COVER PAGE

"Can nature-based solutions support economic recovery? A review of reviews on the economic outcomes of NbS"

Alexandre Chausson[1], Alison Smith[1,2], Brian O'Callaghan[3,4], Yadira Mori Clement[5], Florencia Zapata[5], Nathalie Seddon[1]

1 Nature-based Solutions Initiative, Department of Biology, University of Oxford, Oxford OX1 3PS, UK

2 Environmental Change Institute, University of Oxford, Oxford OX1 3QY, UK

3 Institute for New Economic Thinking, Oxford Martin School, University of Oxford, Oxford, UK

4 Smith School of Enterprise and the Environment, School of Geography and the Environment, University of Oxford, Oxford OX1 3QY, UK

5 Instituto de Montaña, Calle Gral. Vargas Machuca, #408, Lima, Peru

Word count: 11, 455

* Correspondence:

Alexandre Chausson

alexandre.chausson@biology.ox.ac.uk

Keywords: nature-based solutions, economic stimulus, green recovery, natural capital, climate economics

Abstract

Nature-based solutions (NbS) involve working with nature to address societal challenges, with benefits for both people and biodiversity. However, their potential role in recovery from economic crises, such as those arising from conflicts or pandemics, remains underexplored. We conducted a systematic review of reviews on the economic impact of nature-based interventions. From 46 relevant reviews, most demonstrated positive outcomes for income and employment, but national-scale economic growth assessments were scarce. Half of the cases featured nature-based food production investments, and much of the evidence was from sub-Saharan Africa, East Asia and the Pacific. The few reviews that compared NbS with alternative approaches found that NbS delivered equal or higher economic outcomes. NbS also deliver wider benefits such as food and water security, flood protection and community empowerment, which enhance economic prosperity and resilience. We identified factors that affect delivery of benefits and trade-offs, finding that NbS should adhere to best practice standards (especially by involving local communities and disadvantaged groups in their design and implementation) to deliver more equitable outcomes for people and nature.

We find that well-designed NbS can create diverse job opportunities at different skill levels, diversify income, and improve resilience, providing a rapid and flexible response to economic shocks that can be targeted at deprived communities. By bringing together traditional, local and scientific knowledge, NbS can drive eco-innovation, accelerating the transition to a clean, efficient, circular economy, and their high economic multipliers can cascade indirect and induced effects throughout economies. The evidence underscores the need to include NbS in investment programs to concurrently address economic, environmental, and societal challenges. However, we reiterate calls for better monitoring of economic, social and ecological outcomes and suggest development of comprehensive accounting systems to track public and private NbS investments.

Introduction

The vital role of Nature-based Solutions (NbS) for adapting and reducing vulnerability to climate change [1, 2] and tackling greenhouse gas emissions [3, 4] is now widely recognized. There is growing awareness of the potential role of NbS in recovery from economic shocks, including those related to conflicts or pandemics. Indeed, the COVID pandemic raised awareness of the importance of nature in addressing root causes of zoonotic disease emergence (human encroachment in wildlife habitat) and improving human wellbeing (e.g. [5]). Despite the emphasis on 'building back better', there has been little attention to how investments in nature can also boost economic recovery. Through 2020 only 3% of spending on the COVID-19 recovery appeared likely to support natural capital, with up to 17% likely to negatively impact it through new infrastructure, defense services expansion, and other measures [6]. Key barriers to mainstreaming investments in NbS and natural capital include path dependency [7], siloed government decision-making [8, 9], the pervasive belief that environmental protection is bad for business [10], lack of awareness [11], lack of skills, and uncertainty over the economic benefits of NbS compared to alternatives.

Fiscal policy (i.e. government spending and taxation) can be a powerful lever for influencing total demand for goods and services, particularly during economic downturn (see [12, 13]), thereby promoting recovery. Faced with the need to act rapidly, economists have advised that policy makers should respond with measures that are "timely, targeted, and temporary". However, this implies little consideration for the long-term impacts of policy, meaning that the relative benefits of more socially useful or long-term activities might not be appropriately considered. Keynes suggested that priority investments during the latter stages of the US depression should be in "durable goods such as housing, public utilities, and transport", noting that "the necessities for such developments were unexampled" [14]. Given limited funds and capacity to secure finance, it is important that policymakers consider how short-term fiscal measures might influence long-term outcomes [6, 15]. This is particularly important in emerging market and developing economies (EMDEs), where fiscal space is often tightly constrained and new debt is expensive. Put differently, policies that bring long-term debt servicing costs should deliver long-term assets that support well-being ([6] ; see Appendix C for a glossary of terms). Biodiversity and long-term resilience are just some of the factors that might be harmed when recovery investments do not consider long-term needs [16].

In the context of economic recovery from the pandemic, it has been proposed that investments in measures that reduce net greenhouse gas emissions might have economic characteristics equivalent, or perhaps superior, to traditional investments [6, 17-20]. These works built on investigations into low-carbon energy and energy efficiency measures during the Global Financial Crisis (GFC) (e.g. [21-25]). Studies suggested that solutions supporting natural capital might be attractive, as these can sometimes be implemented relatively quickly [6, 19, 26]. This highlights the potential role of NbS - actions to protect, conserve, restore, sustainably use and manage natural or modified terrestrial, freshwater, coastal and marine ecosystems, which address social, economic and environmental challenges effectively and adaptively, while supporting human well-being, ecosystem services, resilience, and biodiversity benefits [27].

Several characteristics of NbS make them attractive to support economic recovery. First, once designed, some NbS can be implemented relatively quickly [6, 28]. Second, their implementation can generate demand for both highly skilled labor (such as to map, design, monitor and evaluate NbS) and low-skilled labor, making the solutions attractive in a situation of high unskilled unemployment [6, 29]. Third, some NbS can be applied in rural contexts where populations are particularly vulnerable [19, 30, 31] – contrasting with other low-carbon stimulus solutions like investing in public transport assets, which often require high population density to make financial sense. Fourth, NbS can support climate change objectives, both mitigation and adaptation, including in concert with built infrastructure [1, 3, 4, 32]. Finally, effective NbS can strengthen natural and social capital to address a range of societal challenges beyond climate (such as pollution, or food and water security), while supporting biodiversity and fostering human well-being [33-36]. However, securing these benefits requires conscientious approaches and design, informed by a robust understanding of potential trade-offs and win-wins, and benefit and cost disaggregation across groups. Therefore, in addition to economic potential it is crucial to understand when, where, and how NbS foster biodiversity, climate, and social benefits, and who wins or loses.

Previous research suggests that investments in nature (e.g. restoration) deliver high gross value added and higher returns per unit of investment than other sectors [10, 29, 37]. However, existing research is mainly limited to project-specific or sector-specific outcomes with a lack of evidence synthesis across the full range of NbS. Existing reviews typically cover specific sub-types of NbS, specific geographical locations, or a subset of economic outcomes. The highly dispersed nature of the evidence challenges the uptake of NbS research to inform fiscal policy measures. Furthermore, recent assessments [38] have not investigated economic recovery potential at a high enough granularity to compare short versus long-term economic characteristics of NbS, and their risks and opportunities. There is also a need to frame the evidence to support systemic policy change, requiring comparison of NbS to other economic recovery options. Finally, there has been a lack of focus on how different benefits are delivered, and how these socially disaggregate. In the absence of such information, nature can be sidelined in economic recovery policies, locking in the continued destruction of nature, with severe impacts for climate, biodiversity, and livelihoods. Economic stimulus packages therefore require robust evidence-based guidelines around what good investments in NbS look like and the benefits they can bring.

To address these issues, we conducted a systematic review of reviews [39] on the economic performance of investments in nature, and the pathways by which these benefits are delivered, focusing on jobs and labor demand, household income and business revenue generation, and economic growth. Reviews of reviews, or "umbrella reviews", predominantly carried out in health and medical fields, allow rapid assessment of the evidence across a broad range of outcomes, interventions, and contexts amidst a rapidly increasing number of primary research studies [40].

Our focus was guided by the recognition that decision-makers involved in fiscal policy, our prime target audience, focus on economic criteria such as fiscal multipliers (leading to GDP growth) and job creation. We recognize that GDP growth is an inadequate measure of human progress, and well-being [41, 42], and that perpetual growth in a finite world jeopardizes progress towards addressing the climate and biodiversity crises [16, 43, 44]. A vast array of social and environmental factors underpin well-being, including material circumstances, (e.g. income, livelihoods, health, the environment), social aspects (e.g. community relations), and subjective aspects (e.g. one's felt psychological state) [45], many of which are linked to our relationship with nature, its ecosystems, landscapes, and nonhuman species [6]. Although we focus on conventional economic outcomes for jobs, incomes and growth, we also discuss the vital role of NbS in delivering many of these wider societal benefits.

Our overarching questions are:

1) What is the distribution of the evidence on the economic impact of NbS between different regions, types of NbS, ecosystems and economic outcomes?
2) What are the reported economic impacts of nature-based solutions?
3) How do nature-based solutions contribute to economic impact?
4) What are the reported trade-offs and win-wins between economic impact outcomes, and biodiversity or climate outcomes?
5) How are costs and benefits distributed across social groups?

We address those questions by a) exploring the scope of NbS outcomes reported under the umbrella of 'economic impact' in the peer-reviewed literature; b) synthesizing this evidence with respect to geography, ecosystem, and type of intervention; c) highlighting trade-offs and win-wins in relation to biodiversity, climate, and social equity; and d) identifying how NbS deliver economic impacts (pathways and mediating factors). Unpacking when and where NbS deliver benefits, and for whom, is crucial to tailor and target NbS in fiscal policy measures to support broader climate and biodiversity objectives, including addressing potential trade-offs and win-wins for resilient development. Our primary method is a systematic review of the literature on the economic outcomes of NbS, but we supplement this with a review of the wider outcomes of NbS for sustainable development, and a detailed case study to add depth and nuance to our understanding. We also highlight knowledge gaps and biases in the literature, with recommendations for practitioners and researchers to support future evidence collection. In addressing these questions, our goal is to enable well-targeted scientific research on NbS to play a stronger role in informing fiscal policy. We conclude with a set of recommendations for policy makers.

Methods

Systematic review protocol

We drafted a systematic review protocol, including a conceptual framework (Appendix A, Supporting Information), to catalogue evidence in a transparent and objective manner [46]. We revised the question scope (Table 1), search string, review selection criteria, and coding framework (Supporting Information Tables S1, S2) in early 2022 through meetings and workshops with an interdisciplinary group of experts in academia, civil society, and government, covering expertise on NbS and economic impact (see Acknowledgements and Supporting Information). We designed the coding framework to ensure relevance for policymakers focusing on economic policy, including economic recovery, while also noting any reported outcomes for climate and biodiversity.

Table 1. The elements of the question scope underpinning the search string, review selection criteria, and exclusion criteria

Target	Intervention
Human individuals, groups, communities and economic sectors (e.g. agriculture, water, forestry, transport, energy).	Interventions managing, restoring, rehabilitating, creating, or protecting biodiversity, ecosystems (semi-natural or natural), or ecosystem services, including in working landscapes (agriculture, forestry, farms, fishing grounds) and urban green infrastructure.
Comparator	**Outcome**
We recorded whether reviews required their component studies to use a comparator (such as baselines, controls, or counterfactuals) but did not exclude reviews that did not.	Reported direct or indirect impacts on economies, including employment, income, or multiplier effects.

Searches and screening process

We ran the search string for English publications in SCOPUS and Web of Science CORE index collections (April 28, 2022), restricting the search to title, abstract content, and author keywords, and refining the search to articles tagged as review. We removed duplicates in EndNote (v8.2) and exported search results into Rayyan [47] for screening using a stepwise procedure, screening first reference titles, then abstracts. We progressively refined selection criteria for clarity and inter-reviewer consistency, and further refined these criteria after abstract screening to produce a manageable number of studies, based on time and team capacity constraints (see Table 1 and Table S1 Appendix E). We included only those studies where the methodology for the review was clearly described.

Decisions at each stage of screening were conservative; we assessed studies for which inclusion eligibility was unclear at the next stage. We randomly selected at least 10% of references to check for inter-reviewer coding consistency with a Kappa test. If the Kappa coefficient was below 0.6 (the threshold at which inter-reviewer coding consistency is deemed sufficient; [48], we reviewed any emerging inconsistencies and revised the screening strategy and selection criteria for clarity. We carried out single reviewer screening cautiously, i.e. checking screening consistency throughout the process. Approximately 15% of all screening decisions at the abstract and full-text stages were made by at least two reviewers. Studies excluded during full text screening, and reasons for their exclusion, are available in the supporting information (Appendix E). Inclusion decisions were guided by whether the review reported one or more economic impact(s) stemming from nature-based interventions, regardless of the aim of the intervention. We did not narrow our scope to studies explicitly using the terminology of NbS or interventions meeting all NbS criteria [49, 50], because this would have excluded many relevant studies. Hence, hereafter we refer to nature-based interventions instead of NbS. In some reviews, the extent to which interventions supported biodiversity or local communities was heavily context dependent (depending on how the intervention was implemented). We did not exclude these reviews unless the information reported indicated that the interventions did not support (or were harmful) to biodiversity or local communities. In other words, if it was not clear whether an intervention fully met the criteria to be an NbS (with benefits for both biodiversity and local communities), we gave interventions the benefit of the doubt, but if it was clear that the intervention was not an NbS then it was excluded.

Coding strategy

The extraction of evidence from studies was guided by a coding framework developed from the conceptual framework (Supporting Information, Appendix B) and entered in Excel. The coding framework captured data at three levels: for each review, for each intervention covered by a review, and for each outcome type recorded for an intervention.

For each review, we recorded bibliographic details and quality criteria such as whether the review was systematic and whether it excluded studies with no comparator. To map the distribution of evidence across geographies, we recorded which world regions or specific nations were associated with the evidence reported, following the World Bank regional classification scheme (2020) [51].

For each intervention, we recorded the broad category: (i) protection, (ii) restoration, (iii) other forms of management (hereafter management), (iv) creation of novel ecosystems, and (v) nature-based food production (see Appendix A, supplementary material for definitions). Ecosystems in which interventions took place were grouped into 28 categories, drawing from the typology devised for a systematic map of nature-based interventions to adaptation [1] to which we added categories for working landscapes (cropland, pastures, agroforestry, plantations, aquaculture) and urban green infrastructure.

For each outcome, we recorded the outcome type, description and direction of effect (positive, negative, mixed, no effect, or unclear). Outcomes were classed as mixed if a mix of positive and negative outcomes were recorded by the component papers of the review, or unclear where component papers found that evidence for outcome direction was inconclusive. Outcome types included i) income, revenue and profitability, ii) employment (jobs and labor demand), iii) job security, iv) skills and training, v) economic growth and multiplier effects. These are all interconnected, as economic growth is a function of income, income is related to employment levels, and job security, skills and training all affect income and employment. For labor demand, we coded increased labor demand as a positive outcome on the macro level, noting that in some micro studies (e.g. for nature-based food production) increased labor was viewed as a negative outcome because it led to increased production costs.

Reported outcomes did not need to be associated with a comparator (for example, if a review reported overall revenue generated, it was coded as positive, unless a baseline assessment was provided indicating that income generation was insufficient to overcome opportunity costs). To characterize the extent of evidence for each outcome category, we also captured the number of underlying studies associated with each outcome statement (where the information was provided by the review). We did not explore whether there was any overlap in the primary studies covered by different reviews due to time limitation, but significant overlaps seem unlikely given that most reviews covered quite different combinations of intervention types and geographical regions.

In addition to recording the economic outcomes, we also recorded whether wider outcomes for ecology, climate change or social equity were considered by the assessments. Ecological outcomes included those associated with species conservation, habitat quality, diversity (e.g. species richness), or resilience of natural ecosystems. Climate change mitigation outcomes included avoided greenhouse gas emissions, or changes in below or above ground carbon storage. For climate change adaptation, we coded outcomes for addressing vulnerability (exposure, sensitivity, or adaptive capacity) to climate change impacts or other hydrometeorological hazards, including climate hazards which may or may not be explicitly linked to climate change. Equity effects were identified as any reported distribution of outcomes across social groups, either within communities embedded in the intervention landscapes, or between local communities and external stakeholders (government, private sector and investors, or civil society organizations). Outcomes were deemed to be positive for equity if they resulted in benefits for low income or marginalized groups, and negative if benefits flowed primarily to high income beneficiaries or those with political power and influence.

Data analysis and mapping

The evidence base was characterized through descriptive statistics, mapping the number and percentage of studies with respect to methodology, geographical region, intervention type, type of ecosystem, type of outcomes, and associations between economic outcomes and intervention type. We then analyzed the direction of reported economic outcomes (positive, negative, mixed, or neutral), any comparisons with alternative approaches, any reported effects on climate change (adaptation and mitigation), and trade-offs and win-wins. For each review, reported evidence disaggregated by intervention (by the review authors) was recorded as a distinct case. Where absolute numbers are shown in figures, we only report percentages in the text.

We summarize reported effectiveness of interventions to characterize the evidence base and guide future analyses. Meta-analysis was not possible given the heterogeneity of the evidence and the underpinning review methodologies. This also precludes weighing reported categorical outcomes by strength of evidence, although we recorded the number of underlying papers supporting each outcome within each review. To test the impact of evidence quality, we compared all results reported with those reported by only the subset of systematic reviews, where appropriate. Further critical appraisal of review quality was not conducted. For this reason, and because of the heterogeneity and context-dependence of the evidence base (meaning that there were a relatively low number of reviews covering each specific combination of intervention type, outcome and context), the results should not be used to generalize the effectiveness of a particular intervention type.

Pathways and mediating factors

Within each review, we inductively extracted the pathways and mechanisms through which nature-based interventions were reported to shape economic outcomes. Relevant passages were extracted into Excel, and progressively refined to identify emergent categories (see Appendix B, Pathway definitions). Interventions and outcomes described within a review can be associated with one or more pathway categories. For example, a nature-based food production intervention such as agroforestry may boost yield (and hence income) by improved ecosystem services (such as pollination and erosion protection) and could also be associated with increased income via payment for ecosystem service (PES) schemes designed to promote adoption or offset opportunity costs.

We also conducted an analysis of mediating factors, i.e. any factors reported to modify the outcome of the intervention (see Appendix B, Mediating factors). First, we grouped mediating factors according to seven categories following categories of ecosystem-based adaptation constraints identified by Nalau et al. (2018) [52], in which most mediating factors fit. We added the category ‘technical factors’ to capture intervention design elements under the deliberate control of implementers (whether physical or biological). We then extracted and coded relevant passages by the relevant category. We coded mediating factors for each review, as disaggregating mediating factors for each intervention was not always possible. We counted the number of times each mediating factor category was represented across reviews (if more than one factor was identified in a review for a given category, we only counted that category once). The analysis of mediating factors and pathways is not exhaustive and is limited by the extent to which they were reported by review authors.

Trade-off and win-win analysis

We extracted all passages in the reviews explicitly mentioning trade-offs and synergies, and categorized them according to whether they specified trade-offs or synergies between outcomes, between stakeholders, across time (e.g. short term costs vs long term benefits), or spatially (e.g. costs in one area, benefits in another). Social trade-offs and synergies were extracted from the previously coded material describing distributional effects and equity. We then identified emerging themes and summarized these narratively within each category along with descriptive statistics (number and percentage of studies reporting each category). We also explored associations between reported outcomes for climate (adaptation and mitigation) and economic impact, even if not explicitly reported as a trade-off or win-win by the underlying reviews.

As well as incomes and employment, NbS can deliver a wide range of societal and environmental benefits, many of which are crucial to support economic prosperity. To illustrate this, we conducted a supplementary analysis of a previous systematic review dataset, drawn from both academic and grey literature, which coded the outcomes of nature-based interventions for development in the Global South, focusing on interventions that delivered climate change adaptation outcomes [53].

Results

Studies identified and methodological approaches adopted

The number of articles retained or excluded at each stage of the searching and screening process is shown schematically in Figure S1. The search of literature reviews on the economic impact of nature-based interventions identified a total of 2,138 studies in Web of Science, and 1,137 in Scopus, resulting in 2,818 references after duplicate removal. After title, abstract and full text screening, 198 of these met initial selection criteria (Table S1), published across 99 academic journals, from 1996 to 2022, but only 46 of these specified a methodology, and therefore were included in our review. Of these, half (23) were categorized by the journal or labeled by the authors as systematic reviews, although not all conformed fully to established systematic review standards [46]. Only 25% (11) conducted some level of quality appraisal of the underlying studies, and only 37% (17) restricted the review to primary studies that used comparators (such as counterfactuals, baselines, or controls).

What is the distribution of the evidence on the economic impact of Nature-based Solutions?

Across the 46 reviews, we identified 68 intervention cases (as a review can have more than one intervention), reporting 122 distinct economic outcomes. The reviews reported between 1 and 9 intervention cases each (mean ± SD = 1.5 ± 1.4), and each intervention case was associated with between 1 and 4 reported outcomes (mean ± SD = 1.8 ± 0.9). Most outcome assessments were based on quantitative data (57%) or both qualitative and quantitative data (14%); 24% were qualitative, and for 6% the type of data was unclear.

Variation in numbers of reviews by region

The most frequently represented region (noting that reviews often cover more than one region) was sub-Saharan Africa (covered in 43% of reviews), followed by East Asia & Pacific (41%), South Asia (28%), Latin America & Caribbean (24%), and Europe & Central Asia (20%) (Figure 1). For most reviews, the geographical scope of the data synthesized was global (19, 41% of studies), followed by national (15, 33%), regional (6, 13%), and sub-national (3, 7%). Only one review was local.

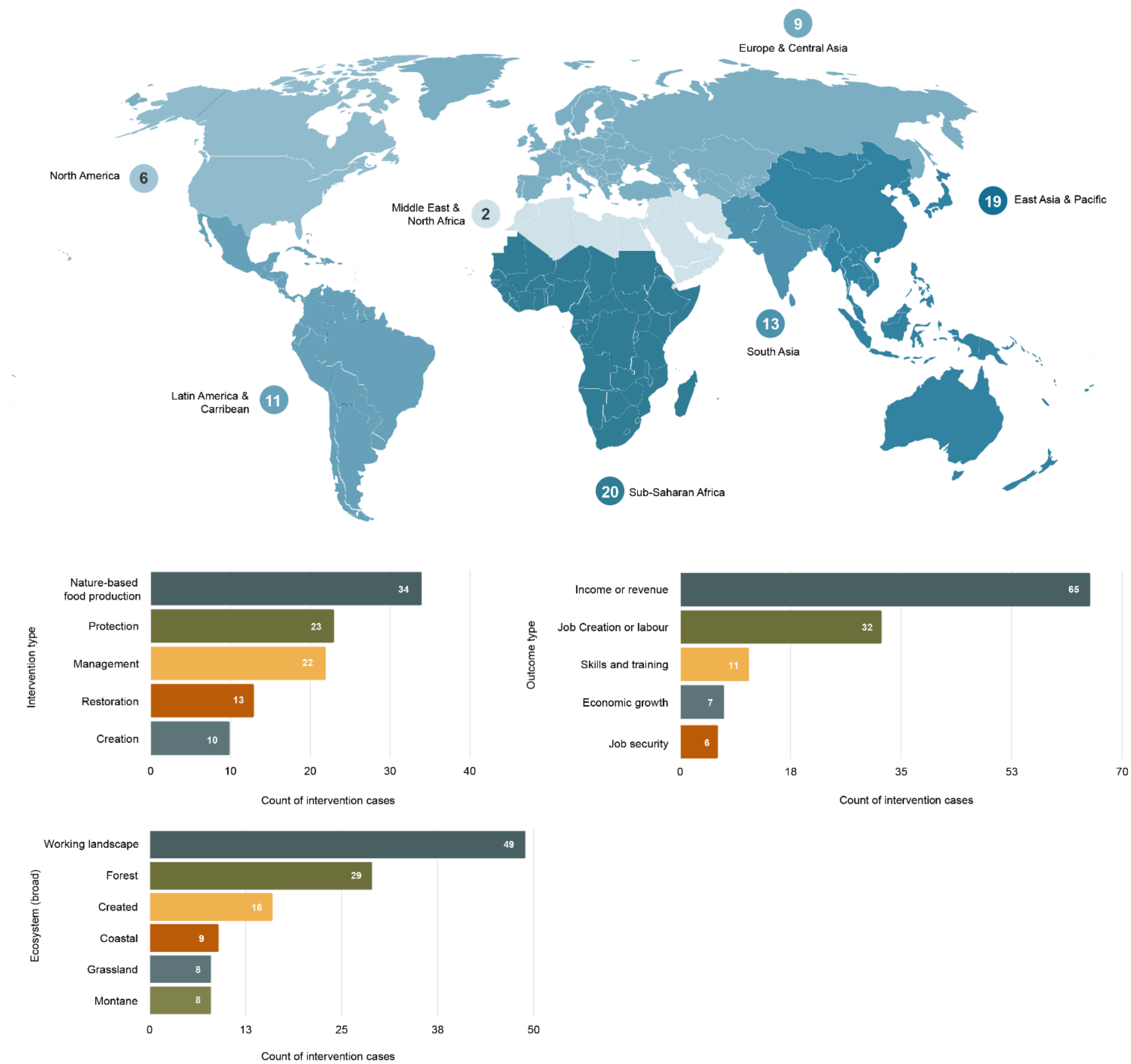


Figure 1. Number of reviews covering (a) world region (World Bank, 2020) (b) the broad type of NbS (c) ecosystem category, and (d) economic outcome type. A review can cover more than one of each category; note that only the most represented (top 6) ecosystem types are indicated.

Type of nature-based interventions

Intervention cases were associated with up to five different broad intervention types (i.e. protection, restoration, management, creation of novel ecosystems or nature-based food production; see Appendix A, supplementary material) (mean = 1.55, S.D. = 0.82). The most frequently represented type of intervention was nature-based food production (50% of cases) followed by protection (34%), management (32%), restoration (19%), and creation of novel ecosystems (15%) (Figure 1a). However, many interventions (35%) used a combination of these approaches (e.g. community-based natural management with natural resource use restrictions was coded as both protection and management). While 43% involved only nature-based food production, just 12% involved only management, 6% involved only creation of novel ecosystems, 4% involved only protection, and none involved only restoration.

Table 2 provides examples of the types of actions within each intervention category. Nature-based food production interventions involved a range of measures in rural working landscapes, plus one case of urban agriculture in South Africa. Of these, 44% involved measures targeting soil health (e.g. conservation tillage, cover crops, mulching), while 56% involved measures for above ground diversification (e.g. agroforestry (including silvopasture), intercropping, farmer-managed natural regeneration). Interventions involving elements of ecosystem protection included marine and terrestrial protected areas, resource use and access restrictions in the context of community-based management, and forest-based ecotourism. Interventions categorized as management involved community-based forest or fisheries management, or grassland management. Restoration measures included forest or rangeland restoration. Finally, interventions creating novel ecosystems involved urban nature-based solutions (e.g. green roofs or walls), or afforestation (i.e. planting trees on naturally treeless habitats or creating plantations of non-native species). Note that afforestation typically does not provide benefits for biodiversity, so it is not considered to be an NbS unless it is part of a process aimed at supporting landscape regeneration (e.g. by rehabilitating degraded land).

Table 2. Examples of nature-based interventions identified in included reviews, for each of the five broad intervention types. Interventions may not meet all guidelines for nature-based solutions (NbS) in practice. We include this evidence because it is generally not possible to evaluate this with the information provided in each review, and it is also needed to build an understanding of what makes for effective NbS.

Intervention type	Specific intervention	Description	References
Nature-based food production	Agroforestry	Agroforestry practices including trees on farms, silvopasture and silvoarable systems, shade-grown crops, homegardens with trees, farmer managed natural regeneration.	Castle et al. 2021; Duffy et al. 2021; Chomba et al. 2020
	Conservation agriculture	Soil health practices including no-till or reduced tillage, cover crops, mulching, residue retention diversified crop rotations	Rosa-Schleich et al. 2019; Reich et al. 2021; Mafongoya et al. 2016
Protection	Protected areas	Terrestrial or marine protected areas or reserves, as spaces designated and managed to protect marine ecosystems, processes, habitats, and species for biodiversity conservation, or to support the restoration and regeneration of resources for social, economic, and cultural aims.	Marcos et al. 2021; Lindsey et al. 2014
	Community-forest management	Community forest management through various forms of tenure and institutional arrangement between local communities and public agencies, involving restrictions on natural resource use.	Pelletier et al. 2016
Restoration	Rangeland restoration	Fencing rangeland or removal of livestock (seasonal or year-round) to restore the ecological services provided by rangeland ecosystems	Li et al. 2016
	Forest restoration	Re-establishment of forests through tree planting, or seeding on land classified as forest, or restoration through assisted recovery of damaged forest ecosystems, or natural forest restoration (spontaneous natural regrowth).	Adams et al. 2016
Management	Forest management	Native (planted) or natural forest stands managed for rural economic development, to provide goods such as walnuts, NTFPs (non-timber forest products), or to promote soil and water conservation.	Shigaeva and Darr, 2020
	Community-based natural resource management	Various forms of community-based natural resource management, involving collaborations between international organizations and local communities in the	Mbaiwa eta l. 2013

		context of sustainable development initiatives. These approaches devolve the management of natural resources to local communities.	
Novel (i.e. ecosystem creation)	Urban green and blue infrastructure	Interventions involving the establishment of green roofs, green walls, or other green and blue spaces, corridors, and elements, to provide ecosystem services within urban or peri-urban areas.	Teotonio et al. 2021; Shackleton, 2021
	Afforestation	The planting of trees on degraded or low productivity farmland, or on barren hills, to prevent soil erosion, mitigate flooding, to regenerate degraded farmland for livelihoods.	Bryan et al. 2018

Ecosystem type

Most intervention cases (72%) were associated with working landscapes (croplands, grazing lands and agroforestry), followed by forests (43%), (primarily tropical and subtropical forests), plantations (16%), coastal ecosystems (13%), and grasslands (12%) (Figure 1c). Of these, 29 (43%) intervention cases only involved created ecosystems or working landscapes, 20 (29%) only involved natural or semi-natural ecosystems, and 15 (22%) involved a mix of semi-natural/natural and working landscapes or novel ecosystems. Few studies reported on urban green infrastructure (5, 7%), freshwater habitats (4, 6%), oceans and seas (5, 7%), or desert and xeric shrublands (3, 4%), and none reported evidence from interventions involving aquaculture, mangroves, or peatlands.

Economic outcomes

Overall, 97% of intervention cases reported outcomes for income or revenue, 47% for labor demand or job creation, 16% for skills and training, 10% for economic growth, and 9% for job security (Figure 1d). We also recorded the number of studies *within* each review that provided evidence to support each outcome assessment to understand the relative size of the evidence base. We found that 74% (993) of the underlying studies provided evidence on income or revenue, followed by job creation (16%, 212 studies), job security (8%, 105), skills and training (2%, 22), and economic growth (1%, 19).

Only 6 reviews reported evidence of indirect job creation, such as where revenue from ecotourism provided indirect employment for transport and local food production to supply eco-lodges in Sri Lanka [art-38]. Of reviews reporting effects of changes in labor demand or job creation only two reported on the job length, with only one quantifying the proportion of short-term and long-term jobs [art-26]. While not the focus of the review, we also noted that broader livelihood outcomes such as the extent of livelihood diversification, or effects on crop production (without converting that into a monetary value) were reported in 49 (72%) cases.

Most outcome assessments were reported at the farm level or household level (35%), followed by community-level effects (16%), and effects at the sub-national scale (14%) (Fig S2). Only 7 (6%) were national scale.

Associations between economic outcome and type of nature-based intervention

We mapped associations between intervention category and outcome type, treating combined interventions as a separate category (Figure 2). This revealed clusters of evidence for the income or revenue outcomes of nature-based food production (28 cases, 97% of all interventions involving nature-based food production) and combined interventions (24 cases, 100%), with smaller clusters for the labor outcomes of combined interventions (14 cases, 58%) and nature-based food production (13 cases, 45%), the income or revenue outcomes of management interventions and the skills or training outcomes of management interventions (8 cases each, 100%). Most of the limited evidence on economic growth and job security was associated with combined interventions (5 cases, 21%; and 4 cases, 17%, respectively).

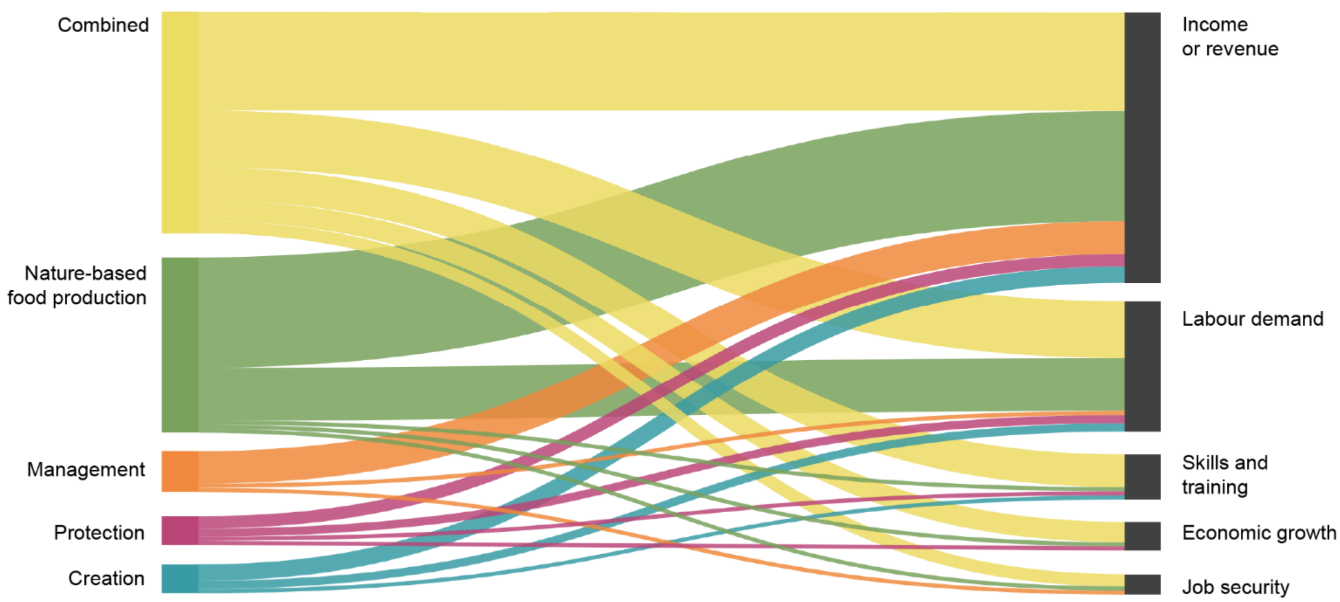


Figure 2. Systematic map of economic impact outcomes by each of the broad intervention types illustrated as a Sankey diagram, where the thickness of each band corresponds to the number of cases involving the linked intervention type and economic impact outcome

What are the reported economic impacts of Nature-based Solutions?

Most reported outcome effects were positive (62%), followed by mixed effects (26%), with only a few being unclear, negative, or neutral (5%, 3% and 3% respectively) (Figure 3, Table S3). The pattern for income and revenue outcomes matched the overall pattern, with most effects positive (67%) some (24%) mixed, and only 3% each unclear, negative, or neutral. In both cases, the proportions were comparable when excluding non-systematic reviews (Table S4). For job creation or labor demand, there was a slightly lower proportion of positive outcomes (50%) (with an increase in labor demand being classed as a positive outcome), with 38% mixed, and again very few unclear or negative (i.e. reduced labor demand). However, when excluding non-systematic reviews, most (56%) outcomes for labor demand were mixed (Table S4). Rather than being an effect of study quality, this is because most systematic reviews reporting on labor demand focused on nature-based food production, where reduced labor demand was often seen as a cost-saving measure (to increase profits). Two thirds (9, 67%) of the interventions framing increasing labor as negative (i.e. a cost) were associated with mixed positive and negative effects on labor demand. In contrast, where labor was framed as positive (for job creation; primarily for interventions other than nature-based food production) most reported outcomes (13, 65%) were positive.

Few outcomes were reported for job security, most (60%) of which were mixed, or for economic growth, of which most (89%) were positive. For example, revenues from the sale of NTFPs (e.g. aromatic resins in Ethiopia) can contribute substantially to national economies [54], and restoration investments in the US were found to yield as many as 33 jobs per $1 million invested, with an economic output multiplier between 1.6 and 2.59 [10].

Proportionally more reported effects on income or revenue were positive for nature-based food production, while there were proportionally more mixed outcomes for interventions involving protection, management, restoration, or ecosystem creation. There were no clear differences between intervention types for employment outcomes.

Overall, few cases (8) reported positive contributions to skills and training, with one case reporting mixed effects, and two reporting neutral outcomes. Investments in capacity strengthening either targeted technical skill building for the intervention itself (e.g. extension and training programs for agroforestry [55], or were complementary (e.g. business skills to establish agri-businesses and micro-enterprises [56]. Neutral effects reflected a lack of investment in capacity building [e.g. [57], or where intervention did not require specialized skills (in turn providing low entry barriers to the labor market; [58]). One review reported mixed effects, where the capacity building did not train workers with transferable skills, thereby limiting their opportunities to integrate into labor markets subsequently [59].

Viewing the results in terms of the number of underlying studies within each review reveals that although the overall pattern are similar, the evidence on skills and training and economic growth comes from a small number of studies (Figure 4).

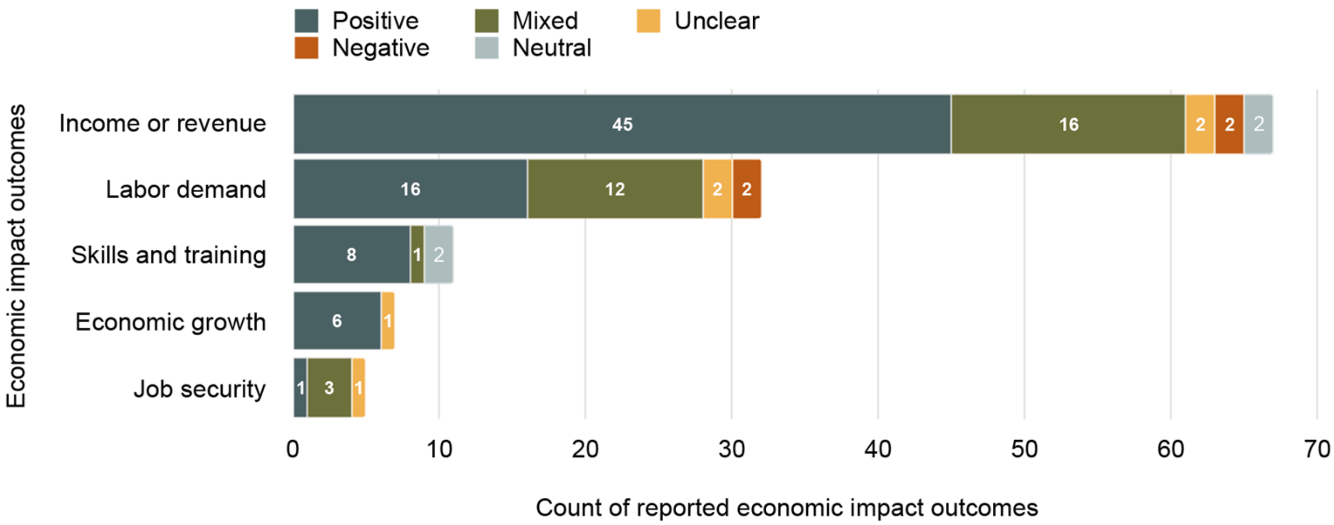


Figure 3. Number of reported outcomes, per economic impact category and effect direction

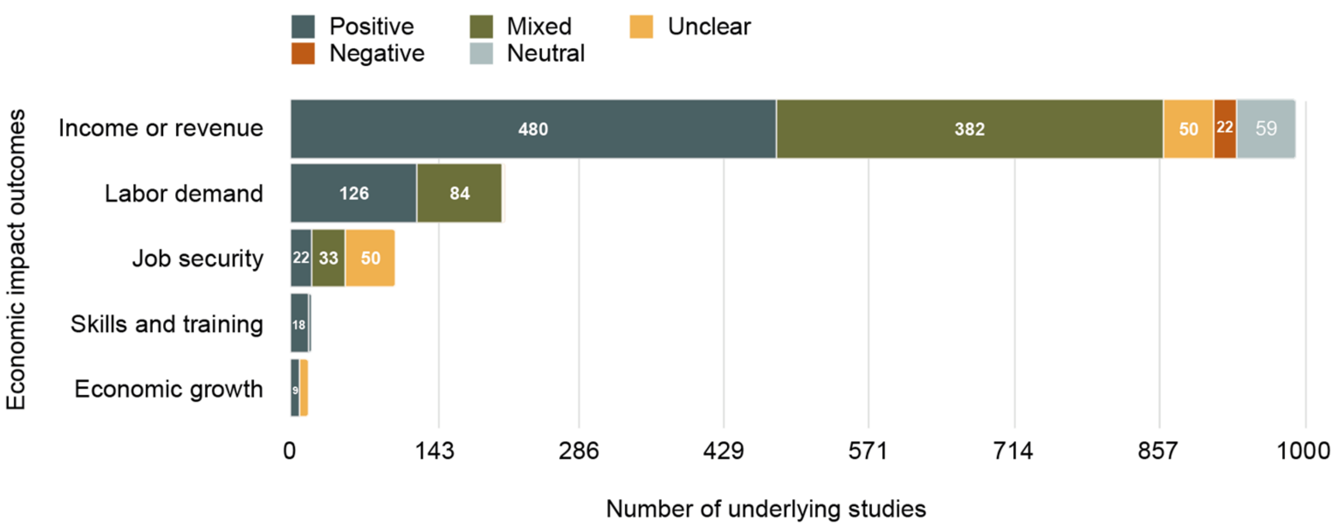


Figure 4. Number of underlying studies supporting each reported outcome

Effectiveness of nature-based interventions compared to alternative approaches

Overall, 17 (39%) of the reviews reported intervention comparisons with alternative non-NbS (15, 30%) and/or other NbS (10, 22%). For the comparisons with non-NbS, the 17 reviews reported 19 comparisons) of which most (58%, 11) were positive, 26% (5) were negative and the remaining 16% (3) mixed, unclear or no effect. Most compared nature-based agriculture (e.g. conservation agriculture or agroforestry) to conventional agriculture or forestry. For example, measures to improve soil health and water retention (such as reduced tillage) tended to increase yields in the long term and often decreased production costs (e.g. irrigation costs), thus increasing profitability [60-63]. Several reviews also reported benefits from adoption of agroforestry, such as higher productivity and yield stability compared to crop monocultures [55, 64]. Only five comparisons were for non-agricultural interventions, all focusing on comparison of revenue generation or profit margins. They included forest management, where one review found that FSC certified management was less profitable than non-certified management because the price premiums tended to be outweighed by higher operational costs [65], and two reviews reported benefits for local communities from decentralized forest management compared to top-down restrictive management [54, 65]. One review found that revenue from green urban infrastructure (green roofs) did not outweigh installation costs, generating losses for building owners compared to conventional roofs, although there were net benefits for society if all benefits were taken into account [66]. Lastly, a review found that the restoration industry had comparable employment multiplier effects to traditional sectors (e.g. oil & gas, construction, or crop agriculture) [10].

Through what pathways do nature-based solutions contribute to economic impact?

All but one of the 46 reviews contained evidence on the pathways by which economic outcomes were delivered. We identified 12 distinct pathways by which NbS contributed to income or revenue (across 45 reviews), 8 pathways for effects on labor demand or employment creation (across 22 reviews), 5 pathways for job security (across 6 reviews) and 4 for economic growth (out of 7 review).

Outcome pathways

Income, revenue, or profitability pathways

These pathways fell into five overarching categories: 1) higher or new revenue generation (e.g. from the sale of goods (e.g. fish, NTFP, crops), services (e.g. offset credits), or property taxes), 2) avoided costs (e.g. energy savings from green roofs and walls, or reduced input costs for agriculture), 3) household income from employment generation, 4) labor shifts to off-farm jobs, which can be higher paid, and 5) household, business or community revenue from subsidies or payments for ecosystem services.

The most common pathway was where investment in nature-based food production influenced income (17 reviews, 40% of all profitability pathways), followed by revenue from payments for ecosystem service schemes (9 reviews, 21%), revenue generation through ecotourism (6, 14%), community-based natural resource management (e.g. sustainable NTFP production) (5, 12%), and labor shifts where landscape restoration interventions freed up agricultural labor for other employment (5, 12%) (Fig 5). Less commonly cited pathways included increased revenue from the sale of offset credits (for carbon storage [67] or wetland restoration [10]), where green infrastructure generated employment or ecosystem services reducing costs (e.g. reduced energy consumption through the installation of green roofs [66]), marine protected areas increasing or sustaining fishery catch [68], and conservation easements or green infrastructure increasing property values and generating tax revenue [66, 69].

For eight out of the 12 pathways for income and revenue, most reviews reported positive effects (Figure 5). For nature-based food production, benefits occurred through reduced input and labor costs [60], reduced exposure to income volatility (such as from diversified income streams or resilience to extreme weather [62]), and increased yield or output [70-72]. Key to these pathways is the positive effect of nature-based food production on ecosystem services (e.g. pollination, pest control, or soil health), thereby also improving job security [70] and climate change adaptation.

For the other four pathways, at least half of the outcomes were mixed. This included cases where price premiums for certified goods were insufficient to overcome implementation costs [73], where producers became over-specialized in the certified commodity, thereby becoming more exposed to price downturns [74], where offset credits were less than opportunity costs of land-use restrictions [75, 76], where there was a lack of market access [77], or where yield fell after transitioning to agroforestry from monoculture [65, 78]. Other factors potentially negatively impacting income included choice of crops [72], costs of human-wildlife conflict [57], or lack of available off-farm employment following restrictions in land-use. The one review reporting a purely negative impact was where the equipment and labor costs of conservation tillage were generally not offset by increased yield, especially where herbicides were used [79].

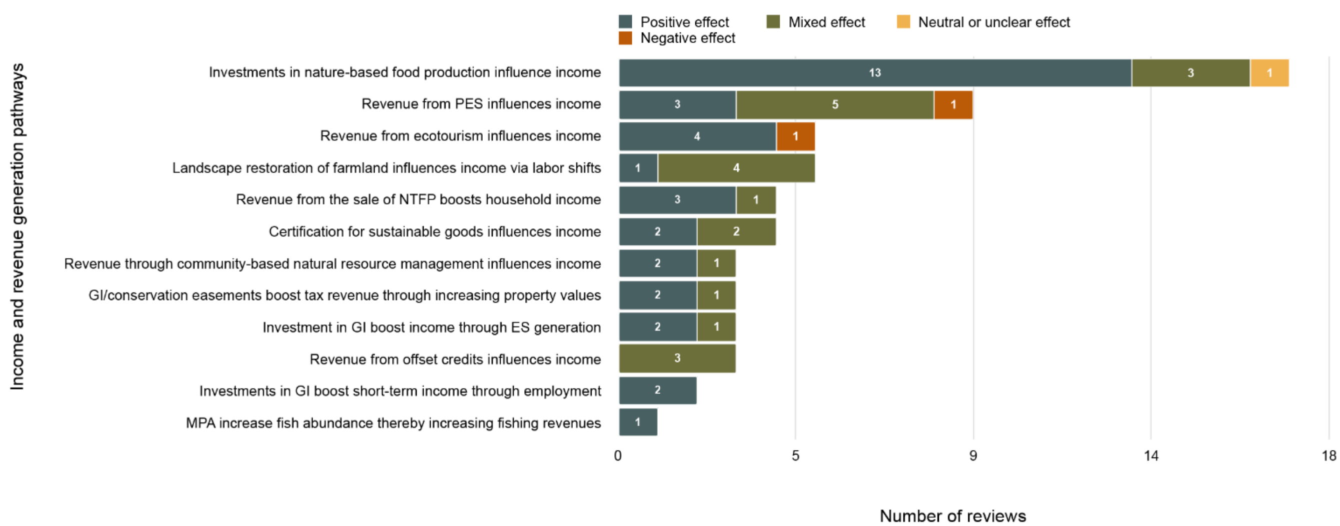


Figure 5. Count of reviews reporting each outcome pathway for income or revenue, along with the associated effect (GI = Green Infrastructure, e.g. green roofs and walls).

Labor demand and job creation pathways

The most common employment pathways involved nature-based food production (5, 24% of the reviews reporting labor pathways), ecotourism (5, 24%), green infrastructure or restoration investments (3, 14%), all of which generally increased labor demand (Figure 6). Positive employment outcomes also occurred through revenue generated by community forest management, and through increased ecosystem services including the sale of NTFPs or increased fishing revenue adjacent to MPAs [80].

Mixed or negative impacts on employment occurred where there was a lack of ecotourism (e.g. due to low wildlife densities or lack of investment in in tourism operation; [57]), from shifts to off-farm labor following land-use restrictions for landscape regeneration [77], or where nature-based food production led to increases and decreases in labor demand, such as through reductions in labor demands for agrochemicals and increasing labor demand for hedge maintenance [62].

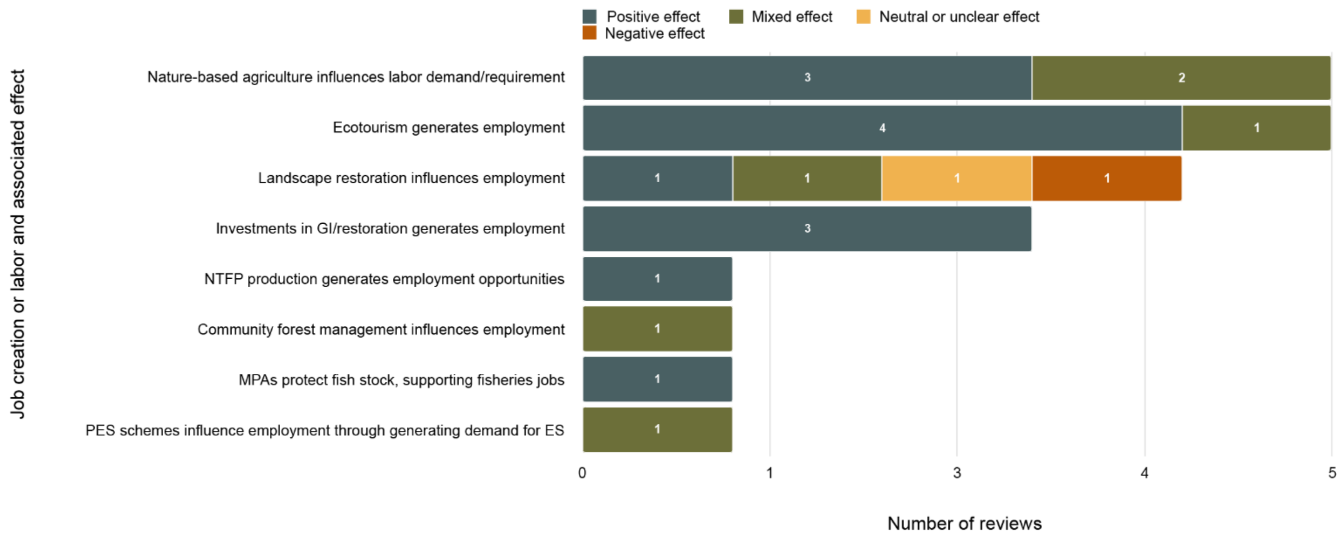


Figure 6. Count of reviews reporting each outcome pathway for job creation or labor, along with the associated effect.

Job security pathways

Job security was reported to increase where agricultural diversification stabilized revenue streams [70], or where community-forestry strengthened ownership, use and access rights [67]. However, a lack of focus on transferable skill development can lead to job insecurity once the intervention ends due to challenges in integrating other sectors [59], or due to a lack of formal employment opportunities (such as where urban green infrastructure is established and maintained by informal workers) [58].

Economic growth pathways

Impacts on economic growth were reported to emerge through revenues generated by ecotourism, [81], the sale of NTFPs [54, 79, 82], and investments in restoration which generated labor demand, business-to-business expenditures, and household spending with high economic multipliers [10]. Blundo-Canto et al. (2018) found mixed (though mainly positive) effects on household expenditure under PES schemes (although a lack of data was noted), with revenue from PES also contributing to infrastructure construction (e.g. schools, clinics, power grids) [77].

Mediating factors

Across outcome pathways, we identified up to 19 mediating factors per review (avg = 5.16; S.D. = 3.21) across 44 (96% of) included reviews. Mediating factors often influenced more than one outcome pathway, either positively or negatively. They included factors internal to the intervention (e.g. the density of trees in agroforestry, or the degree of stakeholder engagement), or external (e.g. legislative and regulatory frameworks, or the level of public and private finance). The most frequently identified category of mediating factors across reviews was economic and financial (identified in 80% of reviews reporting mediating factors), followed by technical (68%), governance and institutional (57%), and social and cultural (52%) (Figure 7). Mediating factors within each category are detailed in Appendix D and E (supplementary results), and Table S3.

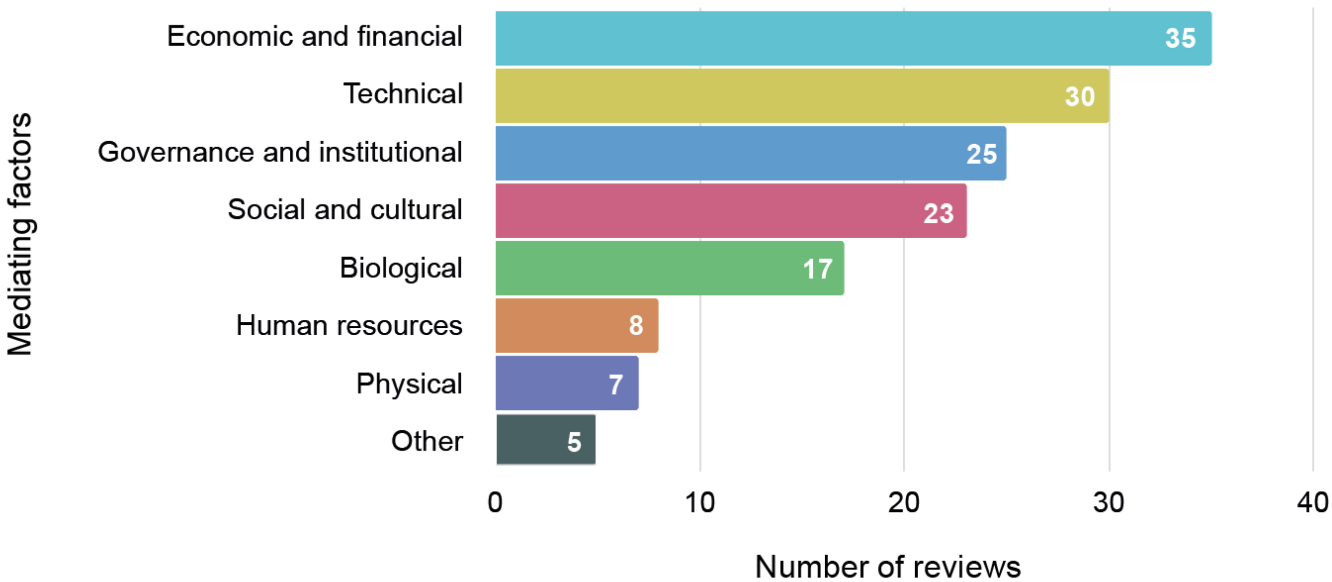


Figure 7. Prevalence of mediating factors identified across reviews. For each category, the number of reviews specifying one or more mediating factors was summed up. See supporting information for category definitions.

What trade-offs and win-wins are reported?

Overall, 35 (76%) of the reviews explicitly reported evidence of trade-offs or win-wins, but nine reviews noted a lack of data. Trade-offs and win-wins were either between outcomes (26, 74%), between stakeholders (distributional effects and equity) (25, 71%), over space (5, 14%), or over time (6, 17%).

Among reviews reporting trade-offs or win-wins between outcomes, 18 (69%) reported trade-offs between economic impact and biodiversity, and 12 (46%) reported win-wins with biodiversity outcomes. The most frequently reported trade-offs or win-wins were between biodiversity and provisioning ecosystem services, e.g. production of food or timber. Only four reviews explicitly reported win-wins and no-trade offs. For the reviews reporting distributional effects (i.e. how costs and benefits disaggregate across social groups), most (25, 90%) highlighted mixed or negative effects on equity (e.g. where income inequality increased between social groups). The two exceptions noted positive impacts: the conservancy system in Namibia was reported to reduce social conflicts between local communities and park authorities [83], and where engagement of coffee farmers in conservation led to more equitable land holdings and greater social stability [70]. All reviews explicitly reporting on spatial or temporal dimensions focused on trade-offs rather than synergies. For example, short-term trade-offs occurred where high implementation costs or slow system maturity in nature-based food production led to a period of reduced profit subsequently offset by longer term increased yield or more resilient production over time [55, 73]. Spatial trade-offs resulted from leakage, with displacement of ecosystem loss and degradation to neighboring areas [75, 84, 85] (Appendix D, supplementary results).

Trade-offs between outcomes

The most frequently reported trade-offs were between biodiversity and income or profitability, which can arise due to several mechanisms. First, restricting the use of natural resources in areas that are being protected or restored can reduce incomes, e.g. when pastoralists lost their livelihoods due grazing bans aimed at restoring degraded grassland in China [75]. Second, some reviews noted cases where nature-based production methods were less profitable than conventional methods, e.g. if the shade cast by agroforestry trees reduces yield, or where agroforestry or organic cropping systems optimized for cash crops provide higher returns but lower biodiversity [55, 70, 74]. Third, high implementation or labor costs can reduce profits, e.g. for agroforestry [62] or conservation agriculture where manual weeding is necessary (the alternative being the use of herbicides, which involves a further trade-off with biodiversity) [86]. Fourth, poor management focused on short term profits can lead to adverse biodiversity outcomes, e.g. where ecotourism geared at maximizing tourism leads to environmental damage in protected areas [81, 87]. Finally, ecosystem protection can be associated with increasing human-wildlife conflicts, reducing crop yield [65]. According to the sampled reviews, the extent of profitability trade-offs for nature-based food production depended on whether farmers received price premiums for nature-friendly products (e.g. through certification schemes) or whether compensation or subsidies offset opportunity and implementation costs (e.g. through PES for agroforestry) [55].

Win-wins between outcomes

Several win-wins were reported in the literature. Agro-diversification was reported to drive increased profits, either from greater yield (e.g. integrated crop-livestock farming [62]), or access to premium prices in markets (e.g. agroforestry [55, 62]). Agro-diversification was also found to reduce the risk of economic loss by promoting food production resilience, such as through crop rotation [62], intercropping [62], agroforestry [62, 70], or integrated crop-livestock farming [62]) (see outcome pathways for more detail). Other nature-based food production measures which were reported to enhance ecosystem services and boost yield included climate-smart agriculture which reduced soil salinity, sustaining soil health and soil ecosystem services [68], and crop residue retention and increased weed herbivory rate under conservation agriculture [79]. Finally, win-wins were observed for conservancy schemes adjacent to protected areas in Namibia which harmonized biodiversity conservation with local livelihoods [83].

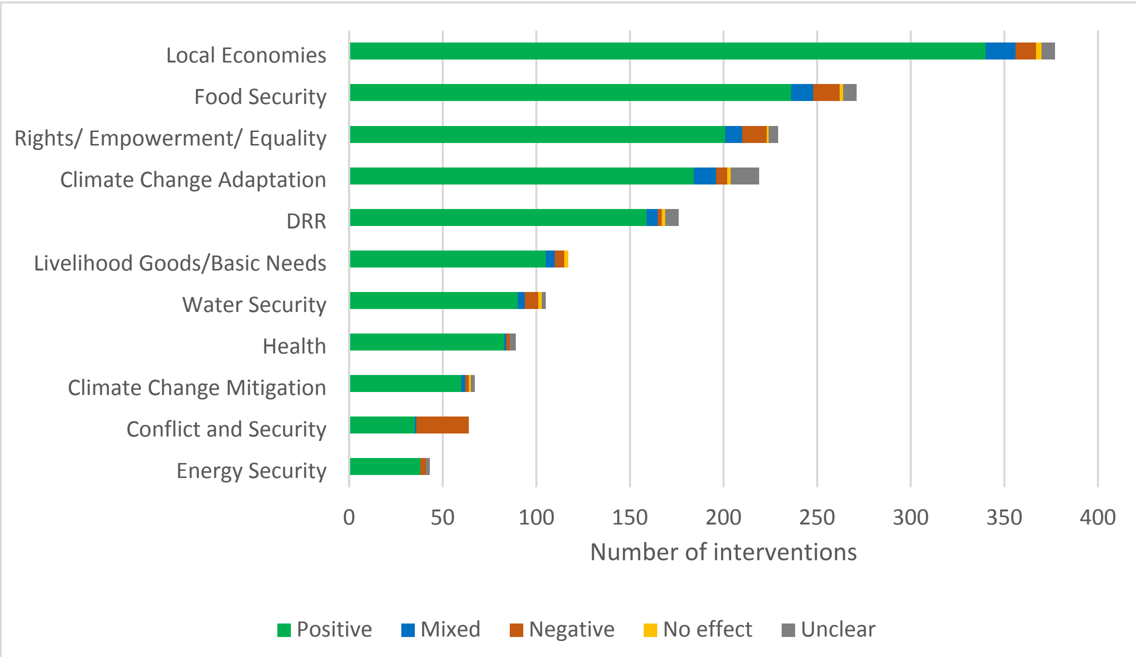
Relationship between economic impact and climate change effect

Most reviews did not explicitly compare economic impact and effects on climate change (adaptation or mitigation); therefore we report associations between independently reported effects on both outcomes. Of reviews reporting on adaptation, 13 (41%) had win-wins (i.e. positive outcomes for climate change adaptation and economic impact), of which 9 involved nature-based food production (see outcome pathways for more detail). Mixed effects on one or both dimensions were reported by 15 (47%) reviews (Fig 5). For reviews reporting climate change mitigation outcomes, 6 (40%) had positive effects on both mitigation and economic outcomes. Of these, three reported evidence of increased farming profitability through improved yields, reduced costs, or regenerating degraded land, while reducing carbon emissions or increasing sequestration. Of those reporting trade-offs between adaptation or mitigation and economic impact, most were due to mixed effects on labor in the context of nature-based food production [60, 62, 68]; for most of these, there were win-wins with increasing income or revenue. Two reviews reported positive effects for climate change adaptation, mitigation, and economic impact (income/revenue). Both were nature-based food production measures focusing on improving soil health (conservation tillage and cover crops) [60, 62].

Wider benefits

Our supplementary analysis of the previous systematic review dataset on the outcomes of nature-based interventions for development in the Global South (Roe et al., 2021) shows a wide range of development outcomes of which most (87%) are positive, 4% are mixed and 5% negative (the other 4% being unclear or having no effect). Direct impacts on local economies are the most frequently reported outcome, followed by food security and then rights / empowerment / equality (Figure 8).

Figure 8. Development outcomes from nature-based interventions for climate change adaptation (based on the dataset created by Roe et al., 2021)



Although conventional direct economic outcomes for jobs, incomes and revenues are reported in the aggregated category of 'Local economies', all development outcomes can have indirect economic impacts. For example, improving household food security or livelihoods, or improving access to urban green spaces, can also improve physical and mental health (e.g. [88]), leading to lower healthcare costs [89, 90] and higher workforce productivity [91]. Similarly, benefits for climate change mitigation, adaptation and disaster risk reduction translate to lower economic costs of damage to infrastructure or crop production from storms, floods, droughts, or fires. For example, coral reefs offer coastal flood protection worth US$272 billion globally [92]. Economic benefits also arise when NbS reduce local conflicts and geopolitical instability through better management of natural resources. NbS can also encourage the empowerment of women, and their contribution to the formal economy, e.g. by starting new businesses (e.g. [93]). Finally, NbS can improve food and livelihood security and provide resilience to economic shocks when other sources of income are lost [53]. This is particularly important as the strength of calls for greater emphasis on resilience in economic policy grow [94].

How are costs and benefits distributed across social groups?

Interventions not tailored to the needs of different social groups led to trade-offs for employment and income. Inequity in benefit distribution was attributed to 1) differential opportunity costs, 2) elite capture, 3) conflict over ecosystem service use, or 4) inequities embedded in the sociocultural and governance context. For example, some interventions increased gender inequity, such as where engrained gender hierarchies subjected women to increased unpaid labor burdens (e.g. PES schemes [77], agroforestry [86], conservation agriculture [86, 95], or where women encountered difficulty in accessing and owning land to generate revenue from agroforestry, lacked support from agricultural and extension public policies [55, 64], or had unequal access to information, program benefits, technology, capital, and markets [55, 65].

The opportunity costs associated with NbS can vary between social groups due to differences in natural resource dependency (e.g. where the establishment of CFM most negatively impacted those most dependent on natural resources [67, 73] . In some cases, certification scheme requirements increased transaction costs for poorer, under-resourced households, risking market concentration by wealthy landowners [74]. Social trade-offs were also associated with spatial trade-offs due to conflicting use of ecosystem services, such as where water conservation measures [61] or forest protection [65] increased water availability in one area while reducing it downstream.

Elite capture, where wealthier or powerful groups benefit disproportionately, was reported by nine reviews across a range of different intervention types (e.g. sustainability certification schemes for agroforestry, ecotourism, community-based natural resource management, or urban green infrastructure). Alongside examples of unequal distribution amongst participants, a few reviews also highlighted increased inequality between participants and non-participant groups, such as in the context of PES [67, 77]. The evidence demonstrates that these social trade-offs can be mitigated through an explicit focus on marginalized groups, such as where mechanisms help the marginalized meet sustainable crop certification standards [96].

A few reviews also highlighted social trade-offs between local communities and governments, such as for revenue distribution from ecotourism or community resource management between government agencies and local communities [56, 57]. One review discussed the unequal distribution of costs and benefits where private investment in green roofs can have a negative return on investment for the individual but overall significant benefits for society [66]. This is an example where the government has a potential role in subsidizing private costs to deliver societal benefits.

Case study: Protected areas in Peru

We complemented the systematic review with a detailed case study of protected areas in Peru (SINANPE) showing how strong participatory governance fosters win-win outcomes where NbS support local livelihoods (Box 2). Landscape use contracts are signed between SINANPE and the local communities that live inside the protected areas or in buffer zones. These enable local employment and revenue generation from eco-tourism and sales of certified sustainably harvested goods at a price premium. Sale of carbon offset credits funds the restoration, maintenance and monitoring of the protected areas which also generates employment, e.g. as park rangers. Eco-tourism also generates multiplier effects through the demand for other services (e.g.

handicraft sales) providing income and employment opportunities, although the estimates in Box 2 do not include induced jobs.

Discussion

To our knowledge, this is the first systematic review reporting on the economic impact of nature-based interventions across a broad range of intervention types and geographical contexts. We conducted a 'review of reviews' to synthesize scattered evidence from multiple interventions and diverse outcome measures. Our aim was to provide a comprehensive summary to enhance utilization of evidence on NbS in fiscal policy, including in response to economic downturns. Here, we supplement our analysis with additional evidence from 'grey' and primary literature, as well as a case study from Peru providing a detailed country-level analysis (see Box 2).

Quantitative meta-analysis was not feasible, due to the variability in reported variables and review methodologies. Therefore, caution is advised when interpreting the results. The prevalence of evidence across categories of economic impact, pathways and mediating factors varies depending on the scope or focus of the underlying studies. Additionally, the most recent evidence may not have been captured by reviews. Nevertheless, our approach allows us to characterize the evidence base and explore pathways and mediating factors in various intervention contexts, enhancing our understanding of how NbS contribute to economic impact.

Synopsis of key findings

Our mapping revealed evidence on a range of nature-based interventions but with significant gaps. We found 46 reviews reporting economic outcomes from nature-based interventions, although few were explicitly categorized as NbS. The evidence was biased towards nature-based food production (50 % of cases); few (19 %) covered ecosystem restoration, or novel ecosystems such as urban NbS (15 %). The majority of the evidence came from sub-Saharan Africa (43 % of studies), East Asia and the Pacific (41 %), South Asia (28%), and Latin America & the Caribbean (24 %), with few studies across North America, and the Middle East and North Africa. This contrasts with the evidence base on the mapping and flows of ecosystem services and their valuation which is concentrated in higher income countries [97, 98], as is evidence on NbS for climate change adaptation [1]. Some gaps may be due to our exclusion of non-English language studies, although some reviews included primary non-English literature, which helped capture additional evidence.

Most evidence on outcomes focused on income or revenue generation, predominantly at the household level, followed by changes in labor demand, including employment generation. We found a lack of research on economic growth impacts, although available evidence indicates that nature-based interventions deliver high gross value added and comparable or higher returns per unit of investment than other sectors [10, 29, 37]. Overall, most reported effects were positive, demonstrating that investments in nature stimulate income generation and employment at different skill levels. Of the few studies that compared the impact of investments in nature with alternative approaches, most showed the former to be more effective, focusing on income or revenue generation.

Most reviews (76%) reported trade-offs or win-wins, especially trade-offs between biodiversity and livelihoods due to transaction or opportunity costs, where interventions reduce agricultural output or limit natural resource use. However, these short-term opportunity costs can be managed through strategies such as securing price premiums, compensation or subsidies, with benefits for ecosystem health, biodiversity, and economic outcomes. Agro-diversification also builds resilience, reducing risks of economic loss. We also found positive associations with adaptation resulting from livelihood or crop diversification, which increased profits through reduced costs, increasing outputs, or complementary revenue sources (e.g. NTFPs) [54, 60, 62, 63, 70]. Positive associations with climate change mitigation also occurred, mainly through nature-based food production increasing carbon sequestration (above or below ground) or reduced emissions, while increasing farming profitability or employment.

How do nature-based solutions deliver economic impact?

We identified a variety of pathways through which nature-based solutions can influence income and revenue generation, as well as employment and labor demand. Effects on income or profits mostly occurred through direct revenue generation from the sale of ecosystem goods or services, avoided costs, employment generation, or through revenue from subsidies or payments for ecosystem services. Direct effects on labor followed shifts to nature-based food production, the implementation of green infrastructure, and investments in ecotourism. Although we found little evidence of indirect and induced job creation, and economic multiplier effects through business-to-business spending, the few studies reporting on economic growth found positive impacts, while highlighting many mediating factors. These include the type of ecosystem or restoration project (which affects the size of investment required), the causes and extent of ecosystem degradation, labor cost, government legislation (shaping regulatory requirements to invest in NbS), and regulatory standards (e.g. procurement rules or requirements to source local labor) [10]. For nature-based food production, mediating factors can reduce revenue, in turn affecting economic growth through reduced expenditure and investment in supply chains. These include low market prices, lack of market regulation, constraints in marketing channels or limited lobbying capacity, lack of access to credit, or elite capture [54, 99].

The importance of mediating factors makes it difficult to predict whether a specific NbS intervention will lead to positive or negative economic outcomes, or if trade-offs or win-wins will occur with other objectives, emphasizing the context dependency of NbS outcomes. A pathway can result in win-wins in one context and trade-offs in another, depending on mediating factors like market access, input costs, the ability to attain price premiums, or adequacy of subsidies or PES to offset opportunity costs. Outcomes are shaped by technical factors relating to intervention design, implementation, and management, but also by other internal and external economic, financial, governance, institutional, social, cultural, and to a lesser extent, biological factors. This highlights the importance of the broader social, economic, and bio-physical character of NbS, corroborating the evidence on how NbS reduce vulnerability [2], or how Ecosystem-based Adaptation (EbA) is effective [52]. This also reinforces the notion that NbS are actions which are based on biodiversity and people [36] through an interplay of human-nature relations [100].

Is labor demand a cost or a benefit?

This review shows that NbS are often more labor intensive than other potential investment options, thus providing significant potential for job creation. For NbS food production however, effects on labor varied depending on the mode of implementation [62]. For example, intercropping, agroforestry, and organic agriculture are generally found to increase labor demand [101], but conservation agriculture can either increase or decrease it for different cultivation stages (with crop residue retention reducing the need for pre-tilling, but reduced tillage potentially increasing the need for weeding unless herbicides are used; [86]). Although most reviews treated labor as a cost, scaling-up nature-based food production can translate into employment opportunities for poor households [86, 99]. These measures also provide job security through diversified income streams and reduced income volatility [70]. Whether increased labor demand is seen as beneficial or negative ultimately depends, from a fiscal policy standpoint, on the economic cycle, whereby job creation is prioritized during economic downturns and periods of high unemployment [102]. However, it is also true that job creation is generally seen as positive by government (who win votes by keeping unemployment down) and negative by business (as profits increase when output per staff member is higher).

Promoting equity in economic impact

Social equity is a core dimension of sustainable development and a central aspect of NbS [49]. How effects (and costs, benefits) disaggregate across social groups has important material implications for achieving human well-being, notably by mediating the overall effectiveness of NbS [2, 103]. Positive impacts on jobs and incomes can mask trade-offs between social groups, highlighting the importance of considering equity, which remains under-reported in the literature [55, 77]. We found that social inequity occurred when interventions were not tailored to the needs of different groups, including consideration of vulnerabilities embedded in the sociocultural and governance context. This aligns with the scholarship on NbS (notably EbA) which calls for exploring how benefits disaggregate across groups, how this affects vulnerability, and in turn, how interventions can more effectively support adaptation [2, 104, 105]. A range of mediating factors shaped distributional effects, notably elite capture, differential opportunity costs per group (due to different types of livelihoods and dependencies on nature) or inequities embedded in the sociocultural or governance context, such as gender hierarchies. Many reviews across a range of intervention types highlighted elite capture as a major issue, and a crucial barrier in achieving equity in economic impact. This is a cross-cutting issue in natural resource management and development, whereby the powerful co-opt finance and benefits, thereby reinforcing unequal power relations [105] and jeopardizing progress towards the SDGs. Addressing this requires ensuring local communities and disadvantaged groups, including women, children, disabled, and minorities, actively participate in intervention design and implementation to avoid skewed distribution of benefits (ibid). For example, SINANPE in Peru (see Box 2) seeks to engage vulnerable groups (e.g., women, indigenous communities) in training to strengthen local capacities, organization skills and empowerment in resource management and conservation. Moreover, SINANPE operates a volunteer program for local people that provides training and a small stipend to support forest monitoring activities, involving 2,366 local community members in 2020.

Wider economic outcomes

Our supplementary analysis of the dataset from [53] demonstrated that NbS foster many societal and environmental benefits that support economic prosperity, including climate change adaptation [1], climate mitigation (e.g. [3, 4]) biodiversity and ecosystem health [106]. Well-governed NbS support food and water security, provide green space for recreation, help protect from floods, droughts and heatwaves, and support social empowerment, all of which improve community health, well-being and economic resilience (ref 1). This was also demonstrated by the case study of protected areas in Peru, where there was emphasis on supporting local livelihoods through agreements allowing sustainable NTFP harvesting for subsistence, along with capacity building through training. Because these public benefits have limited direct market value, and are difficult to quantify in monetary terms, it is crucial to consider plural market and non-market values to stimulate policies that are inclusive and respond to human well-being [98]. This will require new methods to account for the diverse values of nature [107]. Policy and project evaluations and appraisals should also look beyond short-term economic objectives, to ensure long-term resilience and avoid maladaptation [108]. Ultimately, this requires transitioning towards a new economic paradigm, where well-being is the core objective rather than GDP growth and capital accumulation [41, 44]. Such a transition would focus on regenerative human-nature relations, and thus enable a shift to circular economies that sustain both human well-being and the biosphere [42].

Comparison with other studies and evidence gaps for future research

In this section we compare the findings of our academic review with evidence from wider academic and grey literature and consider evidence gaps and priorities for further research.

Temporal dimensions of job creation

Although impacts on labor demand were commonly reported, we found a lack of evidence in the academic literature on the temporal dimensions of job creation (short-term vs long-term), despite growing evidence in the grey literature that NbS stimulates short-and long-term job creation [109, 110] (see Appendix D for supplementary results).

Skills, training needs and job quality

The evidence in our review suggests that nature-based interventions can stimulate both low- and high-skilled jobs. This is supported by additional evidence from grey literature (see Appendix D for supplementary results). For instance, In South Africa, establishing green infrastructure creates jobs that do not require specialized skills, allowing for easy entry into the labor market for low-skilled individuals [58]. On the other hand, technical extension and training programs build specialized skills and knowledge [55] and leverage local traditional knowledge [71] to scale NbS. However, there is still a gap in understanding job quality, despite the recommendation of the IUCN Global NbS Standard [49] to prioritize "decent work" in NbS as defined by the International Labor Organization [111]. These could build on the work of Vardon et al., 2022, who detail the role of natural capital accounting in driving greener recovery [112].

Economic impact at regional or national scales

Our analysis corroborates evidence from large-scale investments in nature in the grey literature (see Appendix D for supplementary results), demonstrating strong job creation and protection to sustain crucial ecosystem services. Most employment outcomes were reported as positive effects (except for studies at the farm-scale that framed labor as a cost). Two studies from our review demonstrate high potential for job creation at national scale, in developing country contexts: [81] estimate that the forest tourism industry in China has employed half a million farmers, reducing poverty across 4,654 villages, and [99] report that 16,000 rural people in Kyrgyzstan were directly employed in the walnut value chain. Similarly, our case study in Peru showed creation of over 36,000 eco-tourism jobs (Box 2).

Direct impacts on growth and multipliers

Although there is compelling evidence that NbS can stimulate growth across a wide array of industries (e.g., via gross value added, economic multiplier effects) [10, 37] (see Appendix D for supplementary results), this comes from relatively few studies. Most studies reported economic outcomes at the household or community level, reflecting a lack of mechanisms to track fiscal policy measures and government spending at broader scales, such as through national inventories [10], as well as general lack of systematic data collection and reporting on NbS implementation. This is challenging because NbS cut across traditional sectors (e.g., water, agriculture, infrastructure, environmental protection), implicating many public and private sector actors. There is no standard industrial classification, and public and private funding sources are diverse, making investment and outcome tracking difficult [37, 104]. To scale up the evidence base, we need comprehensive accounting systems that track both public and private investments in NbS, enabling the integration of this data into economic models for estimating the broader economic impacts of NbS activities, including indirect and induced effects [10].

Under-represented ecosystems

Although the available evidence shows that NbS in grassland, dryland, freshwater, coastal and marine ecosystems hold important potential for both job creation and income generation (see supplementary results in Appendix D), we found a lack of evidence across these ecosystems, in contrast to forest ecosystems and working landscapes (43% and 72% of intervention cases, respectively). This aligns with known biases in the evidence base on NbS towards forest ecosystems [1, 113]. This is concerning, given the critical role of these ecosystems in supporting livelihoods (grasslands – [114, 115]; coastal ecosystems – [116]), climate change adaptation [1, 2, 92, 117] and mitigation [118, 119]. Understanding how NbS in these ecosystems can support economic impact, as well as biodiversity and climate benefits, is critical to increase ambition and guide their scaling-up.

Urban nature-based solutions

Surprisingly, we found little evidence on the direct economic impact of investments in urban NbS, although evidence from the grey literature helps to bridge the gap (see supplementary results). The extensive literature on urban green infrastructure focuses mainly on benefits for climate change adaptation [120], water treatment [121], and human health and well-being [122, 123], sometimes with economic valuation of the indirect outcomes. However, the few reviews that we found report important benefits for employment and income generation [58] and increased profits through reduced energy expenditure [66], with both also noting the potential for increased tax revenues. With the global urban population set to double by 2050 [124], NbS could provide a significant source of jobs and income for urban residents, in addition to benefits for health, human well-being, and climate change adaptation.

Comparison with alternative interventions

We found a lack of comparisons of economic outcomes of NbS investments versus alternatives, particularly outside the context of food production. Evidence is however growing, showing high economic multipliers for nature restoration compared to other sectors [37], with greater benefits for jobs and incomes than conventional alternatives across both high- and low-income countries [125]. Although natural capital investment policies have high potential economic multipliers [19], lack of comparisons makes it more challenging to mainstream NbS in fiscal policy [7, 9-11]. Unless this evidence-base is expanded significantly, economic stimulus policy may continue to focus primarily on traditional investments such as road construction or fossil fuel energy, despite the increasing emphasis on building back better and green economic recoveries [6]. On a regional or national scale, poor data collection on the economic outcomes of NbS investments limits cross-sectoral comparisons on the effects of stimulus measures.

Trade-offs and synergies

Assessing trade-offs to optimize the design of NbS for equitable delivery of multiple benefits is crucial but challenging due to limited evidence. There were few holistic assessments covering multiple outcomes, except for the interactions between biodiversity and livelihoods, jobs, or income [55, 67, 77], and few studies considered temporal or spatial trade-offs. Better monitoring of outcomes across social, economic, ecological, and climate dimensions is crucial to capture the broader array of material and non-material benefits NbS can bring and manage potential trade-offs [1]. This includes disaggregated social assessments of costs and benefits, which is currently lacking [77]. Assessing NbS exclusively through a narrow lens, economic or other, can result in undervaluing NbS and thereby undermining human well-being [126].

Protocol for gathering evidence on economic outcomes

To expand the evidence base, we recommend that researchers and economists work with practitioners to develop guidelines to scale robust assessments of the economic outcomes of NbS. For example, this could learn from the guidance on well-being impact evaluation for conservation interventions developed by de Lange et al. (2017) [127]. Guidance on the use of standardized economic indicators is needed, such as full time equivalent (FTE) job years per unit investment or per Ha of land, while recognizing that the wide range of NbS sectors, contexts and study aims will inevitably require diverse indicators. It is also important to go beyond direct effects and account for indirect and induced impacts on jobs and revenue. Additionally, there is a lack of studies with comparators (e.g. suitable baselines, or counterfactuals such as controls). Although controls can have shortcomings (e.g. where the control and intervention sites evolve in different ways between sampling periods), comparators are crucial to infer impact. Randomized control trials could be explored for investments in some intervention types, if spillovers between control and treatment groups can be minimized, control and treatment groups are truly comparable, and measured indicators are of significance to the individuals and communities that are impacted. There is also a need to better track the social distribution of costs and benefits, as well as potential displacement of negative social and environmental impacts over space (e.g. leakage or potential displacement of jobs or incomes in other sectors), and time (e.g. short term job creation of tree planting vs long term impacts on biodiversity and ecosystem services under natural regeneration).

Conclusion and recommendations for policy makers

This systematic review of reviews demonstrates that NbS can bring economic benefits, stimulating economic output and employment. NbS can generate direct jobs and incomes while offering high gross economic output per unit of investment compared to other sectors, resulting in cascading benefits throughout economies. Well-designed NbS can respond flexibly to economic shocks, providing diverse jobs for different skill levels, targeting deprived communities and disadvantaged groups. They can also diversify income sources and enhance resilience to future shocks. By combining traditional, local, and scientific knowledge, effective NbS can drive green sector growth and eco-innovation, hastening the transition to a clean, efficient, circular economy.

NbS can deliver numerous economic benefits beyond those included in traditional economic assessments. They can restore biodiversity, tackle climate change, reduce reliance on costly resources, improve human health, and enhance resilience. They can prevent climate-related damage, lower healthcare expenses, and strengthen economies, fostering prosperity and resilience. These outcomes are crucial for human well-being, but often overlooked in measures like GDP growth. It is crucial however to carefully design for equitable delivery of multiple benefits to all stakeholders, prioritizing vulnerable groups. To minimize trade-offs, livelihood-focused interventions co-designed with local communities are needed. Enhancing the evidence base and monitoring of economic outcomes is also crucial.

Governments and investors must consider societal benefits and long-term resilience when investing in NbS, going beyond traditional economic measures, short-term impacts, and market-based mechanisms [128]. A holistic policy framework is essential to support well-designed NbS that deliver multiple benefits, manage trade-offs, explicitly support biodiversity, engage Indigenous people and local communities, and are not treated as a substitute for fossil fuel phaseout [36]. This transition can contribute to sustainable circular economies that sustain human well-being and biodiverse ecosystems.

Recommendations for policymakers

Based on our review, we recommend that:

1. NbS suited to the local context form a central component of national and regional investment programs for economic recovery, development and climate action, as they tackle multiple economic, environmental, and social problems.
2. National monitoring and evaluation frameworks are created to track impact of fiscal policy measures and government spending on NbS, and their economic outcomes.
3. Economic assessments incorporate wider outcomes, beyond jobs, incomes, and revenues, GVA and multipliers, to understand the full benefits and trade-offs of NbS compared to alternatives.

4. NbS are led by or designed and implemented in partnership with local communities, farmers, businesses, or indigenous groups, in accordance with the four NbS guidelines (nbsguidelines.info) and the detailed IUCN global standard [49], to ensure effectiveness and delivery of equitable benefits.
5. Government agencies are provided with adequate resources to support the implementation and design of high quality NbS, with or as part of sustainable livelihood-focused interventions, and to monitor environmental, social, and economic outcomes.
6. Governments and businesses invest in education and training programs to develop skills for design, implementation, and maintenance of NbS projects, creating high quality jobs and boosting innovation.
7. Funding is generated for researchers to work with practitioners, economic experts, and local communities to support robust assessment of the socio-economic outcomes of NbS interventions, ensuring attention to the correct use of counterfactuals and a comprehensive indicator sets. Research is also needed to address evidence gaps on outcomes for job security, skills, and economic growth; for under-represented ecosystems (coastal, grassland, montane, mangroves, peatlands and urban); holistic assessments of synergies and trade-offs; and comparisons of NbS to alternative non-NbS interventions.

Box 2. The job creation and income generation potential of Peru's National System of Protected Areas

SINANPE, Peru's national system of protected natural areas (PNAs), includes 76 areas supporting ecosystem services vital for local livelihoods. Participatory governance, sustainable resource use contracts, "Aliados por la Conservación" certification, and eco-tourism promote income generation and subsistence livelihoods. The certification connects local producers to green markets, providing opportunities for people in or near protected areas. These programs supported communities during the pandemic, facilitated by the state's ability to leverage public, private, and international cooperation funds.

To boost climate change adaptation, the protected area system emphasizes ancestral knowledge and sustainable resource management. It promotes ecological resilience through preventative actions, control measures, and ecosystem restoration. SINANPE monitors climate change impacts on forest ecosystems, effectively reducing deforestation rates. Despite a spike during COVID-19 lockdowns, national deforestation decreased from 148,426 Ha in 2019 to 203,272 Ha in 2020, and down to 137,976 Ha in 2021 [129].

Economic impact

Jobs: SINANPE employment grew by 35%, from 942 people in 2011 to 1,273 people in 2021 [130]. Park rangers accounted for 55% of the workforce in 2021, with 26% being women. A volunteer program trained and supported 3,750 community members in 2019 and 2,366 in 2020 with food and stipend [131]. Tourist activities created 36,741 local jobs.

Income: Sustainable use contracts helped 4,587 families (21,100 people) in 2020, rising to 6,334 families in 2021 [132, 133]. They sell local products (e.g, vicuña fiber, chestnut and aguaje fruits), generating USD 1,332,293 income and USD 39,906 for SINANPE [130]. "Aliados por la Conservacion" certification benefits 1,788 families in 18 PNAs, selling diverse products in Lima and international markets. These value-added products from protected areas (e.g, aguaje beverage, chocolate and coffee products, handicrafts, textiles) are sold in Lima or in Europe and USA. Also, 388 eco-tourism contracts were renewed, benefiting 2,621 families [134].

Tourism revenue: Pre-pandemic, there were 2,736,650 visitors in 2019. Visitor numbers dropped to 722,593 in 2020 but increased to 1,422,335 in 2021 due to domestic tourism [130]. Entry ticket sales generated USD 6,839,250 in 2019, USD 2,408,424 in 2020, and 2,721,519 in 2021 [132]. In 2017 economic impact of tourism was approximately USD 723 million, with USD 165 million directly benefiting households and salaries, not considering multiplier effects [135].

Other benefits

Subsistence livelihoods: An additional 69 agreements for sustainable NTFP harvesting (bushmeat, aguaje fruits, various tree and shrubby species, non-viable taricaya eggs) were renewed, benefiting 829 families over 98,199 hectares in 15 PNAs [132].

Greenhouse gas mitigation: SINANPE has 3 REDD+ projects in 4 PNAs, covering 2 million hectares. These projects avoided deforestation of 95,000 Ha from 2008-2020, resulting in 36.6 million tCO_2e of verified emissions reductions [130]. Over 33 million carbon credits were sold, certified by VSC and CCBA standards [130]. Carbon finance funded training, park ranger employment, equipment, education, and livelihood support for local communities.

Conflict of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Author Contributions

Conceptualization (AC, AS, BOC, NS)
Data curation (AC, AS)
Formal analysis (AC, AS)
Funding acquisition (NS)
Investigation (all)
Methodology (AC, AS, BOC)
Project administration (AC)
Resources (NS)
Software (AC, AS)
Supervision (NS)
Validation (all)
Visualization (AC, AS, NS)
Writing – original draft Writing (AC) – review & editing (all)

Funding

This work was supported with funding from the Oxford Martin School's Biodiversity and Society Programme (University of Oxford) and the Waterloo Foundation.

Acknowledgements

We thank Erin Gray and Swati Utkarshini, in particular, for their helpful comments and revisions to the systematic review protocol. We also thank two reviewers and the associate editor for their thorough reviews which improved the manuscript substantially.

References (endnote)

1. Chausson A, Turner B, Seddon D, Chabaneix N, Girardin CA, Kapos V, et al. Mapping the effectiveness of nature-based solutions for climate change adaptation. Global Change Biology. 2020;26(11):6134-55.
2. Woroniecki S, Spiegelenberg FA, Chausson A, Turner B, Key I, Md. Irfanullah H, et al. Contributions of nature-based solutions to reducing people's vulnerabilities to climate change across the rural Global South. Climate and Development. 2022:1-18.
3. Girardin CA, Jenkins S, Seddon N, Allen M, Lewis SL, Wheeler CE, et al. Nature-based solutions can help cool the planet—if we act now. Nature. 2021;593(7858):191-4.
4. Roe S, Streck C, Beach R, Busch J, Chapman M, Daioglou V, et al. Land-based measures to mitigate climate change: Potential and feasibility by country. Global Change Biology. 2021;27(23):6025-58.
5. Labib S, Browning MH, Rigolon A, Helbich M, James P. Nature's contributions in coping with a pandemic in the 21st century: A narrative review of evidence during COVID-19. Science of The Total Environment. 2022:155095.
6. O'Callaghan BJM, E. Are we building back better? Evidence from 2020 and Pathways to Inclusive Green Recovery Spending. 2021.
7. Davies C, Lafortezza R. Transitional path to the adoption of nature-based solutions. Land use policy. 2019;80:406-9.
8. Frantzeskaki N, Vandergert P, Connop S, Schipper K, Zwierzchowska I, Collier M, et al. Examining the policy needs for implementing nature-based solutions in cities: Findings from city-wide transdisciplinary experiences in Glasgow (UK), Genk (Belgium) and Poznań (Poland). Land use policy. 2020;96:104688.

9. Smith A, Chausson, A. Nature-based Solutions in UK Climate Adaptation Policy. A report prepared by the Nature-based Solutions Initiative at the University of Oxford for WWF-UK and RSPB. 2021.
10. BenDor TK, Livengood A, Lester TW, Davis A, Yonavjak L. Defining and evaluating the ecological restoration economy. Restoration Ecology. 2015;23(3):209-19.
11. Sarabi S, Han Q, Romme AGL, De Vries B, Valkenburg R, Den Ouden E. Uptake and implementation of nature-based solutions: an analysis of barriers using interpretive structural modeling. Journal of Environmental Management. 2020;270:110749.
12. Keynes JM. General Theory Of Employment , Interest And Money: Atlantic Publishers & Distributors (P) Limited; 2016.
13. Ramey VA. Can government purchases stimulate the economy? Journal of Economic Literature. 2011;49(3):673-85.
14. Keynes JM. Letter of February 1 to Franklin Delano Roosevelt. Collected Works XXI: Activities 1931-1939. 1938.
15. Zenghelis D. In praise of a green stimulus. Wiley Interdisciplinary Reviews: Climate Change. 2014;5(1):7-14.
16. Otero I, Farrell KN, Pueyo S, Kallis G, Kehoe L, Haberl H, et al. Biodiversity policy beyond economic growth. Conservation letters. 2020;13(4):e12713.
17. Batini N, Di Serio M, Fragetta M, Melina G, Waldron A. Building back better: How big are green spending multipliers? Ecological Economics. 2022;193:107305.
18. Hasna Z. The grass is actually greener on the other side: Evidence on green multipliers from the united states. Cambridge, UK: Univ. Cambridge; 2021.
19. Hepburn C, O'Callaghan B, Stern N, Stiglitz J, Zenghelis D. Will COVID-19 fiscal recovery packages accelerate or retard progress on climate change? Oxford review of economic policy. 2020;36(Supplement_1):S359-S81.
20. Lahcen B, Brusselaers J, Vrancken K, Dams Y, Da Silva Paes C, Eyckmans J, et al. Green recovery policies for the COVID-19 crisis: modelling the impact on the economy and greenhouse gas emissions. Environmental and Resource Economics. 2020;76:731-50.
21. Advisers CoE. A Retrospective Assessment of Clean Energy

Investments in the Recovery Act. In: President EOot, editor. Washington DC2016.
22. Mundaca L, Damen B, editors. Assessing the effectiveness of the 'Green Economic Stimulus' in South Korea: Evidence from the energy sector. 38th International Association for Energy Economics (IAEE) International Conference; 2015: International Association for Energy Economics.
23. Pollitt H. Assessing the implementation and impact of green elements of Member States' National Recovery Plans. Final Report for the European Commission (DG Environment)–UK Cambridge Econometrics. 2011.
24. Tienhaara K. Green Keynesianism and the global financial crisis: Routledge; 2018.
25. Barbier EB. Green stimulus, green recovery and global imbalances. World Economics. 2010;11(2):149-77.
26. Sen M. Forests: at the heart of a green recovery from the COVID-19 pandemic. 2020.
27. UNEA. UNEP/EA.5/Res.5 Nature-based solutions for supporting sustainable development. Nairobi: UNEP; 2022.
28. Bowen A, Fankhauser S, Stern N, Zenghelis D. An outline of the case for a 'green'stimulus. 2009.
29. Edwards P, Sutton-Grier A, Coyle G. Investing in nature: restoring coastal habitat blue infrastructure and green job creation. Marine Policy. 2013;38:65-71.
30. Ankarfjard R, Subsol, S. and Harvey Williams, F. Nature-based Solutions: Key results and lessons learned from IFAD's Adaptation for Smallholder Agriculture Programme. Rome: IFAD, 2021.
31. Lupp G, Huang JJ, Zingraff-Hamed A, Oen A, Del Sepia N, Martinelli A, et al. Stakeholder perceptions of nature-based solutions and their collaborative co-design and implementation processes in rural mountain areas—a case study from PHUSICOS. Frontiers in Environmental Science. 2021:593.

32. Sutton-Grier AE, Gittman RK, Arkema KK, Bennett RO, Benoit J, Blitch S, et al. Investing in natural and nature-based infrastructure: building better along our coasts. Sustainability. 2018;10(2):523.
33. Kabisch N, Frantzeskaki N, Pauleit S, Naumann S, Davis M, Artmann M, et al. Nature-based solutions to climate change mitigation and adaptation in urban areas: perspectives on indicators, knowledge gaps, barriers, and opportunities for action. Ecology and society. 2016;21(2).
34. Mori AS. Advancing nature-based approaches to address the biodiversity and climate emergency. Ecology letters. 2020;23(12):1729-32.
35. Seddon N, Chausson A, Berry P, Girardin CA, Smith A, Turner B. Understanding the value and limits of nature-based solutions to climate change and other global challenges. Philosophical Transactions of the Royal Society B. 2020;375(1794):20190120.
36. Seddon N, Smith A, Smith P, Key I, Chausson A, Girardin C, et al. Getting the message right on nature-based solutions to climate change. Global change biology. 2021;27(8):1518-46.
37. BenDor T, Lester TW, Livengood A, Davis A, Yonavjak L. Estimating the size and impact of the ecological restoration economy. PloS one. 2015;10(6):e0128339.
38. Lieuw-Kie-Song M, Perez-Cirera, V. Nature Hires: How nature-based solutions can power a green jobs recovery. Gland, Switzerland: ILO/WWF, 2020.
39. Smith V, Devane D, Begley CM, Clarke M. Methodology in conducting a systematic review of systematic reviews of healthcare interventions. BMC medical research methodology. 2011;11(1):1-6.
40. Faulkner G, Fagan MJ, Lee J. Umbrella reviews (systematic review of reviews). International Review of Sport and Exercise Psychology. 2022;15(1):73-90.
41. Jackson T. Prosperity without growth: Foundations for the economy of tomorrow: Routledge; 2016.
42. Raworth K. A Doughnut for the Anthropocene: humanity's compass in the 21st century. The lancet planetary health. 2017;1(2):e48-e9.
43. Hickel J, Brockway P, Kallis G, Keyßer L, Lenzen M, Slameršak A, et al. Urgent need for post-growth climate mitigation scenarios. Nature Energy. 2021;6(8):766-8.
44. Costanza R, Atkins PW, Bolton M, Cork S, Grigg NJ, Kasser T, et al. Overcoming societal addictions: What can we learn from individual therapies? Ecological Economics. 2017;131:543-50.
45. Woodhouse E, Homewood KM, Beauchamp E, Clements T, McCabe JT, Wilkie D, et al. Guiding principles for evaluating the impacts of conservation interventions on human well-being. Philosophical Transactions of the Royal Society B: Biological Sciences. 2015;370(1681):20150103.
46. Evidence CfE. Guidelines and Standards for Evidence synthesis in Environmental Management. Version 5.1 (AS Pullin, GK Frampton, B Livoreil & G Petrokofsky, Eds)2022 April 4, 2022.
47. Ouzzani M, Hammady H, Fedorowicz Z, Elmagarmid A. Rayyan—a web and mobile app for systematic reviews. Systematic reviews. 2016;5:1-10.
48. Cohen J. A coefficient of agreement for nominal scales. Educational and psychological measurement. 1960;20(1):37-46.
49. IUCN. Global Standard for Nature-based Solutions. A user-friendly framework for the verification, design and scaling up of NbS. First edition. Gland, Switzerland: 2020.
50. NBSI. Nature-based solutions to climate change. Key messages for decision makers in 2020 and beyond. NBSI; 2020.
51. World bank country and lending groups [Internet]. 2020 [cited February 2, 2022]. Available from: https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups.
52. Nalau J, Becken S, Mackey B. Ecosystem-based Adaptation: A review of the constraints. Environmental Science & Policy. 2018;89:357-64.
53. Roe D, Turner, B., Chausson, A., Hemmerle, E., Seddon, N. Investing in nature for development: do nature-based interventions deliver local development outcomes? London: IIED, 2021.
54. Hassan BA, Glover EK, Luukkanen O, Kanninen M, Jamnadass R. Boswellia and Commiphora Species as a resource base for rural livelihood security in the Horn of Africa: a systematic review. Forests. 2019;10(7):551.

55. Castle SE, Miller DC, Ordonez PJ, Baylis K, Hughes K. The impacts of agroforestry interventions on agricultural productivity, ecosystem services, and human well-being in low-and middle-income countries: A systematic review. Campbell Systematic Reviews. 2021;17(2):e1167.
56. Adhikari L, Khan B, Joshi S, Ruijun L, Ali G, Shah GM, et al. Community-based trophy hunting programs secure biodiversity and livelihoods: Learnings from Asia's high mountain communities and landscapes. Environmental Challenges. 2021;4:100175.
57. Lindsey PA, Nyirenda VR, Barnes JI, Becker MS, McRobb R, Tambling CJ, et al. Underperformance of African protected area networks and the case for new conservation models: insights from Zambia. PLoS one. 2014;9(5):e94109.
58. Shackleton CM. Urban green infrastructure for poverty alleviation: evidence synthesis and conceptual considerations. Frontiers in Sustainable Cities. 2021;3:710549.
59. Rasmussen LV, Fold N, Olesen RS, Shackleton S. Socio-economic outcomes of ecological infrastructure investments. Ecosystem Services. 2021;47:101242.
60. Chimsah FA, Cai L, Wu J, Zhang R. Outcomes of long-term conservation tillage research in Northern China. Sustainability. 2020;12(3):1062.
61. Anantha K, Garg KK, Barron J, Dixit S, Venkataradha A, Singh R, et al. Impact of best management practices on sustainable crop production and climate resilience in smallholder farming systems of South Asia. Agricultural Systems. 2021;194:103276.
62. Rosa-Schleich J, Loos J, Mußhoff O, Tscharntke T. Ecological-economic trade-offs of diversified farming systems–a review. Ecological Economics. 2019;160:251-63.
63. Preissel S, Reckling M, Schläfke N, Zander P. Magnitude and farm-economic value of grain legume pre-crop benefits in Europe: A review. Field Crops Research. 2015;175:64-79.
64. Gonçalves CdBQ, Schlindwein MM, Martinelli GdC. Agroforestry systems: a systematic review focusing on traditional indigenous practices, food and nutrition security, economic viability, and the role of women. Sustainability. 2021;13(20):11397.
65. Razafindratsima OH, Kamoto JF, Sills EO, Mutta DN, Song C, Kabwe G, et al. Reviewing the evidence on the roles of forests and tree-based systems in poverty dynamics. Forest Policy and Economics. 2021;131:102576.
66. Teotónio I, Silva CM, Cruz CO. Economics of green roofs and green walls: A literature review. Sustainable Cities and Society. 2021;69:102781.
67. Pelletier J, Gélinas N, Skutsch M. The place of community forest management in the REDD+ landscape. Forests. 2016;7(8):170.
68. Mukhopadhyay R, Sarkar B, Jat HS, Sharma PC, Bolan NS. Soil salinity under climate change: Challenges for sustainable agriculture and food security. Journal of Environmental Management. 2021;280:111736.
69. Reeves T, Mei B, Bettinger P, Siry J. Review of the effects of conservation easements on surrounding property values. Journal of Forestry. 2018;116(6):555-62.
70. Duffy C, Toth GG, Hagan RP, McKeown PC, Rahman SA, Widyaningsih Y, et al. Agroforestry contributions to smallholder farmer food security in Indonesia. Agroforestry Systems. 2021;95(6):1109-24.
71. Chomba S, Sinclair F, Savadogo P, Bourne M, Lohbeck M. Opportunities and constraints for using farmer managed natural regeneration for land restoration in sub-Saharan Africa. Frontiers in Forests and Global Change. 2020;3:571679.
72. Pulighe G, Bonati G, Colangeli M, Morese MM, Traverso L, Lupia F, et al. Ongoing and emerging issues for sustainable bioenergy production on marginal lands in the Mediterranean regions. Renewable and Sustainable Energy Reviews. 2019;103:58-70.
73. Burivalova Z, Hua F, Koh LP, Garcia C, Putz F. A critical comparison of conventional, certified, and community management of tropical forests for timber in terms of environmental, economic, and social variables. Conservation Letters. 2017;10(1):4-14.
74. Garrett RD, Levy SA, Gollnow F, Hodel L, Rueda X. Have food supply chain policies improved forest conservation and rural livelihoods? A systematic review. Environmental Research Letters. 2021;16(3):033002.
75. Li W, Li Y. Rangeland degradation control in China: A policy review. The End of Desertification? Disputing Environmental Change in the Drylands. 2016:491-511.

76. Adams C, Rodrigues ST, Calmon M, Kumar C. Impacts of large-scale forest restoration on socioeconomic status and local livelihoods: what we know and do not know. Biotropica. 2016;48(6):731-44.

77. Blundo-Canto G, Bax V, Quintero M, Cruz-Garcia GS, Groeneveld RA, Perez-Marulanda L. The different dimensions of livelihood impacts of payments for environmental services (PES) schemes: A systematic review. Ecological Economics. 2018;149:160-83.

78. Huang IY, James K, Thamthanakoon N, Pinitjitsamut P, Rattanamanee N, Pinitjitsamut M, et al. Economic outcomes of rubber-based agroforestry systems: a systematic review and narrative synthesis. Agroforestry Systems. 2023;97(3):335-54.

79. Mafongoya P, Rusinamhodzi L, Siziba S, Thierfelder C, Mvumi BM, Nhau B, et al. Maize productivity and profitability in conservation agriculture systems across agro-ecological regions in Zimbabwe: a review of knowledge and practice. Agriculture, ecosystems & environment. 2016;220:211-25.

80. Marcos C, Díaz D, Fietz K, Forcada A, Ford A, García-Charton JA, et al. Reviewing the ecosystem services, societal goods, and benefits of marine protected areas. Frontiers in Marine Science. 2021:504.

81. Chen B, Nakama Y. Thirty years of forest tourism in China. Journal of forest research. 2013;18(4):285-92.

82. Neudert R, Ganzhorn JU, Waetzold F. Global benefits and local costs–The dilemma of tropical forest conservation: A review of the situation in Madagascar. Environmental Conservation. 2017;44(1):82-96.

83. Mbaiwa JE, Kolawole OD. Tourism and biodiversity conservation: the case of community-based natural resource management in Southern Africa. CABI Reviews. 2013;(2013):1-10.

84. Garrett R, Niles MT, Gil JD, Gaudin A, Chaplin-Kramer R, Assmann A, et al. Social and ecological analysis of commercial integrated crop livestock systems: current knowledge and remaining uncertainty. Agricultural Systems. 2017;155:136-46.

85. Trac CJ, Schmidt AH, Harrell S, Hinckley TM. Environmental reviews and case studies: Is the returning farmland to forest program a success? Three case studies from Sichuan. Environmental practice. 2013;15(3):350-66.

86. Wekesah FM, Mutua EN, Izugbara CO. Gender and conservation agriculture in sub-Saharan Africa: a systematic review. International Journal of Agricultural Sustainability. 2019;17(1):78-91.

87. Zoysa MD. Forest-based ecotourism in Sri Lanka: a review on state of governance, livelihoods, and forest conservation outcomes. Journal of Sustainable Forestry. 2022;41(3-5):413-39.

88. Robinson JM, Breed MF. Green prescriptions and their co-benefits: Integrative strategies for public and environmental health. Challenges. 2019;10(1):9.

89. Freijer K, Tan SS, Koopmanschap MA, Meijers JM, Halfens RJ, Nuijten MJ. The economic costs of disease related malnutrition. Clinical nutrition. 2013;32(1):136-41.

90. Van Den Eeden SK, Browning MH, Becker DA, Shan J, Alexeeff SE, Ray GT, et al. Association between residential green cover and direct healthcare costs in Northern California: An individual level analysis of 5 million persons. Environment International. 2022;163:107174.

91. Buckley RC, Brough P. Economic Value of Parks via Human Mental Health: An Analytical Framework. Frontiers in Ecology and Evolution. 2017;5. doi: 10.3389/fevo.2017.00016.

92. Beck MW, Losada IJ, Menéndez P, Reguero BG, Díaz-Simal P, Fernández F. The global flood protection savings provided by coral reefs. Nature communications. 2018;9(1):2186.

93. E.A. Lamptey EA, J. Clay, J. Corcoran, S. Cox, L. Currado, D. Godfrey, S. Gordon, O. Hughes, WJ Jiang, S. Kanabar, D. Keegan, M. Konsa, R. Lader, E. Lewis, J. Liebl, M. Ma, M. McGraw, B. Payne, J. Quaresma, P. Schecter, M. Sommerschuh, W. Wilding. Equator Initiative case study database: 'Swazi Indigenous Products' and 'Chunoti Co-Management Committee'. 2013.

94. D'Orazio P. Towards a post-pandemic policy framework to manage climate-related financial risks and resilience. Climate Policy. 2021;21(10):1368-82. doi: 10.1080/14693062.2021.1975623.

95. Call M, Sellers S. How does gendered vulnerability shape the adoption and impact of sustainable livelihood interventions in an era of global climate change? Environmental Research Letters. 2019;14(8):083005.

96. DeFries RS, Fanzo J, Mondal P, Remans R, Wood SA. Is voluntary certification of tropical agricultural commodities achieving sustainability goals for small-scale producers? A review of the evidence. Environmental research letters. 2017;12(3):033001.

97. Kadykalo AN, López-Rodriguez MD, Ainscough J, Droste N, Ryu H, Ávila-Flores G, et al. Disentangling 'ecosystem services' and 'nature's contributions to people'. Ecosystems and People. 2019;15(1):269-87.

98. IPBES. Summary for Policymakers of the Methodological Assessment of the Diverse Values and Valuation of Nature of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. IPBES secretariat Bonn, Germany; 2022.

99. Shigaeva J, Darr D. On the socio-economic importance of natural and planted walnut (Juglans regia L.) forests in the Silk Road countries: A systematic review. Forest Policy and Economics. 2020;118:102233.

100. Welden E, Chausson A, Melanidis MS. Leveraging Nature-based Solutions for transformation: Reconnecting people and nature. People and Nature. 2021;3(5):966-77.

101. Reich J, Paul SS, Snapp SS. Highly variable performance of sustainable intensification on smallholder farms: A systematic review. Global Food Security. 2021;30:100553.

102. Samuelson PA, Solow RM. Analytical aspects of anti-inflation policy. The American Economic Review. 1960;50(2):177-94.

103. Pascual U, Phelps J, Garmendia E, Brown K, Corbera E, Martin A, et al. Social equity matters in payments for ecosystem services. Bioscience. 2014;64(11):1027-36.

104. Atteridge A, Remling E. Is adaptation reducing vulnerability or redistributing it? Wiley Interdisciplinary Reviews: Climate Change. 2018;9(1):e500.

105. Eriksen S, Schipper ELF, Scoville-Simonds M, Vincent K, Adam HN, Brooks N, et al. Adaptation interventions and their effect on vulnerability in developing countries: Help, hindrance or irrelevance? World Development. 2021;141:105383.

106. Key I, Smith A, Turner B, Chausson A, Girardin C, Macgillivray M, et al. Biodiversity outcomes of nature-based solutions for climate change adaptation: characterising the evidence base. Frontiers in Environmental Science. 2022;10.

107. Dicks J, Dellacio, O, Stenning, J. Economic costs and benefits of nature-based solutions to mitigate climate change. Cambridge, UK: Cambridge Econometrics & RSPB, 2020.

108. Haider LJ, Schlüter M, Folke C, Reyers B. Rethinking resilience and development: A coevolutionary perspective. Ambio. 2021;50:1304-12.

109. Mutafoglu K. tB, P., Schweitzer J-P., , Underwood E., Tucker G., Russi D., Howe M., Maréchal A., Olmeda C., Pantzar M., Gionfra, S. and Kettunen M. . Natura 2000 and Jobs: Scoping Study. . Brussels: IEEP, 2017.

110. Raes L, Mittempergher, D., Piaggio, M. and Siikamäki, J. . Nature-based Recovery can create jobs, deliver growth and provide value for nature. Gland, Switzerland: IUCN, 2021.

111. Payen J, Lieuw-Kie-Song M. Desk review study on Employment Impact Assessment (EmpIA) potential of Natural Resource Management (NRM) investments on employment creation. International Labour Organization (ILO) Working Paper 24, 2020.

112. Vardon M, Lucas P, Bass S, Agarwala M, Bassi AM, Coyle D, et al. From COVID-19 to Green Recovery with natural capital accounting. Ambio. 2023;52(1):15-29. doi: 10.1007/s13280-022-01757-5.

113. Sudmeier-Rieux K, Arce-Mojica T, Boehmer HJ, Doswald N, Emerton L, Friess DA, et al. Scientific evidence for ecosystem-based disaster risk reduction. Nature Sustainability. 2021;4(9):803-10.

114. Coppock DL, Fernández-Giménez M, Hiernaux P, Huber-Sannwald E, Schloeder C, Valdivia C, et al. Rangeland systems in developing nations: conceptual advances and societal implications. Rangeland systems. 2017:569-642.

115. Parr CL, Lehmann CE, Bond WJ, Hoffmann WA, Andersen AN. Tropical grassy biomes: misunderstood, neglected, and under threat. Trends in ecology & evolution. 2014;29(4):205-13.

116. Selig ER, Hole DG, Allison EH, Arkema KK, McKinnon MC, Chu J, et al. Mapping global human dependence on marine ecosystems. Conservation Letters. 2019;12(2):e12617.

117. Reguero BG, Storlazzi CD, Gibbs AE, Shope JB, Cole AD, Cumming KA, et al. The value of US coral reefs for flood risk reduction. Nature Sustainability. 2021;4(8):688-98.

118. Burden A, Garbutt A, Evans C. Effect of restoration on saltmarsh carbon accumulation in Eastern England. Biology letters. 2019;15(1):20180773.

119. Ward SE, Smart SM, Quirk H, Tallowin JR, Mortimer SR, Shiel RS, et al. Legacy effects of grassland management on soil carbon to depth. Global change biology. 2016;22(8):2929-38.
120. Hobbie SE, Grimm NB. Nature-based approaches to managing climate change impacts in cities. Philosophical Transactions of the Royal Society B. 2020;375(1794):20190124.
121. Stefanakis AI. The role of constructed wetlands as green infrastructure for sustainable urban water management. Sustainability. 2019;11(24):6981.
122. Kabisch N, van den Bosch M, Lafortezza R. The health benefits of nature-based solutions to urbanization challenges for children and the elderly–A systematic review. Environmental research. 2017;159:362-73.
123. Van den Bosch M, Sang ÅO. Urban natural environments as nature-based solutions for improved public health–A systematic review of reviews. Environmental research. 2017;158:373-84.
124. Bank W. Urban Development Overview: World Bank; 2022 [November 4, 2022]. Available from: https://www.worldbank.org/en/topic/urbandevelopment/overview#1.
125. O'Callaghan B, Kingsmill N, Waits F, Aylward-Mills D, Bird J, Roe P, et al. Roadmap to Green Recovery. Oxford University Economic Recovery Project. .
126. Wild T, Henneberry J, Gill L. Comprehending the multiple 'values' of green infrastructure–Valuing nature-based solutions for urban water management from multiple perspectives. Environmental research. 2017;158:179-87.
127. de Lange E, Woodhouse E, Milner-Gulland E. Evaluating the impacts of conservation interventions on human well-being: guidance for practitioners. Oryx. 2017;51(1):14-5.
128. Chausson A, Welden E, Melanidis MS, Gray E, Hirons M, Seddon N. Going beyond market-based mechanisms to finance nature-based solutions and foster sustainable futures. PLOS Climate. 2023;2(4):e0000169.
129. MINAM MdA-. Bosque y pérdida de bosques. Geobosques, Programa Nacional de Conservación de Bosques para la Mitigación del Cambio Climático. . 2022.
130. SERNANP SNdÁNPpeE-. Memoria Anual 2020. Lima: SERNANP, 2021.
131. SERNANP SNdÁNPpeE-. Informe de Transferencia de Gestión. Julio 2020 - noviembre 2020. Lima: SERNANP, 2020.
132. SERNANP SNdÁNPpeE-. Memoria Anual 2021. Lima: SERNANP, 2022.
133. SERNANP SNdÁNPpeE-. Información del Seguimiento de los Programas Presupuestales 2021. Lima: SERNANP, 2022.
134. SERNANP SNdÁNPpeE-. Informe de Logros SINANPE (Diciembre 2011 - octubre 2021). Lima: SERNANP, 2021.
135. Vilela T, Rubio J, Escobedo A, Bruner A, Conner N. El impacto económico local del turismo en áreas protegidas del Perú. Documento de Trabajo CSF. 2018.

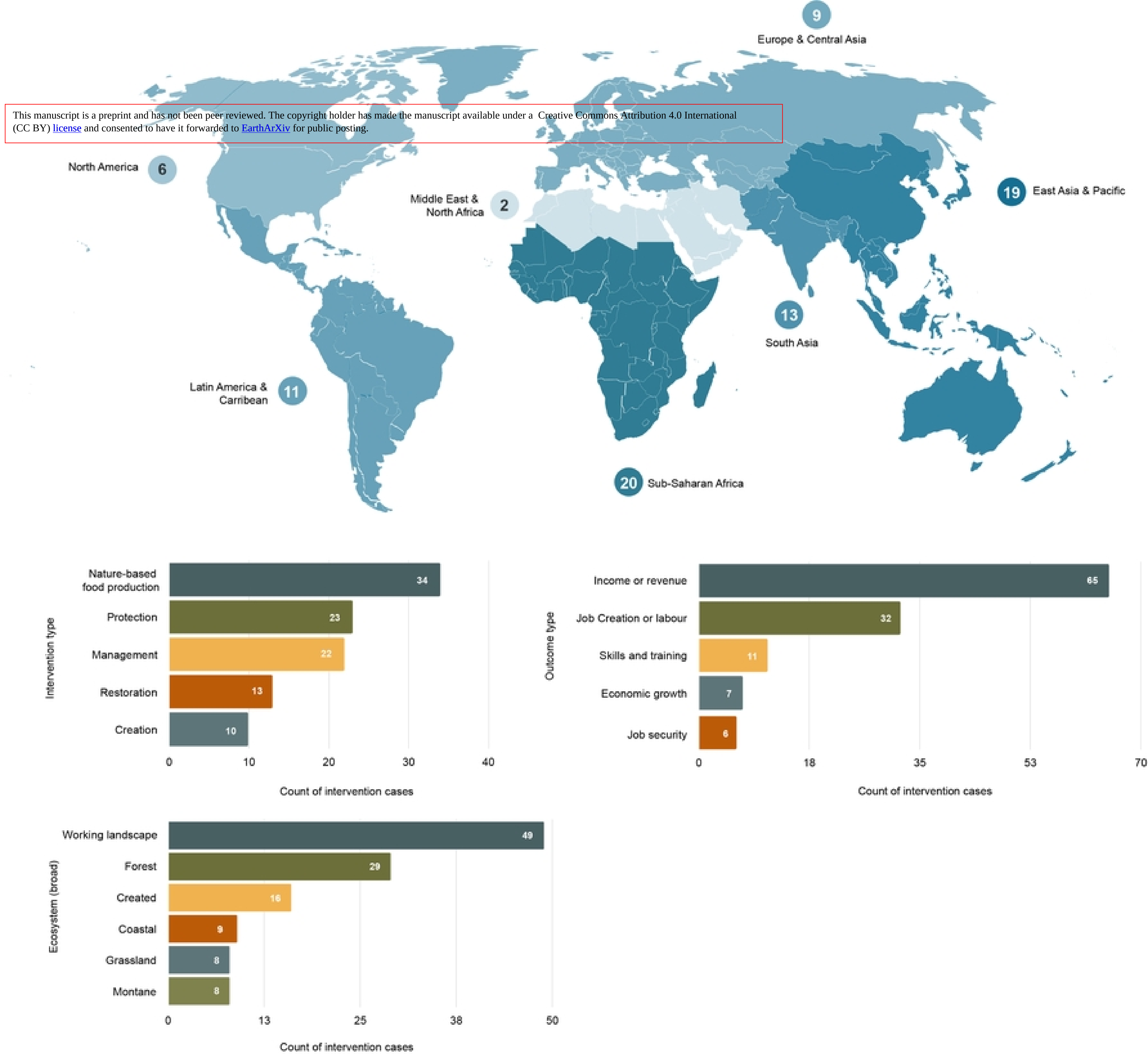

9
Europe & Central Asia
North America
6
Middle East &
North Africa
2
19
East Asia & Pacific
13
South Asia
Latin America &
Carribean
11
20
Sub-Saharan Africa
Intervention type
Nature-based
food production
34
Protection
23
Management
22
Restoration
13
Creation
10
0
10
20
30
40
Count of intervention cases
Outcome type
Income or revenue
65
Job Creation or labour
32
Skills and training
11
Economic growth
7
Job security
6
0
18
35
53
70
Count of intervention cases
Ecosystem (broad)
Working landscape
49
Forest
29
Created
16
Coastal
9
Grassland
8
Montane
8
0
13
25
38
50
Count of intervention cases

Figure1


Combined
Nature-based
food production
Management
Protection
Creation
Income
or revenue
Labour demand
Skills and
training
Economic growth
Job security

Figure2

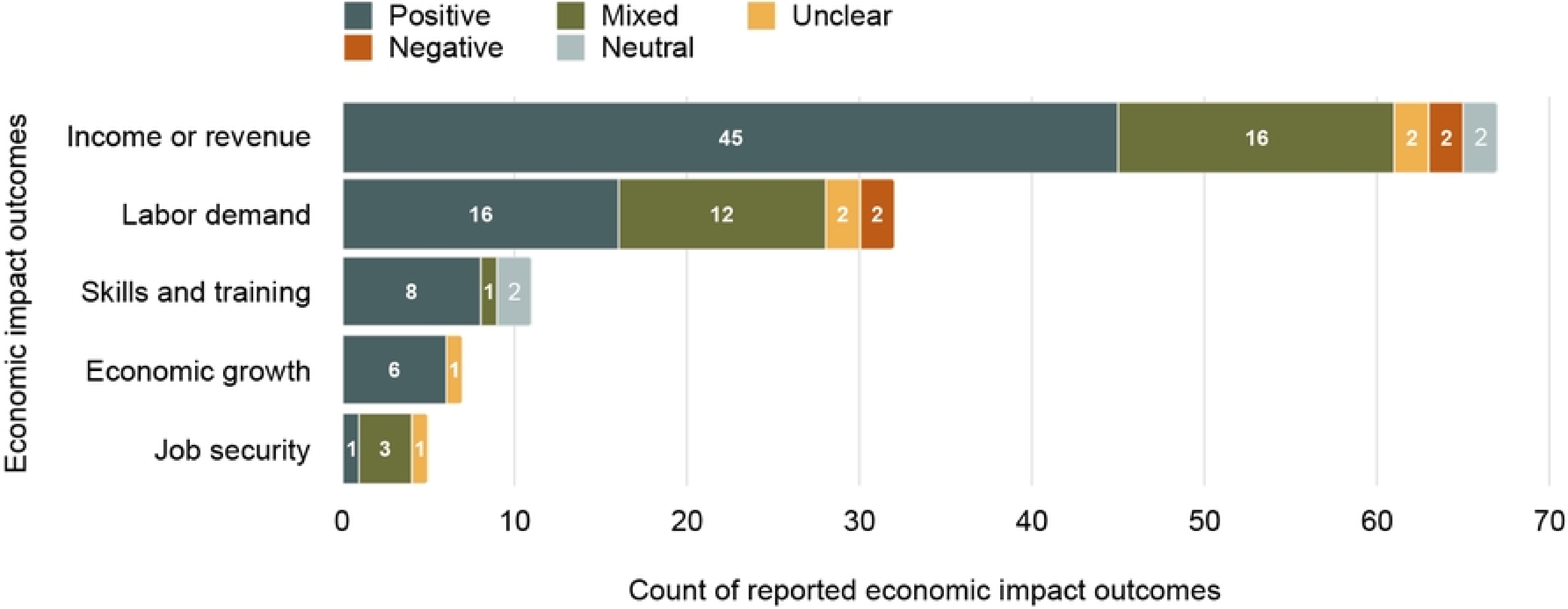

Positive
Mixed
Unclear
Negative
Neutral
Economic impact outcomes
Income or revenue
Labor demand
Skills and training
Economic growth
Job security
45
16
2
2
2
16
12
2
2
8
1
2
6
1
1
3
1
0
10
20
30
40
50
60
70
Count of reported economic impact outcomes

Figure3

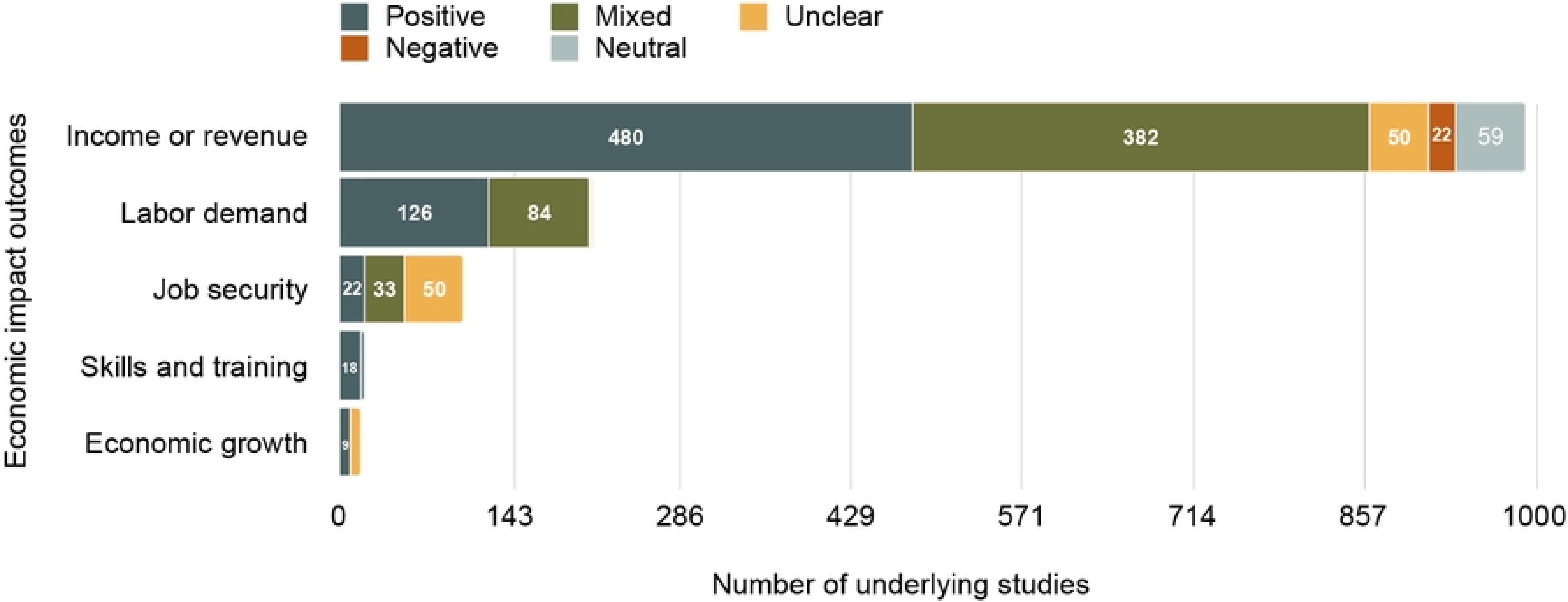
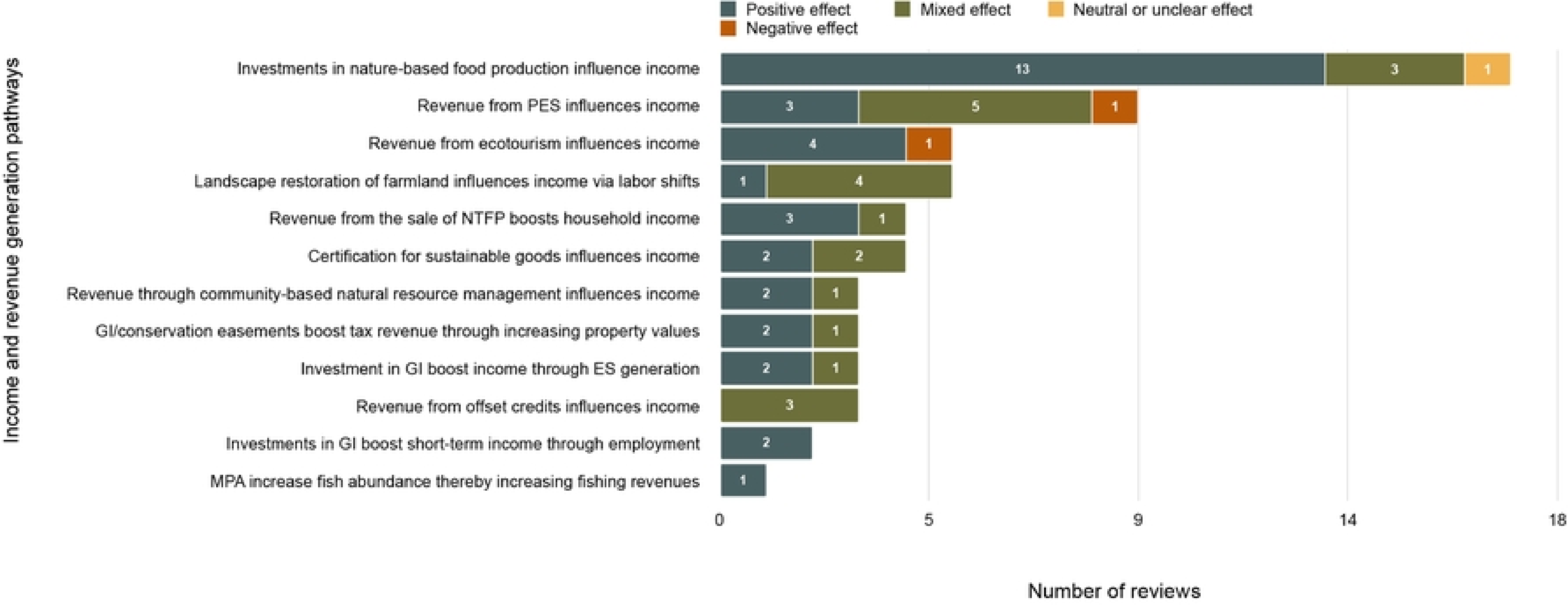

Positive
Mixed
Unclear
Negative
Neutral
Economic impact outcomes
Income or revenue
Labor demand
Job security
Skills and training
Economic growth
480
382
50
22
59
126
84
22
33
50
18
9
0
143
286
429
571
714
857
1000
Number of underlying studies

Figure4



Positive effect
Mixed effect
Neutral or unclear effect
Negative effect
Income and revenue generation pathways
Investments in nature-based food production influence income
13
3
1
Revenue from PES influences income
3
5
1
Revenue from ecotourism influences income
4
1
Landscape restoration of farmland influences income via labor shifts
1
4
Revenue from the sale of NTFP boosts household income
3
1
Certification for sustainable goods influences income
2
2
Revenue through community-based natural resource management influences income
2
1
GI/conservation easements boost tax revenue through increasing property values
2
1
Investment in GI boost income through ES generation
2
1
Revenue from offset credits influences income
3
Investments in GI boost short-term income through employment
2
MPA increase fish abundance thereby increasing fishing revenues
1
0
5
9
14
18
Number of reviews

Figure5

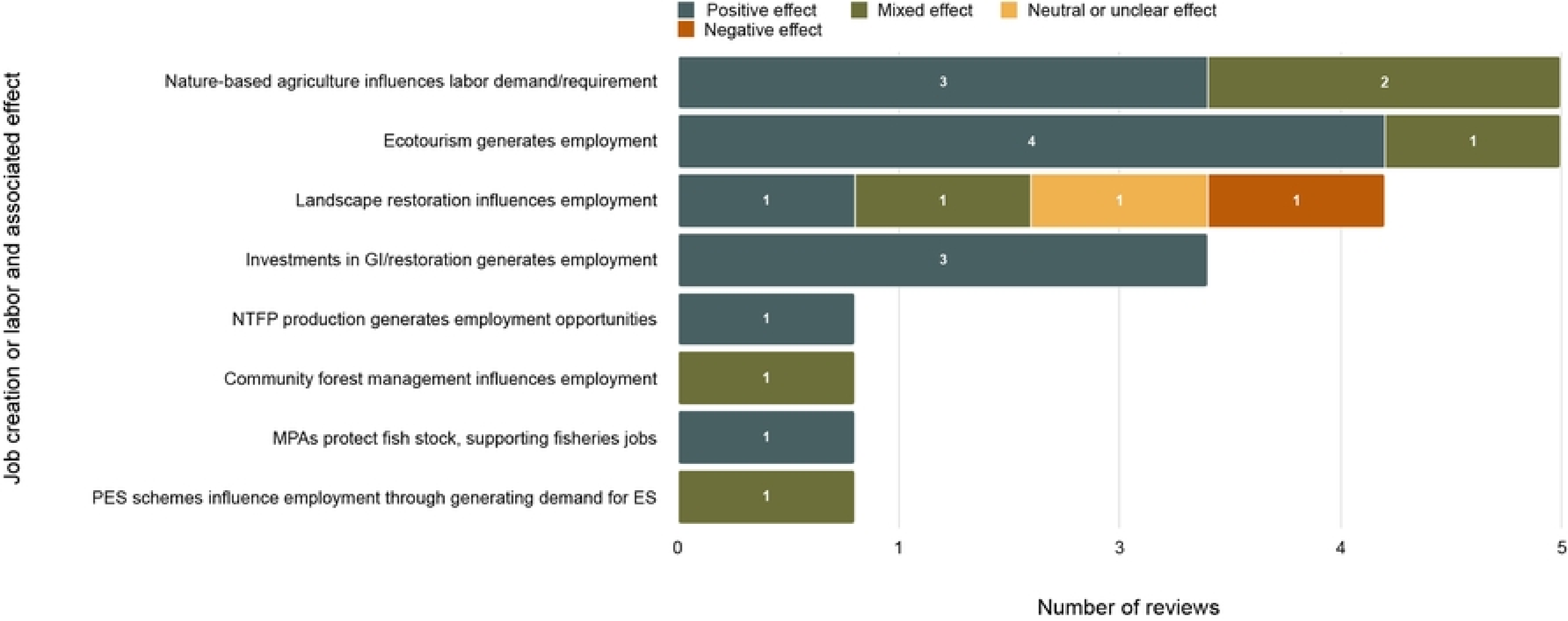

Positive effect
Mixed effect
Neutral or unclear effect
Negative effect
Job creation or labor and associated effect
Nature-based agriculture influences labor demand/requirement
Ecotourism generates employment
Landscape restoration influences employment
Investments in GI/restoration generates employment
NTFP production generates employment opportunities
Community forest management influences employment
MPAs protect fish stock, supporting fisheries jobs
PES schemes influence employment through generating demand for ES
3
2
4
1
1
1
1
1
3
1
1
1
1
0
1
3
4
5
Number of reviews

Figure6

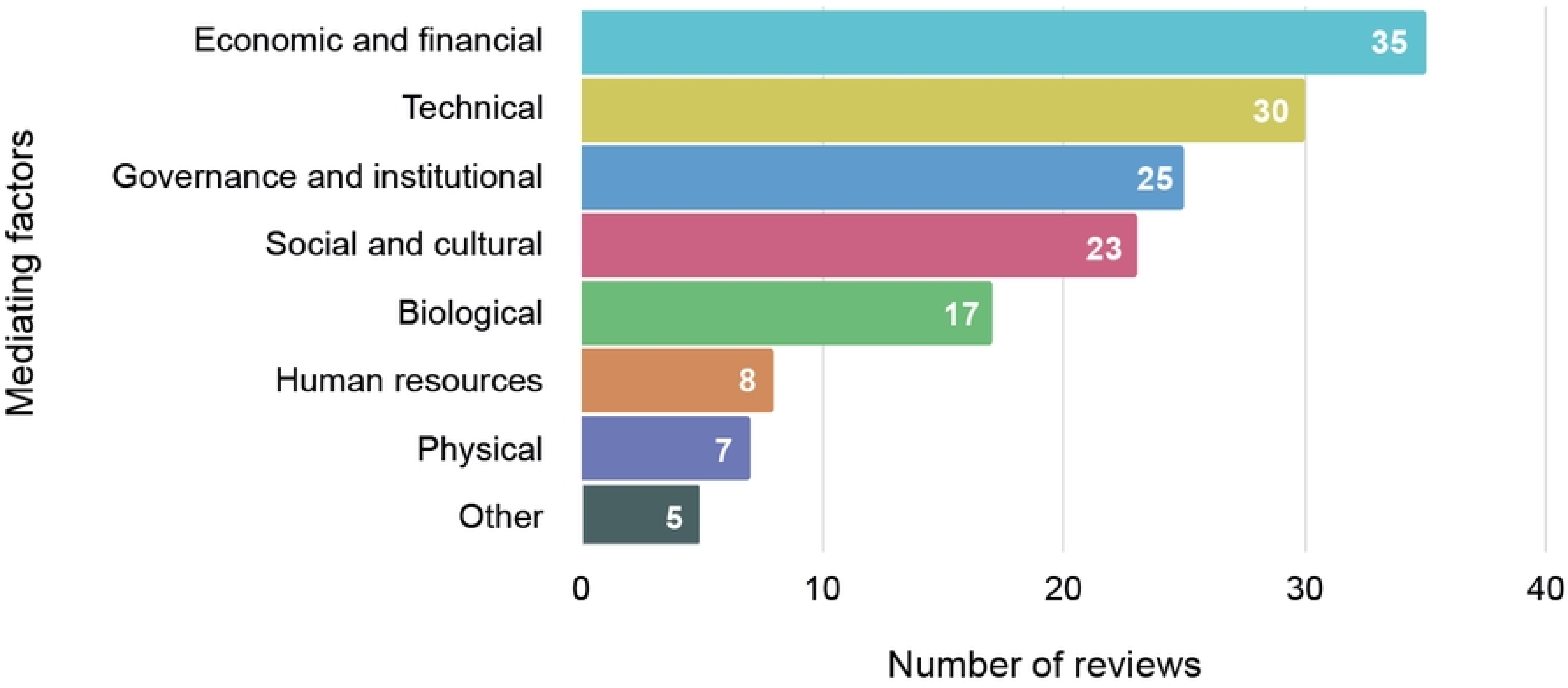
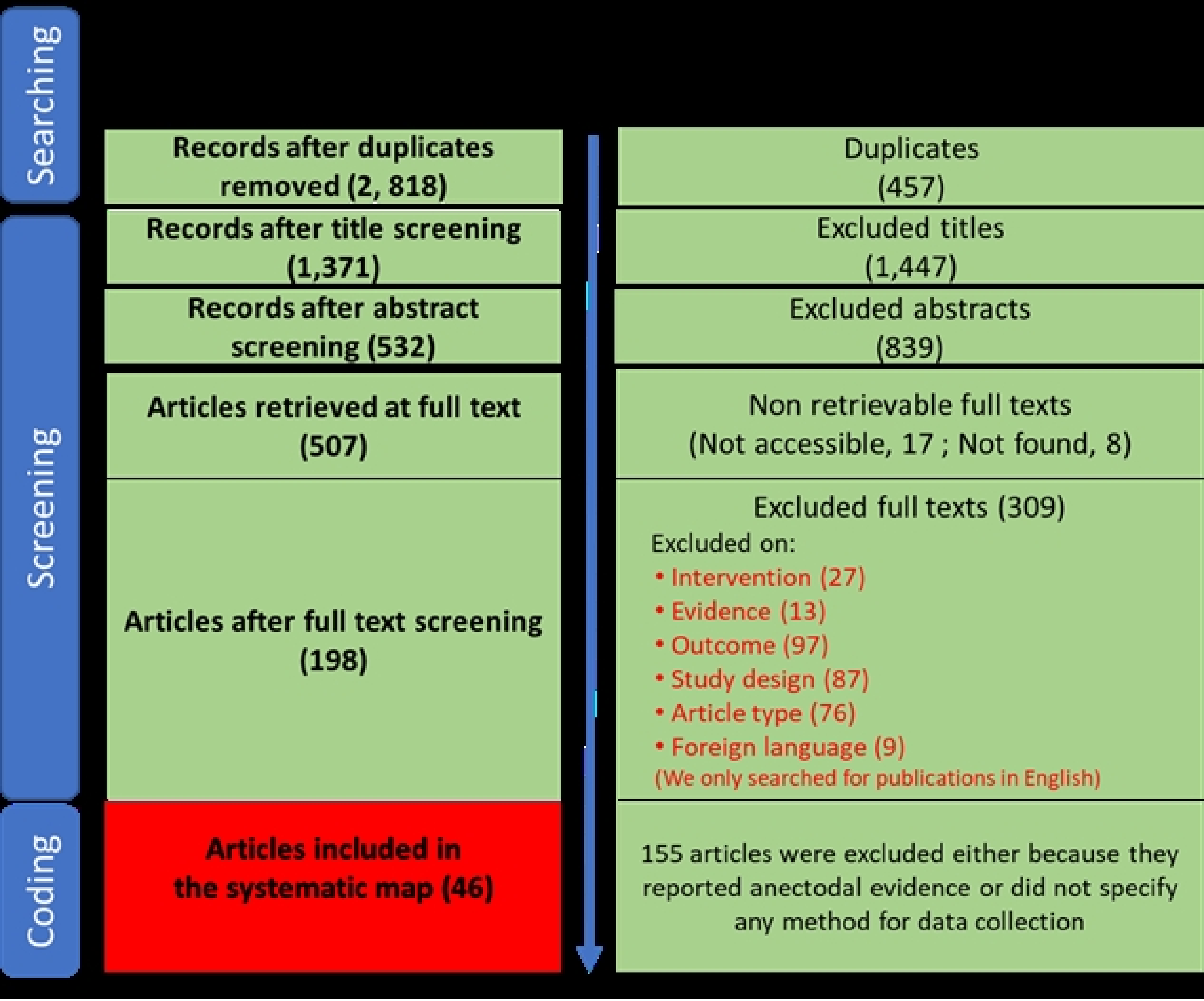

Economic and financial
Technical
Governance and institutional
Social and cultural
Biological
Human resources
Physical
Other
35
30
25
23
17
8
7
5
Mediating factors
0
10
20
30
40
Number of reviews

Figure7



Figure_prisma

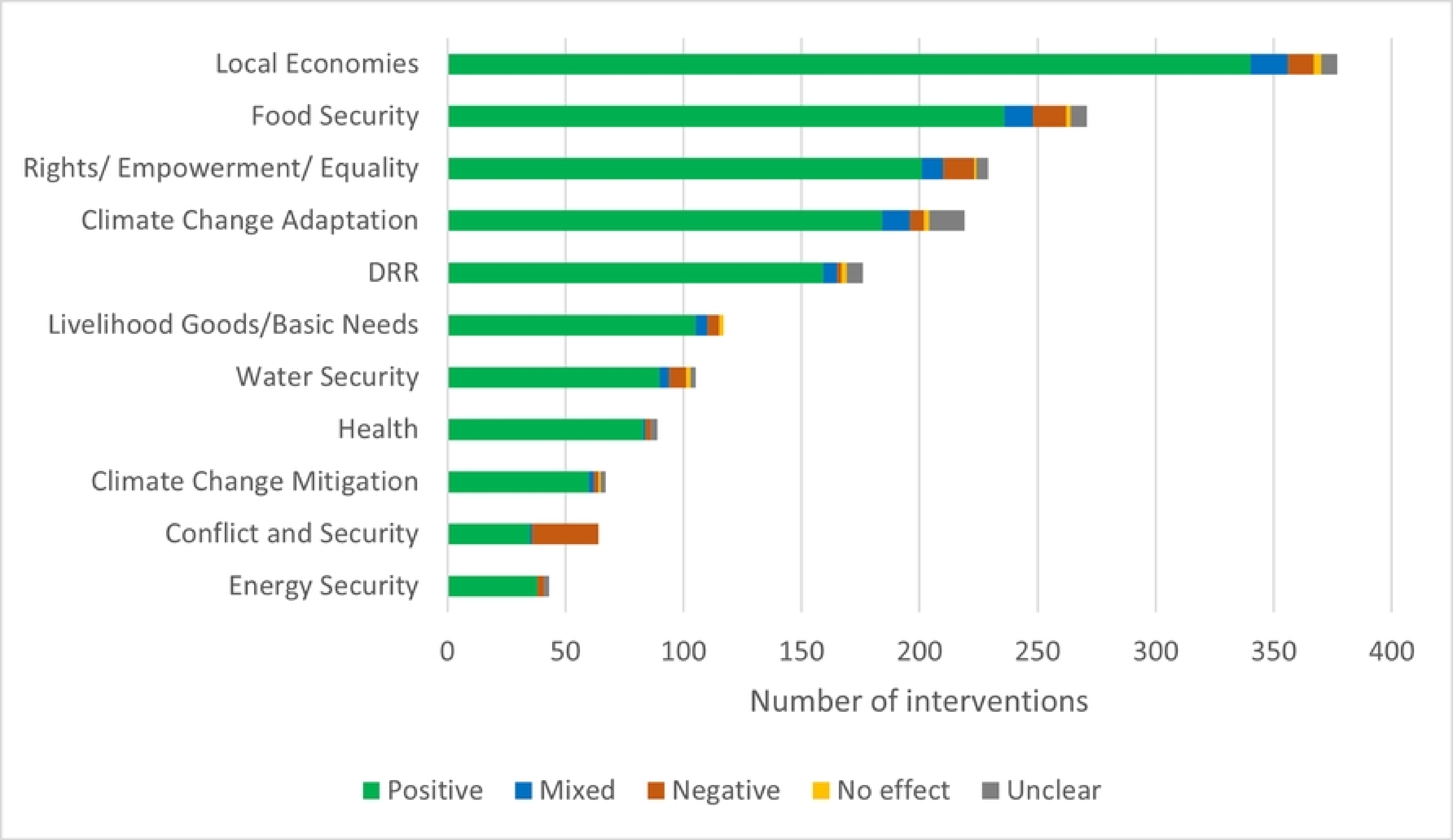

Local Economies
Food Security
Rights/ Empowerment/ Equality
Climate Change Adaptation
DRR
Livelihood Goods/Basic Needs
Water Security
Health
Climate Change Mitigation
Conflict and Security
Energy Security
0
50
100
150
200
250
300
350
400
Number of interventions
Positive
Mixed
Negative
No effect
Unclear

Figure8