emissions must be complemented by adaptation measures to manage the unavoidable impacts. The costs of inaction on climate change will far outweigh the costs of acting (OECD, 2017; IPCC, 2023).



Combating climate change and biodiversity crises are also integrated within the Sustainable Development Goals (SDGs), specifically SDGs 13, 14 and 15. These relate to limiting climate change and its impacts, conserving and sustainably using oceans, seas and marine resources, and protecting, restoring and promoting the sustainable use of terrestrial ecosystems (UNDESA, 2020). Through this EGM, we intend to provide a comprehensive map of the rigorous evidence that has evaluated the connections between climate change, biodiversity, and human wellbeing. In doing so, the EGM can enable policy-makers, practitioners and researchers working in the sector to make evidence-informed decisions towards achievement of these SDGs.

2. Why this EGM is needed

The contemporary policy landscape addressing climate change and biodiversity crises is fraught with challenges and opportunities, especially in L&MICs. Research by Ferraro and Pattanayak (2006) and Prowse and Snilstveit (2010) emphasised the importance of evidence-based interventions in mitigating the risks associated with climate change and biodiversity loss, reducing the likelihood of wasting funds, time, and other resources on ineffective programmes. An EGM is apt in this scenario as it provides a systematic and visual overview of the existing evidence, highlighting areas where research is needed and where sufficient evidence already exists to prioritise future research in terms of IEs and SRs.

Existing studies have contributed significantly to the body of knowledge on climate and biodiversity interventions. For instance, Gonzalez Parrao and colleagues' EGM (2024b) updated a previous map on land use change and forestry programmes, revealing substantial evidence from Sub-Saharan Africa, Latin America, and East Asia and Pacific regions. Similarly, Cheng and colleagues (2023) mapped primary and secondary evidence on nature-based interventions in subtropical and tropical regions, concentrating on ecosystem protection and restoration. Their outcomes included climate change mitigation measures like GHG emissions reduction and carbon sequestration, alongside co-benefits such as biodiversity conservation and social resilience. Berrang-Ford and colleagues (2021) synthesised a vast array of articles on human adaptation strategies to climate change, documenting local-level responses that ranged from behavioural and technical to institutional measures. Meanwhile, the Nature-based Solutions Initiative (NbSI, 2021) provided an evidence map of best practice examples of nature-based solutions for climate adaptation and mitigation, though the case-study approach made attribution of changes to interventions challenging.

Despite these contributions, existing studies exhibit limitations in their coverage, target areas, and outcomes. No study has yet focused on mapping the evidence on the twin crises of climate change and biodiversity and their interactions across multiple natural systems and productive activities over climate mitigation, biodiversity preservation and restoration, and human wellbeing to support adaptive capacities. This gap underscores the necessity of a new, comprehensive EGM that incorporates the data and findings from previous studies.

This EGM is designed to address these gaps by mapping interventions that tackle both climate change and biodiversity loss across diverse ecosystems and productive sectors, and have measured their individual and interacting effects on environmental or human wellbeing outcomes. This endeavour involves synthesising relevant evidence from past studies while ensuring no duplication of efforts by leveraging existing data and collaborating with previous authors where necessary. The EGM and this resulting report are then a resource to guide strategic investments, policy and practice decisions and future research.

What is an Evidence Gap Map (EGM)?

EGMs organise rigorous evidence of effectiveness thematically, aiding policy-makers, practitioners, and researchers in making informed decisions within a specific thematic area. EGMs organise the body of evidence over a framework of interventions and outcomes that represents a theoretical linkage to the concepts of the theme. EGMs improve accessibility to existing evidence, aiding in prioritising future research by mapping studies in a field based on interventions and outcomes. Along with the volume of evidence, EGMs also report the type of evidence (completed or ongoing), impact evaluations (IEs), or systematic reviews (SRs), research gaps, and SR confidence rating reflecting the degree to which SRs followed gold-standard methodology. The results are displayed on 3ie's platform, offering a graphical and interactive representation of the evidence in a matrix form. The interactive map allows users to filter evidence in the EGM by region, country, evaluation method, population characteristics among other options. EGMs do not provide information on interventions' effectiveness and cost-benefit analysis (beyond identifying which studies include cost data).

3. What are the objectives of this EGM?

- Identify and describe impact evaluations and systematic reviews on the effects of climate change and biodiversity interventions on environmental and human wellbeing outcomes in L&MICs
- Identify primary evidence and synthesis gaps
- Characterise the population, settings, design and implementation factors of interventions in the available evidence
- Summarise high-level findings of high/medium confidence SRs

The EGM is available as a resource for policy-makers, practitioners and researchers working in the sector to make evidence-informed decisions. The EGM is available on the open-access Development Evidence Platform (DEP), presented in an interactive format. There are also filters which users can apply to sort the evidence by different dimensions, such as study design, country, population, and other cross-cutting issues, such as gender, inclusion and equity. Appendix A provides more details on how to interpret and interact with EGMs.

4. Conceptual approach for the EGM

The framework for this EGM was developed in Gonzalez Parrao and colleagues (2024a). Global climate change and biodiversity targets and key policy and strategy documents guided the development of the conceptual framework. This was followed by extensive consultations with an Advisory Group of researchers and practitioners (more details on the Advisory Group are presented in Appendix B). It aims to reflect efforts to improve environmental outcomes in terms of climate mitigation and protection, conservation and restoration of biodiversity. This framework also focuses on adaptation of individuals and communities to the impacts of these two crises. The links across mitigation, biodiversity and adaptation justify focusing on them in the same EGM. Often, it is not possible to distinguish whether interventions are specifically aimed to address climate mitigation,

biodiversity crisis, adaptation and human wellbeing. Therefore, we consider efforts across any of these three areas. We restrict the scope of the EGM to four natural systems and productive activities: i) *land and forests*; ii) *agriculture and livestock*; iii) *aquaculture and fisheries*; and iv) *coasts and oceans*. Also, we focus the analysis on L&MICs as they are disproportionately affected by the climate change and biodiversity loss (WMO, 2021).

Figure 2: Conceptual framework

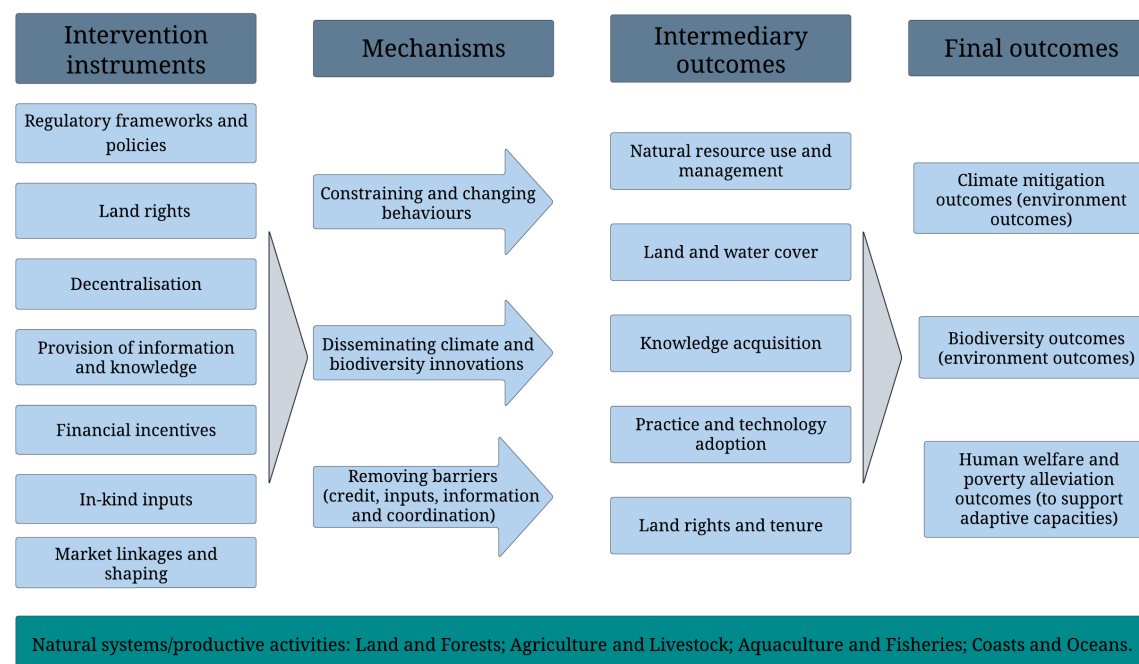


Figure 2 shows the relevant intervention/policy instruments and outcomes across the four natural systems and productive activities included in the map. We discuss below the seven intervention instruments and how they affect the environment and communities through different pathways, notably through constraining and changing behaviours, disseminating climate or biodiversity innovations, and eliminating social and economic barriers. These intervention instruments first aim to improve use and management of natural resources and of local biodiversity through increased knowledge and adoption of improved practices in the short term. Ultimately, these changes should in turn increase climate mitigation, preserve and restore natural resources and improve human welfare outcomes, resulting in more effective climate change adaptation.

4.1 Intervention instruments

4.1.1 Regulatory frameworks and policies, and Land rights

Regulatory frameworks and policies are designed to limit harmful behaviours and promote incentives and innovations that support efforts to combat climate change and biodiversity loss. These interventions, such as *protected areas*, *wildlife conservation policy*, or other conservation policies, encompass conservation efforts across key natural systems and productive activities aimed at protecting the local environment. For instance, *protected areas* safeguard terrestrial ecosystems, while marine conservation policies aim to preserve fish biodiversity. Within conservation policies, we include efforts to restore forests and biodiversity (ecosystems and animal species). Additionally, policies

such as agricultural regulations and fishery quotas influence producers' incentives to adopt responsible management and sustainable practices. Land rights reforms can also significantly impact local environmental management by altering incentives and promoting better stewardship of natural resources.

4.1.2 Decentralisation

Decentralisation involves transferring the management of and decision-making authority over natural resources from national to local actors. Local communities often have a greater economic reliance on these resources and, therefore, a stronger incentive to manage them sustainably. Decentralised management aims to promote the sustainable use of resources and environmental protection. Examples include community-based forest management to reduce deforestation, restore forests and enhance livelihoods, and similar initiatives in coastal and marine areas to protect and restore local biodiversity while supporting sustainable livelihoods. These policies empower local stakeholders to take an active role in conservation efforts, potentially leading to more effective and locally adapted solutions.

4.1.3 Provision of information and knowledge

Interventions focused on providing information and knowledge aim to promote and disseminate climate and biodiversity innovations. This group includes systems for weather forecasting and environmental disaster alerts, which help communities prepare for climatic shocks such as floods, droughts, and wildfires. Additionally, training and extension services facilitate the adoption of improved technologies and practices, enhancing resource use and contributing to climate mitigation, biodiversity conservation and restoration, and adaptation across various natural systems and productive activities. These knowledge-based interventions are crucial for building local capacity and fostering resilience against environmental changes.

4.1.4 Market integration (*Financial incentives, In-kind inputs, Market linkages and shaping*)

Market integration interventions address barriers and market failures in L&MICs that hinder the dissemination of climate mitigation, adaptation, and biodiversity-restoring and enhancing technologies and practices. These interventions include financial incentives such as payments for ecosystem services, subsidies, and cash transfers, which encourage pro-environmental practices. They also provide in-kind inputs like equipment and machinery to overcome credit market failures. Establishing cooperatives and contract farming and fisheries can help address information barriers and create market linkages across value chains. Market shaping instruments, such as results-based finance (e.g., REDD+) and advance market commitments, and weather index insurance can also support adaptation and resilience efforts. These measures aim to integrate local producers into broader markets, enhancing their capacity to adopt sustainable practices and technologies.

4.2 Outcome domains

Our analysis includes environmental and human wellbeing and poverty alleviation outcomes. These two outcome domains are organised in the following sub-groups and categories:

Environmental outcomes:

- Intermediary outcomes include *natural resource use and management*, and *land and water cover* measures
- *Climate mitigation* outcomes include *GHG emissions* and *carbon storage* measures
- *Biodiversity* outcomes cover measures of *environmental status and health*, and measures related to *species complexity* and *habitat structural complexity*

Human wellbeing and poverty alleviation outcomes:

- Intermediary outcomes include measures of *knowledge acquisition, practice and technology adoption* related to mitigation, biodiversity and adaptation, and *land rights and tenure*
- Human welfare outcomes include measures of *productivity; income, assets and basic materials; employment and livelihood; food security; nutrition; health and wellbeing* and *multi-dimensional poverty*. We also include outcomes on *climate risk exposure and resilience*, *access to water* and *clean air*. We finally consider outcomes on *social relations* and *governance and empowerment*. Improvements in these human welfare outcomes may convey a greater ability to adapt to climate change.¹

5. Methods

We adhered to the standards and methods developed by 3ie for EGMs (Snijlsteit et al., 2017; Snijlsteit et al., 2016). A detailed description of the planned screening, data extraction, critical appraisal of SRs and quality assurance is available in sections 3.3 and 3.4 of the EGM protocol (Marion et al., forthcoming).

5.1 Inclusion criteria for studies in the EGM

Table 1 summarises the inclusion criteria used to select studies for the EGM following the PICOS framework (population, intervention, comparison, outcomes and study design). Appendix C provides the detailed inclusion criteria, including definitions for the full list of intervention and outcome categories.

Table 1: Summary of inclusion criteria

Criteria	Description
Population	Studies that evaluated interventions in L&MICs, classified by World Bank income status at the start of the intervention. No limitations on demographic, social or health characteristics.
Interventions	Climate and biodiversity-friendly interventions reflecting the four domains of natural systems and productive activities, namely <i>land and forests; agriculture and livestock; aquaculture and fisheries; and coasts and oceans</i> .
Comparison	Studies must have identified a comparison group (of any type).
Outcomes	Environment outcomes covering intermediary, biodiversity and climate mitigation measures. Human wellbeing and poverty alleviation outcomes covering intermediary and human welfare outcomes, which can support adaptive capacities.

¹ We discuss how the outcomes framework was adjusted relative to the protocol in Appendix E.

Criteria	Description
Study design	IEs using experimental or quasi-experimental methods to estimate effects of an intervention with a counterfactual scenario, attributing changes to the intervention by comparing outcomes to what would have occurred without it. SRs aiming to synthesise the evidence of the effects of a relevant intervention on outcomes of interest.
Publication year	Studies published in 2000 or after.
Language	Studies in any language, although we used search teams in English.
Study status	Published or unpublished studies (grey literature), whether completed or ongoing (i.e., prospective study records, protocols, and trial registrations).

5.2 How we searched for evidence

To identify relevant literature, we conducted a comprehensive search for eligible studies using the standards and methods developed by Snilstveit and colleagues (2016; 2017) for compiling an Evidence Gap Map. Our search was developed in collaboration with an information specialist and referring to the guidance by Kugley and colleagues (2017) on searching for literature to inform these activities. We developed a set of English search terms that were applied to a wide array of electronic academic and institutional databases and repositories. Our search terms combined Boolean terms with a list of keywords related to the map's inclusion criteria. The search strategy and search terms were internally peer-reviewed.

An information specialist conducted a comprehensive search across 16 academic databases between 07 February and 17 March 2024. The search for relevant studies also spanned 27 grey literature sources. Appendix D provides the full list of academic databases and grey literature sources, as well as an example of the search strategy used.² We complemented the search by conducting forward and backward citation tracking of included studies.

5.3 How we screened and extracted study characteristics

We managed the selection of studies for data extraction in EPPI-Reviewer (Thomas et al., 2024), including importing records, de-duplication, training screeners, and screening titles, abstracts, and full texts. Appendix E provides details of the changes made in the implementation of the map, relative to the EGM protocol.

To accelerate the title and abstract screening process, we used EPPI-Reviewer's classifier models feature, which makes use of machine learning to assign a likelihood of inclusion to unscreened records. The training set for the classifiers was obtained from studies screened by the core team at title and abstract from the list of studies identified in 3ie's Development Evidence Portal and from relevant previous studies (Gonzalez Parrao et al., 2024b; Cheng et al., 2023). Full texts were initially double screened, with a third team member resolving any disagreements. Due to the volume of studies found and time restrictions, after half of the studies were double-screened at full text, the remaining studies were single-screened.

² The full list of search strategies used in each source will be publicly available at 3ie's Dataverse.

We systematically extracted data from all included studies using the tool described in the protocol, with key categories becoming filters in the online interactive map. The data extraction process included training coders with data extraction tools, conducting a pilot extraction exercise, and performing main data extraction with ongoing quality checks. To ensure a comprehensive and accurate representation of the included studies, we consolidated relevant information from multiple sources such as linked publications.³ All included SRs were critically appraised with confidence ratings of low, medium or high following the guidelines in Lewin and colleagues (2009) and Snilstveit and colleagues (2017). This appraisal assesses systematic reviews according to criteria relating to the search, screening, data extraction, and synthesis activities conducted, and covers the most common areas where biases are introduced. The tool used for this process is presented in Appendix F. We do not critically appraise impact evaluations, as this is typically beyond the scope of EGMs.

6. What we found

6.1 Search results

We followed the PRISMA guidelines for reporting reviews (Page et al., 2021). Figure 3 shows the number of records found, screened and included in the map. We identified a total of 200,547 records from 16 academic databases and 9,817 records from 27 grey literature databases. Through forward and backward citation tracking, we identified an additional 35,400 records and 1,266 from other relevant sources, which include the work of Gonzalez Parrao and colleagues (2024b) and Cheng and colleagues (2023).

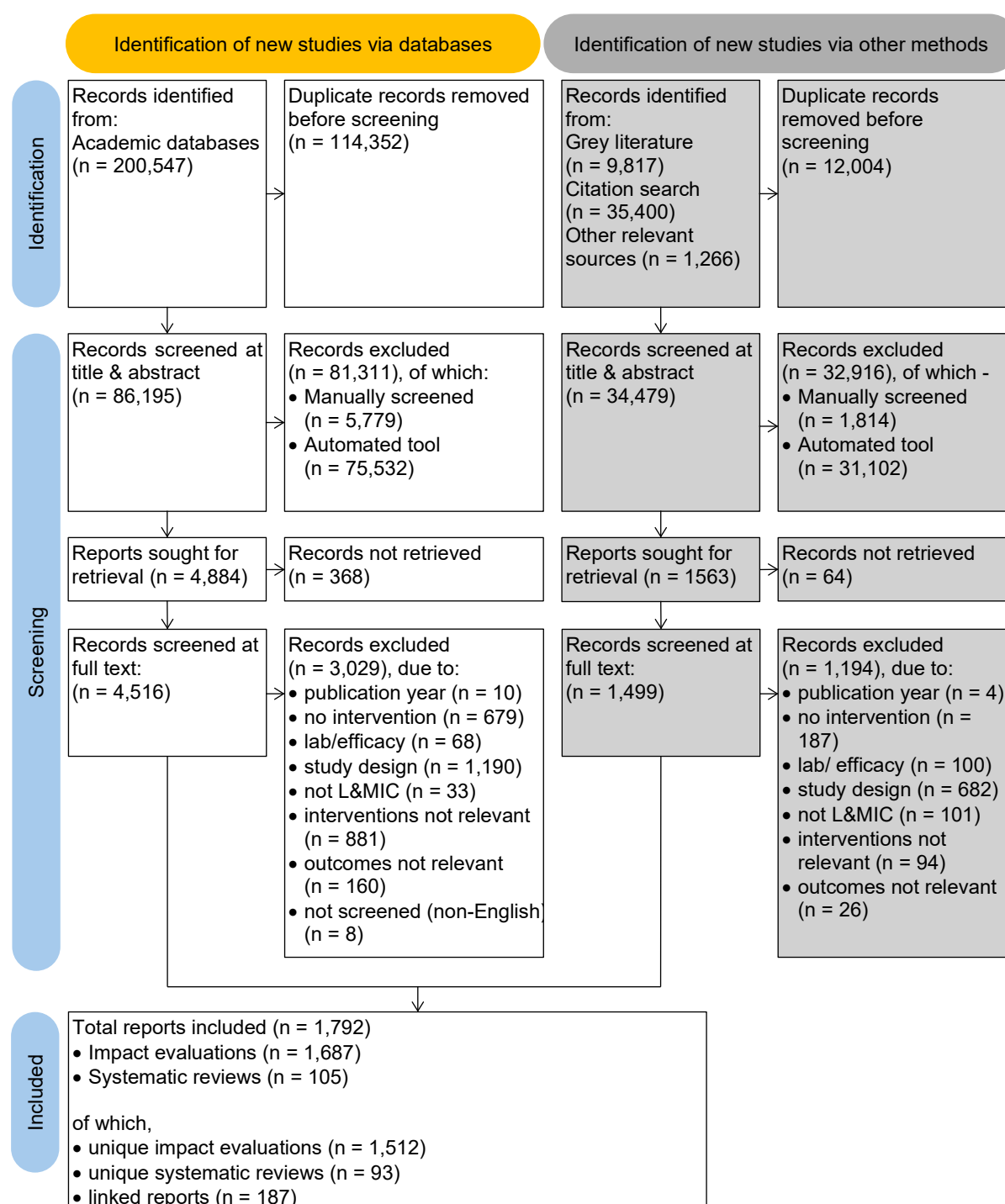
After removing 126,356 duplicate records and identifying linked studies, a total of 120,674 records remained for screening. The high number of duplicates was expected because the search results were not deduplicated prior to importation into EPPI-Reviewer.⁴ Based on initial screening training sets and EPPI Reviewer's classifier tool, we auto-excluded 106,634 records. We excluded 7,593 more records after double, independent screening at title and abstract. A total of 6,015 studies were screened at full text, of which the first half was done by two independent coders. Examples of studies excluded at full text can be found in Appendix G. The full list of excluded studies is available upon request.

We included 1,792 records that met our inclusion criteria: 1,512 unique IEs (59 are ongoing), and 93 unique SRs (including eight review protocols). Hence, the online map shows 1,605 studies. The full list of included studies can be found in Appendix H.

³ Linked publications are different versions of the same unique study (i.e., when the same group of authors publishes more than one paper in relation to one particular study on a specific population). Descriptive information was extracted once for each group of linked publications, drawing on all linked publications so that extraction is as comprehensive as possible. When there are multiple publications from the same study, the publication included in the map is, in most cases, the most recently published peer-reviewed journal article. However, in cases when an older publication from an included study is already indexed in 3ie's DEP, that existing DEP record will be shown in the map.

⁴ We also encountered a series of technical difficulties when retrieving the search results from EBSCO databases. Although we cannot confirm, this may have affected the high number of duplicates identified.

Figure 3: PRISMA flowchart of the systematic search and screening

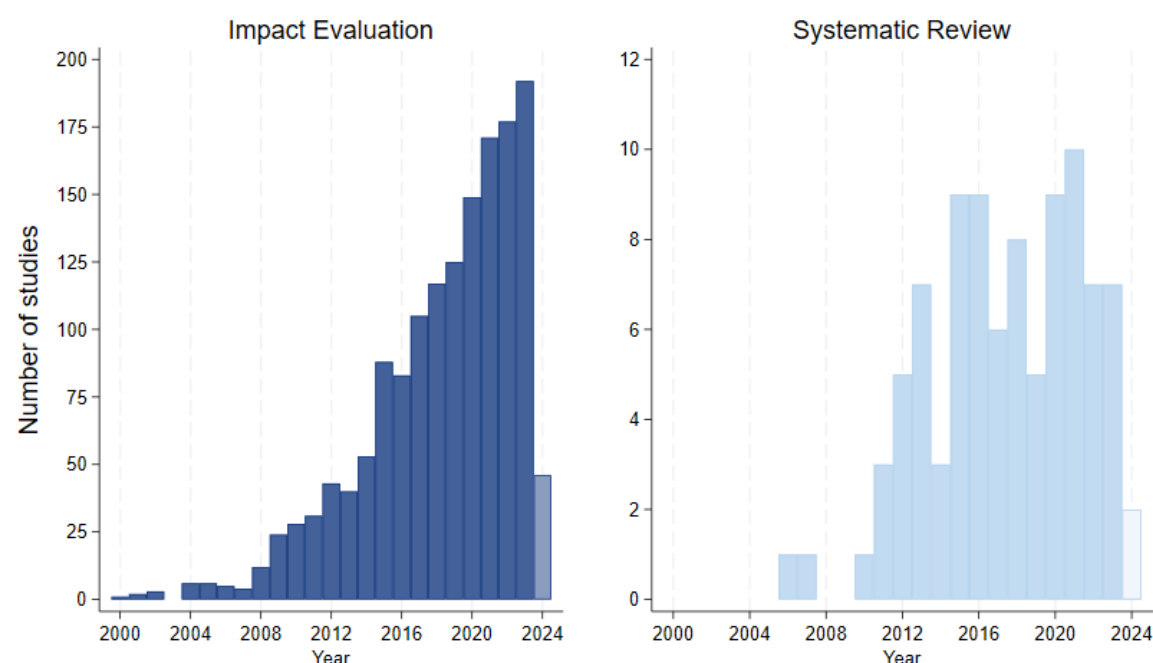


6.2 Characteristics of the evidence base

6.2.1 The number of publications in the sector has significantly increased in the last five years and is driven by a substantial rise in IEs.

Since 2000, the number of IEs has consistently grown relative to previous years, peaking in 2023 with 192 IEs (Figure 4). Almost 85% of all IEs emerged after 2014. The period of 2020-2024 alone produced 38% of all IEs. We do not observe the same trends for the number of published SRs over time. The first SR was published in 2006 and between 2015-2023, the number of published SRs reached seven to ten papers annually.

Figure 4: Distribution of studies by publication year and study type



Note: The number of publications in 2024 is based on early-year data.

6.2.2 Evidence is concentrated in a few countries such as China, Ethiopia, Brazil, India and Indonesia showing a lack of evidence from countries with high vulnerability related to climate change and biodiversity.

Figure 5 shows an uneven geographic distribution of included IEs across regions and countries. A total of 544 papers studied interventions in Sub-Saharan Africa, reflecting just over a third of all included IEs. East Asia and the Pacific follows closely with 461 publications. In other regions, the number of IEs is lower, with 328 IEs in Latin America and the Caribbean and 156 publications in South Asia. We observe 13 IEs focusing on interventions in Europe and Central Asia and three IEs in Middle East and North Africa. Five countries represent 40% of all included IEs, with one-fifth of IEs on China ($n = 309$). The other four countries are Ethiopia ($n = 128$; 8%), Brazil ($n = 125$; 8%), India ($n = 93$; 6%) and Indonesia ($n = 60$; 4%). Sixty-three IEs evaluated interventions in multiple countries.

Across the 45 Least Developed Countries (LDCs) as classified by the United Nations, we did not find any IEs or SRs for 15 countries.⁵ Out of the 1,605 included IEs and SRs in this EGM, 466 evaluated interventions in LDCs (29%, 453 IEs and 13 SRs). More than a quarter of these IEs took place in Ethiopia ($n = 125$, 28%). The next four countries with the most IEs were Uganda ($n = 40$), Malawi ($n = 37$), Zambia ($n = 34$) and Tanzania ($n = 29$). We included IEs and SRs from seven countries within the 39 Small Island Developing States.⁶ Within these countries, we observe ten IEs and one SR, with three IEs in Haiti, and two IEs each in Dominican Republic and Guyana.

⁵ Angola, Central African Republic, Comoros, Djibouti, Eritrea, Guinea-Bissau, Kiribati, Lao PDR, Myanmar, Solomon Islands, Sudan, Togo, Timor-Leste, Tuvalu and Yemen.

⁶ Singapore was not considered in this EGM as it is classified as a high-income country since 1987.

Figure 5: Geographic distribution of IEs

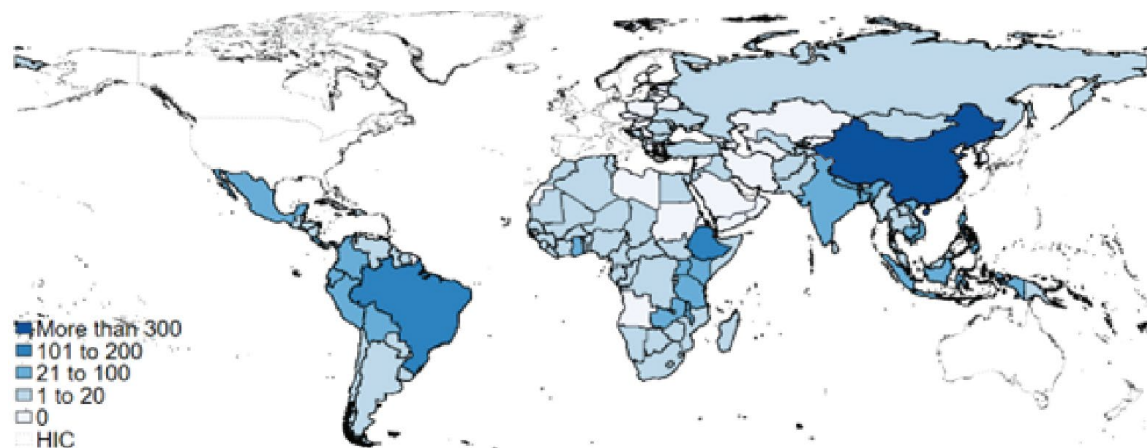
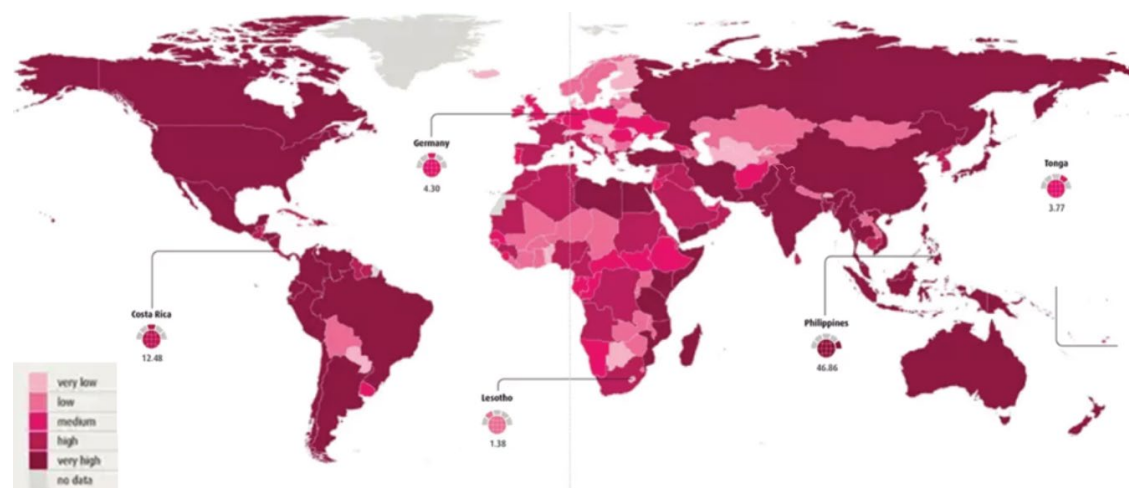


Figure 6: World Risk Index 2023



Source: Bündnis Entwicklung Hilft / IFHV, 2023. Colours of countries in this map are based on specific ranges of the World Risk Index scores (Very low: 0-1.84; Low: 1.85-3.20; Medium: 3.21-5.87; High: 5.88-12.88; Very high: 12.89-100).

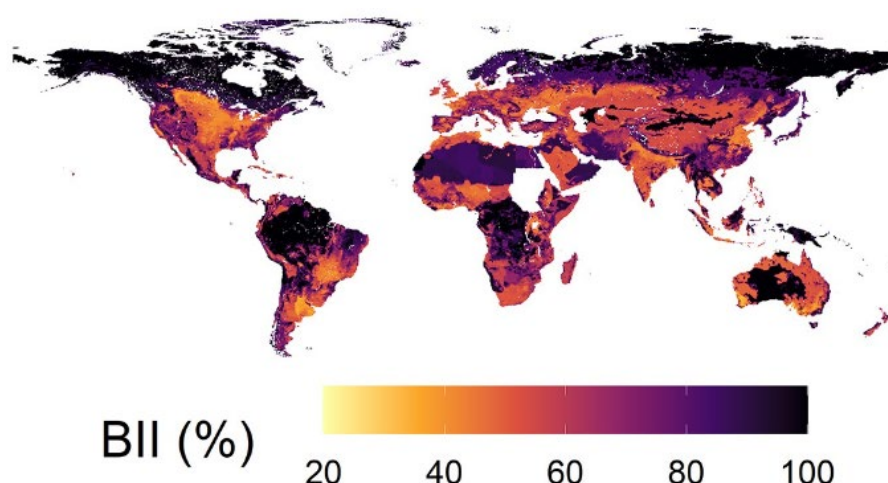
A comparison between the number of included IEs per country and the risk, exposure, and vulnerability levels to natural extreme events (based on the World Risk Report, Bündnis Entwicklung Hilft / IFHV, 2023) reveals that these factors may not be the key determinants for producing research in this literature (Figure 6). While some countries with high World Risk Index⁷ (WRI) scores receive extensive research focus, significant gaps remain. For example, China and India are ranked tenth and third on the WRI, and show substantial research activity (305 and 93 IEs were conducted in these countries, respectively). However, other high-risk countries have less research attention. Philippines (46.86 index score) and Indonesia (43.50 index score) had the highest WRI scores in 2023, yet we identified relatively fewer studies conducted in these countries (21 and 56 IEs studies, respectively).

⁷ The World Risk Report index is based on two factors: exposure to natural disasters and vulnerability. The latter includes three indicators: susceptibility caused by socio-economic factors, lack of coping capacities and lack of adaptive capacities. A high index score represents higher risk and exposure levels to natural extreme events. Lower scores represent less risk. All scores range between 0 and 100.

The WRI is composed by two main elements: exposure and vulnerability. Countries that score high in one element but low in the other can still have an overall low risk level. Such is the case of countries like Somalia, South Sudan, and the Central African Republic, which have the highest vulnerability scores worldwide (73.63, 72.19 and 70.67, respectively) but show a lower risk index (25.09, 4.25, 3.36 respectively). The EGM shows that these countries have limited available evidence. In turn, Ethiopia, with a relatively high vulnerability score of 65.44, concentrates more than a hundred IEs.

The evidence in the EGM is then compared with the areas with higher biodiversity loss. A third of the IEs identified focused on East Asia and the Pacific, and based on the Biodiversity Intactness Index⁸ figures for 2020 (Natural History Museum, 2022, Figure 7), East-Asia shows the lowest index score (63%) compared to the other regions covered in the map. Sub-Saharan Africa, the region with the highest number of studies, shows an index score of 77%, the same as the global average for 2020⁹. The geographical distribution of IEs is therefore not directly linked to lower measures of Biodiversity Intactness. Regions with the lower index scores, such as East-Asia, deserve greater focus. At the country level, four of the top-five countries with the highest number of IEs in the map show an index score below the global average (China = 64%; Brazil = 75%; India = 62%; Indonesia = 71%).

Figure 7: Biodiversity Intactness Index 2020



Source: Natural History Museum (2022)

6.2.3 Quasi-experimental designs dominate the research in this field, with 85% of total IEs.

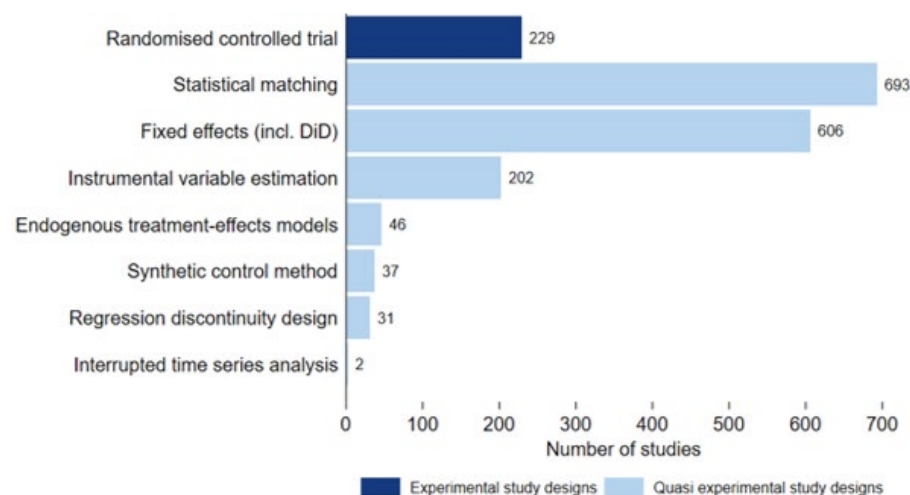
From a total of 1,512 IEs, most were based on a quasi-experimental design, usually statistical matching (n = 693; Figure 8) and fixed effects models including difference-in-difference (DiD; n = 606). Less than a fifth of papers used experimental designs (n = 229). IEs with instrumental variable estimations (n = 202) and regression discontinuity

⁸ The Biodiversity Intactness Index estimates the proportion of original species, and their abundance, that remain in an area after human pressures. The index ranges from 0-100%, with higher levels indicating a larger area of natural biodiversity remaining intact.

⁹ The global average is the average value of the Biodiversity Intactness index score across all countries with available data that year.

designs ($n = 31$) are also less common.¹⁰ While we searched for quantitative impact evaluations, we found that, less than one-fifth of the papers also reported findings from qualitative research methods ($n = 236$).

Figure 8: Distribution of IEs by study design



Around one-third of the IEs incorporated geospatial data for analysis ($n = 438$). Studies using this type of data show an upward trend, in line with the rise in the number of published studies on the map. Many of these studies used quasi-experimental designs ($n = 409$), mostly statistical matching techniques or fixed effects models, including DiD. While it would be typical for quasi-experimental papers to use geospatial data due to their need to control for spatial confounding and matching precision, experimental studies also reported valuable uses for geospatial data. Examples of experimental designs using geospatial data include measuring forest cover changes in treatment and control areas using satellite data from, for example, Sentinel-1 and 2, RapidEye, and PlanetScope (Jack et al., 2022; Christensen et al., 2021; Eisenbarth et al., 2021).

6.2.4 A significant share of the evidence (77%) relate to land and forests and agriculture and livestock, but even in these areas gaps remain.

Around half of the IEs focused on interventions within *land and forests* (46%; Table 2), while almost a third of IEs evaluated *agriculture and livestock* interventions (31%). For *aquaculture and fisheries* and *coasts and oceans*, we found a relatively low number of IEs representing 2% each among included IEs. Almost twenty percent of IEs evaluated interventions with multiple components. These IEs mostly focused on two or more intervention categories within *agriculture and livestock* ($n = 153$) or two or more intervention categories within *land and forests* ($n = 70$). Less than a fifth of multi-component IEs ($n = 59$) evaluated interventions across more than one natural system or productive activity. Around two-thirds of multi-component interventions combined training

¹⁰ To provide an example of studies with an instrumental variable estimation, Du and colleagues (2023) evaluated the effect of a video extension intervention aimed at increasing adoption of environmentally-friendly farming technique systems. Authors used the proportion of other farmers in the village who have received video extension except the interviewed farmer to instrument for participation in the video extension intervention. In turn, de Janvry and colleagues (2016) used a regression discontinuity design, in which they exploited the thresholds determined in a weather index insurance to evaluate the effect of the insurance payments in Mexico.

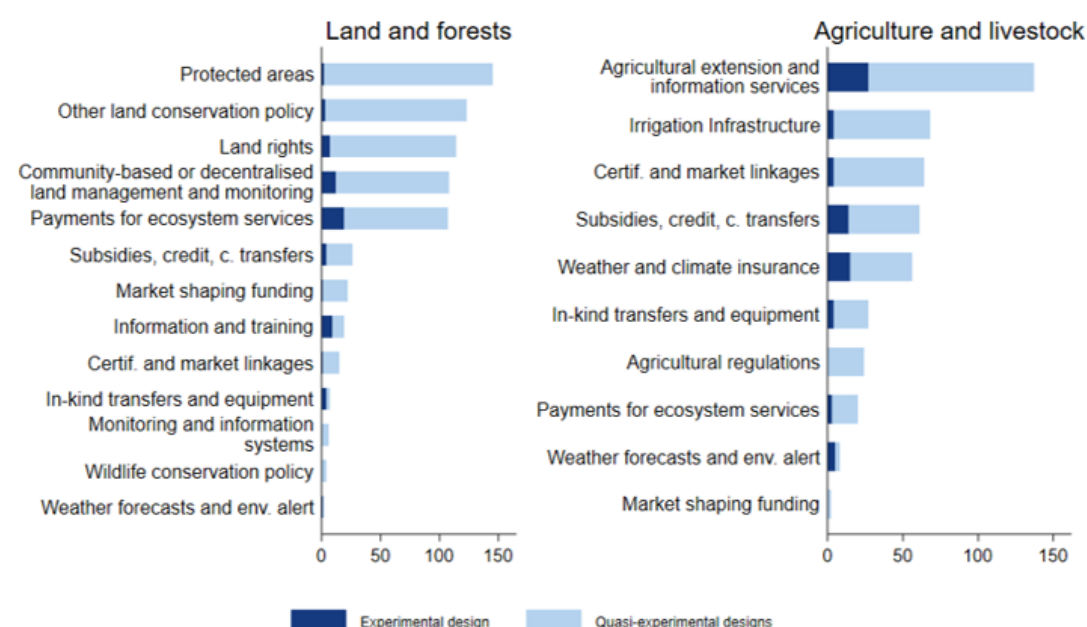
or extension interventions¹¹ with a range of other activities (n = 183), or paired *subsidies, credit, and cash transfers* interventions¹² (n = 40) with other activities. The remaining 69 IEs evaluated other combinations of intervention categories.

Table 2: Distribution of IEs across natural systems and productive activities

Natural systems and productive activities	Number of IEs	%
Land and Forests	698	46%
Agriculture and Livestock	470	31%
Aquaculture and Fisheries	24	2%
Coasts and Oceans	28	2%
Multi-component interventions	292	19%

Despite having the highest number of IEs relative to the other natural systems and productive activities, the evidence on interventions within *land and forests* is mainly focusing on a few intervention categories, meaning that other intervention categories are much less studied (Figure 9). *Protected areas* (n = 145; 10% of IEs), *other land conservation policy* (n = 123; 8%), *land rights* (n = 114; 8%), *community-based or decentralised land management and monitoring* (n = 108; 7%) and *payments for ecosystem services* (n = 106; 7%) were the most evaluated intervention categories. In *agriculture and livestock*, the intervention categories with the most IEs were: *agricultural extension and information services* (n = 136; 9%), *irrigation infrastructure* (n = 67; 4%), *certification and market linkages* (n = 64; 4%), *subsidies, credit, and cash transfers* (n = 60; 4%) and *weather and climate insurance* (n = 56; 4%, Figure 9).

Figure 9: Distribution of IEs by intervention categories and study design (for land and forests; agriculture and livestock)



¹¹ These comprise the following categories: *information and training* for *land and forests*, and *coasts and oceans*; and *traditional and digital extension and information services* for *agriculture and livestock*, and *aquaculture and fisheries*.

¹² All four natural systems and productive activities included this intervention category.

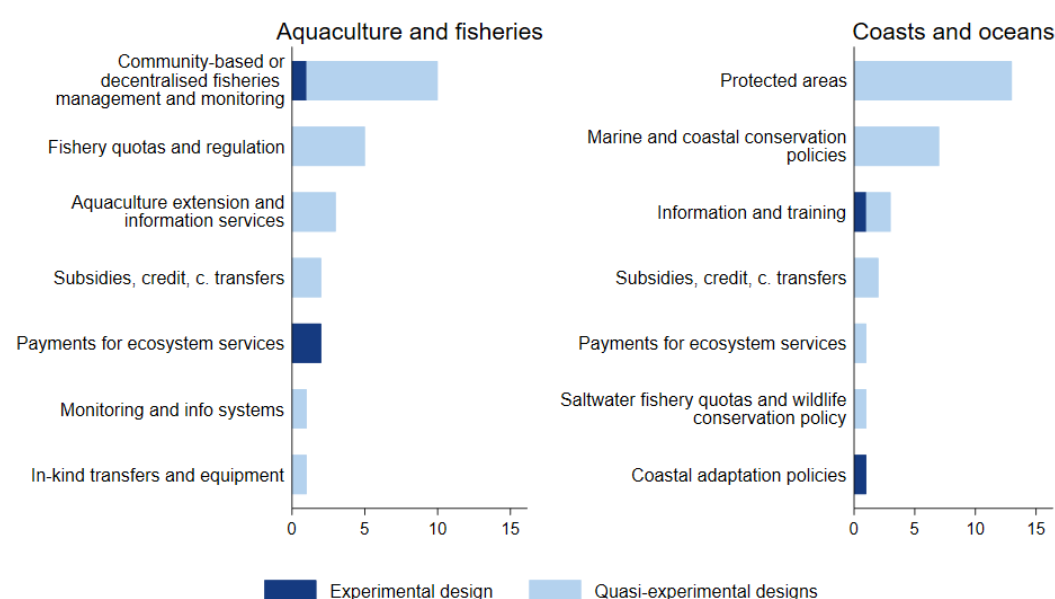
A few IEs reported effects on intervention categories such as *wildlife conservation policy* (n = 4), *weather forecasts and environmental disaster alerts* in both *land and forests* (n = 2), and in *agriculture and livestock* natural systems and productive activities (n = 7). We did not find any IEs in the following intervention categories: *digital agricultural extension and information services* and *monitoring and information systems in agriculture and livestock*.

The proportion of IEs with experimental study designs is low (most often, less than 15%) within all *land and forests* and *agriculture and livestock* intervention categories. Across intervention categories with more than 10 IEs, studies with experimental designs exceeded 20% only for three intervention categories: *information and training* (47%) within *land and forests*, and *weather and climate insurance* (27%) and *subsidies, credit, and cash transfers* (22%) within *agriculture and livestock*.

6.2.5 The evidence on aquaculture and fisheries and coasts and oceans is very sparse.

Figure 10 illustrates the limited available evidence within these two natural systems and productive activities. In all intervention categories, the number of IEs is less than 15. Across *community-based or decentralised fisheries management and monitoring*, and *fishery quotas and regulation*, we found ten and five IEs, respectively. In *coasts and oceans*, thirteen IEs focused on *protected areas* and seven IEs evaluated *marine and coastal conservation policy* interventions. We did not find any IEs in *digital aquaculture extension and information services*, *weather forecasts and environmental disaster alerts*, *market shaping funding*, *certification and market linkages* in *aquaculture and fisheries*. Similarly, there were no IEs in *community-based monitoring*, *weather forecasts and environmental disaster alerts*, *in-kind transfers and equipment*, *market shaping instruments*, *certification and market linkages* and *monitoring and information systems* in *coasts and oceans*. In the other intervention categories, the available evidence did not exceed five IEs. The number of studies using experimental designs to evaluate interventions in *aquaculture and fisheries* and *coasts and oceans* is low.

Figure 10: Distribution of IEs by intervention categories and study design (for aquaculture and fisheries; coasts and oceans)

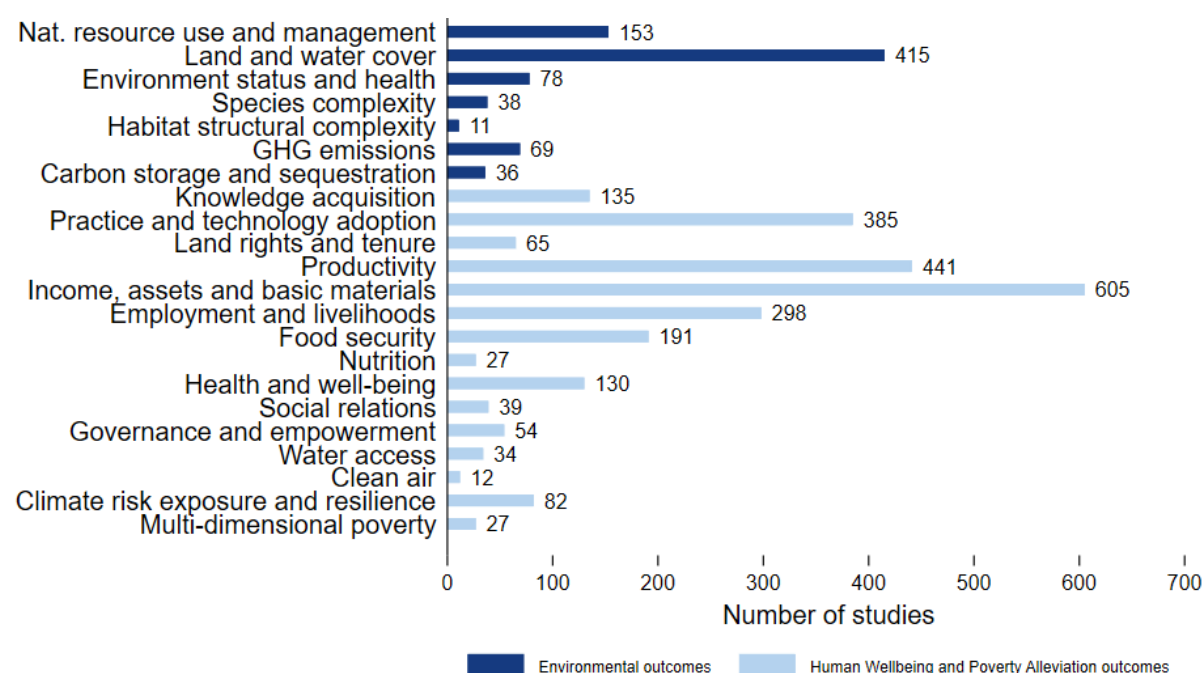


6.2.6 Environmental outcomes mostly relate to intermediary measures, such as natural resources management and land and water cover outcomes.

Over a third of the 1,512 included IEs provided a measure for intermediary environmental outcomes, making it the most prevalent outcome sub-group (n = 527; 35%, Figure 11). At the outcome group level, we note that over a quarter of IEs provided a measure of *land and water cover* outcomes (n = 416; 28%) with a large majority of those studies focusing on *land and forests* (n = 336). This outcome group is followed by *natural resources use and management* outcomes (n = 153; 10%). For example, Alix-Garcia and colleagues (2015) analysed the effects of Mexico's federal payment for hydrological services programme (PSAH) between 2003 and 2011 on forest cover. In Tanzania, Persha and Meshack (2016) analysed the effect of Tanzania's joint forest management (JFM) on restoring forest, improving livelihoods and strengthening local governance. Another example includes the work of Kahsay and colleagues (2023), who analysed the effects of a community-based forest management in Ethiopia on conservation outcomes.

Although all environmental outcome groups are represented in the EGM, *biodiversity outcomes* (n = 113; 8%) and *climate mitigation* measures (n = 99; 7%) are covered by a smaller number of IEs. This is particularly critical for *habitat structural complexity* (n = 11; 1%), *carbon storage and sequestration* (n = 36; 2%), and *species complexity* (n = 38; 3%). Despite their high absolute number of studies, other outcomes such as *GHG emissions* (n = 70; 5%) and *environment status and health* (n = 78; 5%), represent a relatively small portion of the body of evidence. Examples of studies focusing on these outcome categories include the work from Xiaoyao and colleagues (2023) on the effect of the Chinese protected area Pudacuo National Park on water conservation, soil conservation, carbon storage, and habitat quality outcomes. Sharma and colleagues (2015) also assessed the effect of REDD in Nepal on forest carbon stocks, forest ecology, forest product extraction and livelihood outcomes.

Figure 11: Distribution of IEs by outcome categories



6.2.7 Human wellbeing outcomes are mostly related to livelihoods measures.

We observe a large cluster of evidence on human wellbeing outcomes (n = 1,150; 76%; Figure 11). Over two-thirds of the included studies provide a measure under the *human welfare (to support adaptive capacities)* outcome group (n = 984; 65%) and on *intermediary outcomes* (n = 487; 32%). The analysis of outcome categories reveals a number of gaps and clusters. The most prevalent groups include *income, assets and basic materials* (n = 605; 40%), *productivity* (n = 441; 29%), *practice and technology adoption* (n = 386; 25%) and *employment and livelihoods* (n = 229; 15%). Relative gaps include *clean air* (n = 12; 1%), *water access* (n = 34; 2%), *nutrition* (n = 27; 2%), *multidimensional poverty*¹³ (n = 27; 2%), *social relations* (n = 39; 3%), or *governance and empowerment* (n = 53; 3%). Tobacman and colleagues (2017) performed a rigorous evaluation of the long-term impacts of rainfall insurance access and coverage in India on outcomes related to agricultural investment, consumption and wellbeing. Another example is the work from Ring and colleagues (2018) on the effect of the new irrigation structures created through the Menabe and Melaky development programme in Madagascar. They analysed the effects of the intervention on water delivery and access to extension services, and the ability to crop in more than one season.

6.2.8 Climate, biodiversity and human wellbeing are strongly linked but IEs mostly measured outcomes from one of these groups.

We found that a majority of IEs evaluated the effect of interventions only on climate (n = 34; 2%), biodiversity (n = 14; 1%) or human wellbeing outcomes (n = 860; 57%). Sixteen percent of IEs (n = 241) reported at least one environmental outcome and one human wellbeing outcome. Across these 241 IEs, the two most prevalent intervention categories were: *community-based or decentralisation of land management and monitoring* (n = 32) and *land and forests payments for ecosystem services* (n = 28). Dikgang and Muchapondwa (2016), for example, assessed how land redistribution affected whether households had access to nature, per capita income and household poverty status. Eleven IEs (1%) included both climate and biodiversity outcomes. Luintel and colleagues (2018), for example, examined the effect of community forestry in Nepal on both aboveground tree and sapling carbon (in tonnes of carbon per hectare) and numbers of species present. The evidence base focusing on the effects on climate mitigation, biodiversity and human wellbeing is therefore limited, indicating another gap in the primary studies literature.

6.2.9 A large majority of studies do not account for equity in their research designs.

Almost nine out of ten studies (IEs and SRs) do not address a gender or other equity dimensions¹⁴ in their research designs (n = 1,410; 88%), revealing an important evidence gap. Among studies with an equity dimension, the most prevalent approach is

¹³ *Multidimensional poverty* outcomes are measures of poverty that integrate multiple indicators into an index, including, for example, household health, education, assets ownership, access to hot water, type of dwelling, employment status, etc. Measures of poverty based on income or assets only are included in the outcome category *income/assets/basic materials*.

¹⁴ 3ie's data extraction protocol assesses how IEs and SRs address equity considerations to understand different conditions that individuals may face and that affect their vulnerability. We define *equity* as the absence of avoidable and unfair conditions between or among people that hinder or prevent them from attaining their full potential. We analyse the specific approaches and methodologies used by authors to incorporate these dimensions in their research and findings.

to conduct heterogeneity analyses¹⁵ (n = 128), commonly through a sub-group analysis by sex (n = 48). Sub-group analyses by sex are particularly prevalent among studies analysing the effect of *agricultural extension and information services* (n = 21) and for measures of *productivity* (n = 23) and *income, assets and basic materials* (n = 27) outcomes. An example of this is the work from Buehren and colleagues (2019), who analysed the effect of the Rural Capacity Building Project in Ethiopia on access to extension services by gender of the household head.

Other approaches to equity consist in adopting an equity-sensitive analytical framework (n = 20), research process (n = 15), or methodology (n = 12).¹⁶ Once again, those approaches are prevalent among studies focusing on *agricultural extension and information services* (n = 12) and on *productivity* and *income*-related outcomes (n = 17 & 32, respectively). For example, Call and Sellers (2019) adopted a gender-sensitive approach in their systematic review of sustainable natural resource-based livelihood initiatives. They synthesised articles that addressed sex differences in intervention adoption, participation and outcomes.

Among the limited number of studies with an equity focus, five percent focused on sex as an the equity dimension (n = 82), which is mostly considered in studies focusing on *agricultural extension and information services* (n = 14), and *land rights* (n = 12). Another five percent of studies looked at socio-economic status (n = 72). Studies providing information on this equity dimension mostly focused on *payments for ecosystem services* (PES; n = 13) and *irrigation infrastructure* (n = 11). For example, Dang and NaRanong (2019) analysed the effect of a PES scheme in Vietnam, focusing on the effect of the intervention on financial capital, and disaggregated the results between non-poor and poor households.

Other equity dimensions included the place of residence (n = 29), age (n = 18), land size (n = 11), head of household (n = 12) or land ownership (n = 11). However, we observe gaps related to ethnicity, social capital, caste, culture, conflict-affected situations, HIV/AIDS, disability and religion, as they are all covered by less than 10 studies. For example, the study from Gurney and colleagues (2015) is the only one in the map considering religion in their analysis of a community-based marine protected area project in Indonesia. Their study evaluated the socio-economic effects of this intervention by religion (Christianity and Islam). The EGM includes 45 IEs and one SRs that refers to indigenous communities (based in their title or abstract). Thirteen of these IEs focused on interventions in Brazil (followed by four in Bolivia and another four in Ecuador) and 80% of these IEs evaluated interventions within *land and forests* natural systems and productive activities (notably *land rights*, and *payments for ecosystem services*).

¹⁵ Heterogeneity analyses refer to the examination of the variation of an intervention effect across different subgroups, context, or specific characteristics (e.g. sex, fragile context, age). It can be implemented by splitting data into sub-groups to make comparisons between them or by other methods, (e.g. interaction term for treatment and characteristics, quantile regressions, marginal effects).

¹⁶ An equity-sensitive analytical framework would discuss the role of drivers of equity considerations in the intervention and study context, and would embed it in the analysis framework or theory of change. An equity-sensitive research process would address potential influences of gender and equity considerations during, for example, data collection. An equity-sensitive methodology would explore differential effects based on social or structural inequality.

6.2.10 Evidence on the research or projects funding, and implementation agencies is not consistently reported.

While the EGM studies usually report who implemented the project (59% of studies provided this information), 38% of the studies reported how the intervention was funded. Government agencies, including those for which we identified a large number of studies (e.g., China, Brazil, Ethiopia) are the most common project implementers and funders. International aid agencies, for example USAID and the World Bank Group, are also frequently reported as project funders.

The organisations funding the studies included in the map show a similar trend: government and international aid agencies are frequent commissioners of this research, including the National Natural Science Foundation of China, USAID, the US National Science Foundation, FCDO, 3ie, and CGIAR.

6.2.11 Studies mainly evaluated interventions implemented at a local level and in rural settings.

Close to half of the evidence focused on interventions implemented at the local or community level (n = 770; 48%). Other prevalent intervention scales included provincial or regional level (n = 516) and national level (n = 351). We observe a lower number of studies reporting on the implementation of interventions at the transnational level (n = 47). A large majority of interventions were implemented in rural settings (n = 1,420; 88%), while other settings had relatively limited evidence, such as urban (n = 67) or peri-urban settings (n = 19).

Most of the studies targeted the whole population and not specific sex/gender groups. One study reported targeting men and 21 studies reported targeting women. The remaining studies did not specify this information or targeted the whole population. Similarly, the majority of the evidence base did not target specific age groups (n = 1,534; 96%) and a small proportion of studies explicitly targeted people older than 19 years-old (n = 54; 3%).

6.2.12 Despite a higher prevalence compared to other sectors, cost reporting remains an evidence gap.

A large majority of IEs and SRs do not report information related to the cost of the interventions (n = 1,165; 73%). Although we observe a gap in cost reporting, we note that the proportion of studies reporting this information is higher than in recent benchmarks in international development literature, where approximately one in five IEs integrated cost information into their evaluations (Brown and Tanner, 2019). For the studies providing information on the cost of the interventions, 90 studies provided a cost-effectiveness analysis, followed by 75 studies reporting the total budget of the intervention. The intervention categories with the highest prevalence of cost data reporting are *payments for ecosystem services* (n = 60) and *agricultural extension and information services* (n = 33).

6.3 Appraisal and findings of systematic reviews

6.3.1 Critical appraisal and interventions of included SRs

We found 93 SRs synthesising climate change and biodiversity interventions on environmental and human wellbeing outcomes in L&MICs. The majority of the SRs (81%;

Table 3) were appraised as having low confidence.¹⁷ Common issues in these SRs were identified in the analysis method, as many of them used descriptive approaches or vote counting to synthesise the evidence from primary studies. In addition, information reported on the databases searched and the criteria used for the quality/risk of bias assessment of primary studies were often missing or incomplete. Less than half of high/medium confidence SRs are from academic sources (and therefore, most probably peer-reviewed). For low confidence SRs, this rises to 80%, hence, the absence of the peer-review process is not likely to be driving the low rate of these SRs. Government agencies and international aid agencies funded, respectively, 28% and 20% of these low confidence SRs.

Out of the eight ongoing SRs, the protocols were published between 2012 to 2023. Five were published before 2017, while three were published in the last three years: Saran and colleagues (2022) wrote a protocol on a SR on interventions promoting resilience through climate-smart agricultural practices for women farmers; Zain and colleagues (2022) focused on marine site protection on poverty of coastal communities in Southeast Asia; and Konci and colleagues (2023) outlined an SR on coastal and terrestrial water-sector interventions in developing countries.

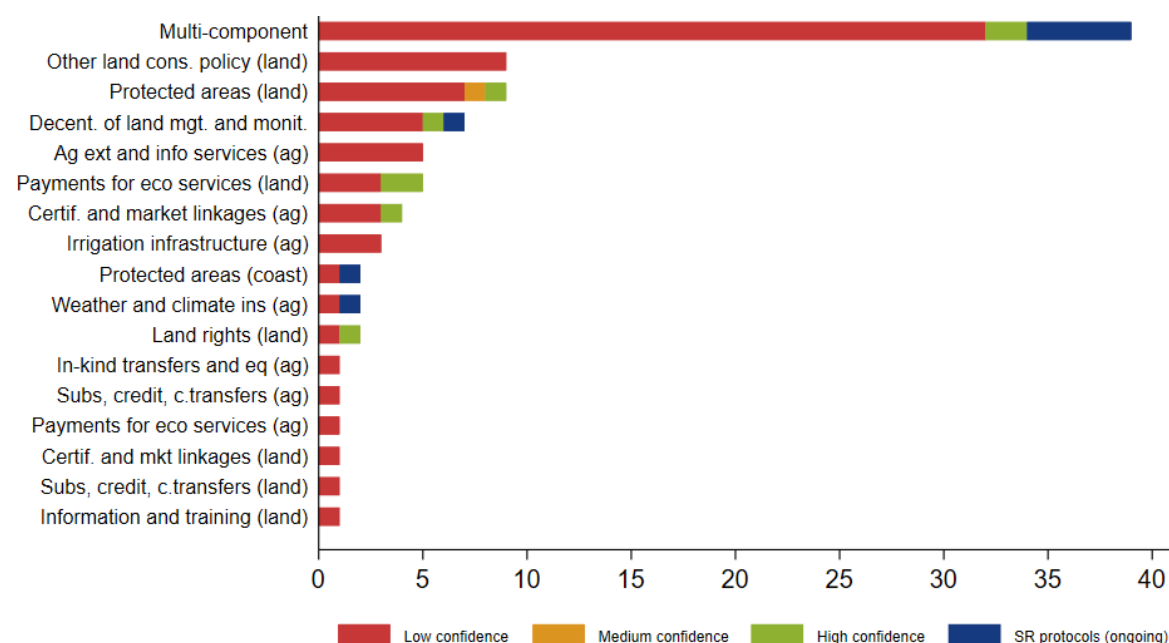
Table 3: Distribution of SRs by the critical appraisal confidence rate

Critical Appraisal	Number of SRs	%
High confidence	8	9%
Medium confidence	1	1%
Low confidence	76	81%
SR protocols (ongoing)	8	9%

Across the 93 SRs identified in the map, 39 synthesised the effects of multiple intervention categories (Figure 12). Among the 32 low confidence SRs evaluating multiple interventions categories, the most prevalent category combinations were *agricultural extension and information services* associated with other *agriculture and livestock* interventions (12 SRs, 38%). Other prevalent interventions evaluated by SRs are within the *land and forests* system: *protected areas* (n = 9), *other land conservation policy* (n = 9), and *community based or decentralised land management and monitoring* (n = 7).

¹⁷ Within the development sector, this is a high rate. For example, about 55% of appraised SRs in 3ie's DEP, which span across all development sectors, are low confidence.

Figure 12: Distribution of SRs by intervention categories and confidence rate (all natural systems and productive activities)



Of the nine high/medium confidence SRs, two focused on the effects of *payments for ecosystem services* and two covered *protected areas* within *land and forests*. We identified one SR for each of these interventions: *land rights* and *community based or decentralised land management and monitoring* within *land and forests*, and *certification and market linkages* within *agriculture and livestock*. Two SRs synthesised effects from a combination of intervention categories.¹⁸ We did not identify any high or medium confidence SRs on interventions in *aquaculture and fisheries* or *coasts and oceans*.¹⁹

6.3.2 Main findings of high and medium confidence SRs

While findings from high/medium confidence SRs suggest the potential for some land or agricultural interventions to improve income, productivity or deforestation outcomes, authors suggest interpreting these findings with caution. Appendix I provides more information on these nine SRs, including detailed findings and geographic coverage. The main takeaways from the high/medium confidence SRs are:

- Land rights, agricultural interventions and payments for ecosystem services:** While SRs suggested positive effects for income and/or productivity, one or more concerns limited the SRs ability to draw strong conclusions or generalise findings (Lawry et al., 2014; Waddington et al., 2014; Oya et al., 2017; Snilstveit et al., 2019). For example, SRs often included a small sample of primary studies to draw from, or reported quality issues for primary studies (such

¹⁸ Waddington and colleagues (2014) evaluated three categories within agriculture and livestock: *agricultural extension and information services*, *in-kind transfers and equipment*, and *certification and market linkages*. Waddington and colleagues (2019) covered two land and forests categories: *community-based or decentralised land management and monitoring*, and *protected areas*; plus *irrigation infrastructure*.

¹⁹ There is a recent SR on coastal and terrestrial water sector interventions in developing countries (Ategeka et al., 2024). We identified the SR protocol (Konci et al., 2023) but the final report was published after the EGM search was conducted; hence, it was not included.

as not using appropriate study designs or control groups to accurately gauge effects, and a wide variation in effect sizes or outcome measurement).

- **Protected areas, payments for ecosystem services, or decentralised forest management programmes:** average deforestation effects showed substantial heterogeneity especially for payments for ecosystem services (Snilstveit et al., 2019). Across these three intervention categories, these effects also appeared to be small, or were highly context-dependent and based on evidence with similar study quality concerns as those highlighted above. This makes findings difficult to interpret or generalise (Geldmann et al., 2013; Snilstveit et al., 2019; Samii et al., 2015a; Samii et al., 2015b).
- **The evidence base from high/medium confidence SRs is five or more years old.** Knowledge about what works to improve environmental and human wellbeing outcomes may not reflect the most recent climate or biodiversity and trends, including intervention and implementation advancements.

7. Conclusions

This EGM is the first to focus on rigorous IEs and SRs evaluating the effects of climate change and biodiversity interventions across four natural systems and productive activities (*land and forests, agriculture and livestock, aquaculture and fisheries, coasts and oceans*) on environmental and human wellbeing outcomes in L&MICs. This map organises IEs and SRs according to our conceptual framework of interventions and outcomes, which draws from the latest climate change and biodiversity global policies and strategy documents.

Based on a systematic search for relevant studies in 16 academic databases and 27 grey literature sources, **this EGM includes 1,512 IEs and 93 SRs**, representing the available evidence of the effects of climate change and biodiversity interventions on environmental and human wellbeing outcomes in L&MICs. **This literature has significantly expanded over the last decade, as almost 85% of all IEs were published after 2014.** This result suggests an increased interest in understanding the connection between climate, biodiversity and people's livelihoods.

We identified clusters of evidence within specific *land and forests* intervention categories, such as *protected areas, other land conservation policy, land rights, community-based or decentralised land management and monitoring, and payments for ecosystems*. Similarly, **many IEs have focused on the effects of *agricultural extension and information services, and irrigation infrastructure* interventions.** **Extensive evidence is available for a few countries** such as China, Ethiopia, Brazil, India and Indonesia, and reflect the overall distribution of IEs by intervention categories. **Most IEs reported on short-term environmental outcomes**, especially *land and water cover measures*, and **livelihood outcomes** such as *productivity; income, assets and basic materials*; and *employment and livelihoods* measures.

Although the EGM includes a large number of studies, significant gaps in the literature still exist. The main gaps related to primary evidence are:

- Following the World Risk Report (2023), few IEs have been conducted in some of the most climate-vulnerable countries, such as Central African Republic, Somalia and South Sudan. Similarly, we only found ten IEs and one SR within seven of the 39 Small Island Developing States as classified by the UN.

- The regions with the lowest number of IEs are Europe and Central Asia (n = 13), and Middle East and North Africa (n = 3).
- We identified less than 30 IEs evaluating the effects of interventions within *aquaculture and fisheries*, and *coasts and oceans*.
- Some interventions within *land and forests* and *agriculture and livestock* have been scantily evaluated: we found less than 10 evaluations of *wildlife conservation policies* and *weather forecasts and environmental disaster alerts*. Likewise, we did not find IEs for two *agriculture and livestock* categories: *digital agricultural extension and information services*, and *monitoring and information systems*.
- Most IEs reported outcomes from one of our groups (climate, biodiversity or human wellbeing): 16% of 1,512 IEs reported environmental *and* human wellbeing outcomes, while only 1% of IEs reported both climate *and* biodiversity outcomes.
- Around a quarter of studies reported information of the interventions' costs or estimated the projects benefits relative to their costs. The intervention categories with the highest prevalence of cost data reporting are *payments for ecosystem services* (n = 60) and *agricultural extension and information services* (n = 33).
- Only 12% of studies reported to have designed, implemented, or analysed interventions based on equity-sensitive approaches.

We found nine high or medium confidence SRs, which focused on a few intervention categories including *payments for ecosystem services*, *protected areas*, *land rights*, *community based or decentralised land management and monitoring* within *land and forests* and *certification and market linkages* within *agriculture and livestock* interventions. **None of these reviews focused on aquaculture and fisheries, or coasts and oceans interventions.** In addition, **these SRs were published at least five years ago**, meaning that they may not reflect the most recent climate change or biodiversity trends, including intervention and implementation advancements, and evidence. **The lack of recent high/medium confidence SRs on these topics represents a major synthesis gap.** Table 4 provides the interventions with the highest number of IEs, along with the number of high/medium confidence and ongoing SRs. These areas present potential opportunities for future synthesis. Out of the 93 SRs, excluding ongoing/protocol SRs, we found that the remaining 76 SRs were appraised as having low confidence SRs as they did not meet the necessary international standards for conducting and reporting systematic reviews.

Table 4: Evidence synthesis gaps

Intervention category	Completed (ongoing) IEs	High/medium confidence SRs (year of latest SR)	Ongoing SRs
Land and forests			
Protected areas	145 (0)	3 (2013)	0
Other land conservations policy	123 (0)	0	4
Land rights	109 (5)	1 (2014)	0
Community-based or decentralised land mgmt. and monitoring	106 (2)	2 (2015)	1
Payments for ecosystem services	104 (3)	2 (2019)	0

Intervention category	Completed (ongoing) IEs	High/medium confidence SRs (year of latest SR)	Ongoing SRs
Agriculture and livestock			
Agricultural extension and information services	132 (5)	1 (2014)	2
Irrigation infrastructure	64 (4)	0	1
Certification and market linkages	63 (1)	2 (2017)	1
Subsidies, credit and cash transfers	58 (3)	0	1
Weather and climate insurance	54 (2)	0	2

Note: numbers in parenthesis in the first column are ongoing IEs, and the year of publication of the most recent high/medium confidence SRs in the second column. The number of SRs is higher than in Table 3 as SRs can cover multiple interventions.

While we tried to be as systematic and comprehensive as possible, this EGM has some limitations. First, having search terms in English only may represent a bias towards English language publications. The search of studies may have missed research from specific non-anglophone countries published in local publications if they do not provide an English abstract. We aimed to minimise this risk by complementing the initial search with additional searches derived from included studies. Second, other than English, the EGM includes 14 studies published in Chinese, Indonesian, French, Portuguese and Spanish; however, we encountered eight studies in Chinese and Russian language for which we did not have resources available to assess them. These studies account for a very small portion of the total number of studies screened at full text (8 of 6,015 studies, equivalent to 0.1%).

7.1 Implications for policy-makers

- Policy-makers and practitioners can use this EGM to identify whether rigorous evidence is available for programme design of climate change and biodiversity interventions, specific to the context, targeted population and region of interest.
 - There is a wealth of studies to explore and draw from, particularly within a few interventions across the *land and forests* and *agriculture and livestock* groups, such as *protected areas*, *other land conservation policy*, *land rights*, *community-based or decentralised land management and monitoring*, and *payments for ecosystems*.
 - Findings from individual IEs should be interpreted with caution due to possible biases in reported effects and also due to local and time-specific factors. While IEs provide rigorous quantitative evidence, apt to identify changes attributable to the interventions, each IE is one piece of a bigger picture.
- Policy-makers and practitioners should be cautious when using the findings from the SRs included in the map.
 - Findings from low confidence SRs, which are most prevalent in this EGM, are subject to serious bias concerns.
 - High/medium confidence SRs suggest that specific interventions within *land and forests* and *agriculture and livestock* may lead to positive effects. However, these SRs do not incorporate the evidence from the last five years,

and the extent and quality of the evidence they draw from presents serious limitations and restricts authors' conclusions.

7.2 Implications for future research

- This EGM provides interesting learnings about the state of the evidence on climate, biodiversity and livelihoods. Funders and the research community in general can incorporate findings into future research agendas. In order to make meaningful contributions to the knowledge base, evaluations should incorporate rigorous methodological designs and ensure that research is reported transparently in a way that allows for assessments of study quality.
- The production and commissioning of future IEs should prioritise research:
 - in regions with limited or no existing evaluations, such as Europe and Central Asia and the Middle East and North Africa.
 - on interventions within *aquaculture and fisheries* and *coasts and oceans* and across under-researched areas, such as *weather forecasts and environmental disaster alerts*, *wildlife conservation policies*, *monitoring and information systems*, *market shaping funding*.
 - on the effects of interventions on final climate and biodiversity outcomes, such as GHG emissions or species complexity.
 - on the effects of interventions on both environmental (biodiversity or climate mitigation), and human wellbeing outcomes in order to fully capture the intended and unintended effects of these interventions.
 - on the most climate-exposed and vulnerable countries, which may lack the resources or infrastructure to conduct or attract extensive research.
 - that embeds intervention costs and equity-sensitive approaches into the design, implementation and analysis of relevant projects.
- Beyond these evidence gaps, new rigorous IEs should consider the following learnings when designing and implementing evaluations:
 - It is essential to consider effects along the causal chain, including short- and long-term effects, as well as how these effects may change over time.
 - IEs can leverage geo-spatial data for measuring climate, biodiversity, and natural resource outcomes, which can limit data collection costs and can be useful for collecting high-frequency and long-term data.
- Synthesis efforts in this sector should be aligned with international standards for conducting and reporting systematic reviews (Page et al., 2021; The Methods Group of the Campbell Collaboration 2019b; 2019a; and Higgins et al., 2022). The SRs should report sufficient information on the search and selection of primary studies and the methods for data extraction and quality appraisals.
- Future SRs should prioritise the evaluation of interventions in areas with a large number of IEs but no recent high/medium confidence SR. All intervention categories, even where there are clusters of research, lack a recent high/medium confidence SR.

Online appendix

Online appendix A: Interpreting and using EGMs

<https://3ieimpact.org/sites/default/files/2024-09/CCB-DEFRA-EGM-report-Online-appendix-A.pdf>

Online appendix B: Advisory group

<https://3ieimpact.org/sites/default/files/2024-09/CCB-DEFRA-EGM-report-Online-appendix-B.pdf>

Online appendix C: Criteria for including and excluding studies

<https://3ieimpact.org/sites/default/files/2024-09/CCB-DEFRA-EGM-report-Online-appendix-C.pdf>

Online appendix D: Search methods

<https://3ieimpact.org/sites/default/files/2024-09/CCB-DEFRA-EGM-report-Online-appendix-D.pdf>

Online appendix E: Deviations from the protocol

<https://3ieimpact.org/sites/default/files/2024-09/CCB-DEFRA-EGM-report-Online-appendix-E.pdf>

Online appendix F: Critical appraisal tool

<https://3ieimpact.org/sites/default/files/2024-09/CCB-DEFRA-EGM-report-Online-appendix-F.pdf>

Online appendix G: Examples of excluded records

<https://3ieimpact.org/sites/default/files/2024-09/CCB-DEFRA-EGM-report-Online-appendix-G.pdf>

Online appendix H: Lists of included records

<https://3ieimpact.org/sites/default/files/2024-09/CCB-DEFRA-EGM-report-Online-appendix-H.pdf>

Online appendix I: Detailed summaries of high- and medium-confidence SRs

<https://3ieimpact.org/sites/default/files/2024-09/CCB-DEFRA-EGM-report-Online-appendix-I.pdf>

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