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Mapping the evidence on interventions to address climate and biodiversity crises in low- and middle-income countries

A framework proposal

January 2024

Working Paper 60

Agriculture, fishing, and forestry

3ie International Initiative for Impact Evaluation

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About this working paper

The paper "*Mapping the evidence on interventions to address climate change and biodiversity crises in low-and middle-income countries"* is a framework produced by the International Initiative for Impact Evaluation (3ie) with funding from the UK's Department for Environment, Food and Rural Affairs (Defra). The proposed framework categorises existing interventions and outcomes in climate change and biodiversity programming in L&MICs and is intended to serve as a comprehensive basis for an Evidence Gap Map (EGM) of interventions in the climate and biodiversity sectors. This work is the result of broad consultation of the policy and research literature as well as the collection of input from academics, practitioners, donors, and key stakeholders working in this space. The technical team for this report was led by Dina Rodrigues and Constanza Gonzalez Parrao, with support from Claudia Romero.

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Mapping the evidence on interventions to address climate and biodiversity crises in low- and middle-income countries: a framework proposal

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1. Introduction

1.1 Twin crises of climate and biodiversity risk irreversible negative effects on health and human wellbeing

A large and growing evidence base highlights that humanity's mismanagement and exploitation of nature has resulted in global crises of climate and biodiversity breakdown (e.g., Dasgupta, 2021; IPCC, 2023; Stern, 2006). The effects of these crises are already manifesting themselves in irreversible ways, with negative effects on human wellbeing and development being disproportionately affecting low- and middle-income countries (L&MICs; Dasgupta, 2021; IPCC, 2023; Stern 2006; World Meteorological Organization, 2023).

For example, human-caused climate change has led to increased frequency and intensity of extreme temperatures and heatwaves, as well as weather and disaster events such as floods, droughts, wildfires, and tropical cyclones (IPCC, 2023). Extreme precipitation has increased in East and West Southern Africa, Southeastern South America, and all across Asia. Agricultural and ecological droughts have increased in West and Central Africa, East Southern Africa, East Asia, and Northern South America (IPCC, 2023). Developing countries have among the highest occurrence of natural disasters, and most concerningly, the highest number of people affected by them. The World Meteorological Organization (2023) estimates that between 1970 and 2021, over 60% of economic losses and 90% of deaths due to weather-, climate- and water-related disasters were reported in L&MICs.

Biodiversity losses remain at unprecedented levels, threatening the collapse of entire ecosystems (Dasgupta, 2021; Secretariat of the Convention on Biological Diversity, 2020). Despite progress towards achieving some of the 20 Aichi Biodiversity Targets, with six targets rated as 'partially achieved', none of these benchmarks are fully met (Secretariat of the Convention on Biological Diversity, 2020). Forests, oceans, and fisheries continue to be exploited at unsustainable levels, with significant losses in biodiversity (ibid; IPBES, 2019). In addition, ecosystem services, such as animal pollination, which are essential to around 75% of global food crop production, continue to decline (IPBES, 2019). Key policy levers like subsidies and other financial incentives continue to be used in ways that harm, rather than support biodiversity (Secretariat of the Convention on Biological Diversity, 2020).

Climate change and biodiversity losses are intrinsically linked, with climate change aggravating pre-existing patterns of biodiversity degradation, and declining biodiversity reducing human capacity for adaptation (Dasgupta, 2021; IPBES, 2019; Secretariat of the Convention on Biological Diversity, 2020). With 20% of the world population relying on wildlife for income and food (IPBES, 2019), climate-caused biodiversity losses represent substantial negative shocks to livelihoods and human wellbeing (Armand & Kim Taveras, 2021).

Ocean and other aquatic systems also face increased pressure. For example, nearly 50% of coastal wetlands have been lost over the last century due to the combined effects of localised human pressure, sea level rise, warming, and extreme climate events (IPCC, 2023). Ocean warming has contributed to a decrease in maximum catch

potential, compounding the effects of overfishing of some fish stocks (e.g., Vollset et al., 2022; Rogers-Bennett & Catton, 2022; World Bank, 2012). Moreover, ocean acidification has adversely affected aquaculture and fisheries, with effects disproportionately felt in L&MICs, where 97% of all workers employed in marine capture reside, the majority in small-scale and artisanal fisheries for local consumption (World Bank, 2012).

Much has been claimed about the potential contribution of "nature-based solutions" to GHG reduction (Secretariat of the Convention on Biological Diversity, 2020; Seddon, 2022). However, evidence of their effective contribution in alleviating the impacts of climate change remains scant.

1.2 Addressing the climate and biodiversity crises through evidence informed action

In efforts to halt and address the global climate and biodiversity crises, the global community has responded by establishing a number of international frameworks for action. The United Nations Framework Convention on Climate Change (UNFCCC) and the Paris Agreement set the climate agenda at the national and international levels, with the overarching goal of limiting global mean temperature increase to 1.5°C above pre-industrial levels. For this goal to be achieved, GHG emissions must peak before 2025 and decline 43% by 2030 (UNFCCC, March 2023).

In late 2022, the global community agreed on the Kunming-Montreal Global Biodiversity Framework (KMGBF), which first long-term goal involves "the integrity, connectivity and resilience of all ecosystems are maintained, enhanced, or restored, substantially increasing the area of natural ecosystems by 2050; human induced extinction of known threatened species is halted, and, by 2050, extinction rate and risk of all species are reduced tenfold and the abundance of native wild species is increased to healthy and resilient levels; and the genetic diversity within populations of wild and domesticated species, is maintained, safeguarding their adaptive potential" (Secretariat of the Convention on Biological Diversity, 2022, p.1). Target 3 of the framework – related to effectively conserving and managing at least 30% of terrestrial, inland water and coastal and marine areas by 2030 – has gained particular visibility in recent years (The Nature Conservancy, 2023). The KMGBF sets other high-level objectives, such as the integration of biodiversity conservation into the planning and management of high-impact sectors (agriculture, forestry, fisheries, infrastructure, and energy); closing the global biodiversity funding gap and reducing harmful subsidies. Importantly, the framework recognises the linkages between biodiversity and climate change, setting targets for climate adaptation and the dissemination of nature-based solutions (Secretariat of the Convention on Biological Diversity, 2022).

While there has been an increase in funding dedicated to addressing climate change and biodiversity conservation, the resources available fall far short of the targets established in international frameworks. In 2020, total climate finance provided and mobilised by rich countries to their L&MIC counterparts reached USD 83.3 billion, representing a 4% increase relative to the previous year, but still short of the USD 100 billion annual goal established under the UNFCC (OECD, 2022). When it comes to biodiversity, estimates for annual public international finance flows from high-income to L&MICs range from USD 3.9 billion to USD 9.3 billion (annual mean for the 2015-2017 period; OECD, 2020).

These figures are remarkedly far from the KMGBF target to increase annual biodiversity-related financial flows from rich- to low-and-middle-income economies to at least USD 20 billion by 2025 and USD 30 billion by 2050 (Secretariat of the Convention on Biological Diversity, 2022).

The shortfall in funding to address the climate and biodiversity crises, combined with the severity of the crises and risks associated with insufficient mitigation, highlight the importance of evidence informed action. While there has been significant focus on developing the evidence base on the causes and consequences of climate change and biodiversity loss, the evidence of effective actions to tackle these threats is more nascent (Ferraro & Pattanayak, 2006; Prowse & Snilstveit, 2010) and continues to accumulate slowly (e.g., Guizar-Coutino et al., 2022). For instance, efforts to identify, map and synthesise evidence on different climate and biodiversity interventions have highlighted the lack of significant bodies of literature addressing the causal effects of common environmental management programmes, including protected areas, payment for environmental services (PES), decentralised forest management and sustainable agriculture (Pullin et al., 2013; Samii et al., 2015a; Samii et al., 2015b; Snilstveit et al., 2016; Snilstveit et al., 2019; Oya et al., 2017).

The calls for fast-tracking and scaling *effective* climate and biodiversity action could not be louder. We urgently need to know which programmes work. There is always a human and financial cost of dedicating resources to policies and programmes that do not work. For the climate change and biodiversity crises the costs are multiplied and potentially catastrophic. Without better evidence there is a high risk we waste funding on programmes that fail,[1] and importantly we lose out on the opportunity to test, refine, and develop effective solutions.

There is an urgent need for a strategic and coordinated effort to develop the evidence base on effective interventions to address the global climate change and biodiversity crises. Drawing on and informed by our existing climate change research programme, 3ie is currently working to develop a coalition of stakeholders with a shared goal of identifying effective solutions to the climate and biodiversity crises and promoting evidence informed action. We call on the international policy and evidence community to support and coproduce a climate change and biodiversity evidence programme, with activities broadly structured according to the following three workstreams:

1) Evidence mapping and synthesis activities to make the most of existing evidence and develop strategic research agendas;
2) Generating impact evaluation evidence targeting priority gaps, and piloting and evaluating highly promising interventions across a range of locations and conditions;
3) Promoting knowledge translation and evidence uptake to inform policy design and the implementation of interventions.

[1] For programmes such as payment for environmental services and other mitigation efforts that are included in carbon trading mechanisms, the risk is not just that programmes have no effect, but they may inadvertently contribute to a net increase in emissions if they do not achieve a reduction in emissions. They may also irreversibly influence livelihood trajectories of local actors.

In this report, we outline a proposed framework of climate change interventions and outcomes, which will act as the starting point for strategic and coordinated evidence generation and synthesis activities. The framework should be read as a draft, and we welcome feedback and suggestions for revisions.

2. Developing a framework for climate change and biodiversity action

In what follows, we propose a framework for thinking about and classifying climate change and biodiversity intervention and outcomes. Our goal is for the framework to be inclusive of existing interventions and outcomes in climate change and biodiversity programming in L&MICs. In developing the framework, we have aimed to define mutually exclusive concepts and terminology that are rooted in the existing academic and policy literatures.

We consulted key strategy and policy papers in the sector to define the framework scope. For example, the IPCC Sixth Assessment Report (IPCC, 2023) provided a state-of-the-art description of the *status quo* on climate change science and policy action, as well as a blueprint of adaptation and mitigation intervention options under varying environmental and economic scenarios. Dasgupta (2021) presented the economic rationale for biodiversity protection, conservation, and restoration, contributing to the nascent literature on the biodiversity and poverty nexus. ICF's report (2023) provided an overview of key challenges and best practices to accurately measure the cost-effectiveness of ecosystem restoration activities, particularly as related to the KMGBF target 2 ("to ensure that by 2030 at least 30% of areas of degraded terrestrial, inland water, and marine and coastal ecosystems are under effective restoration"; Secretariat of the Convention on Biological Diversity, 2022, p1). FCDO (2022) reviewed the economics literature on the cost-effectiveness of some nature-based solutions and climate mitigation technologies, although the report is not intended to be a comprehensive listing of existing innovations. We drew from FCDO's grouping of interventions by natural system (forests, coasts and oceans, water, cities, and agriculture) and granular examples of practices, behaviours, and technologies to develop our framework.

Following this literature and other 3ie work (Gonzalez Parrao et al., 2023; Snilstveit et al., 2016), we first group interventions by type of natural system and productive activities, namely:

- Land and forests, including major types of natural land systems in L&MICs, namely (tropical) forests, woodlands, grasslands, savannas, inland wetlands, and peatlands;
- Coasts and oceans, including major types of coastal and marine natural systems in L&MICs, namely coastal areas, wetlands (mangroves, salt marshes), oceans, coral reefs, seagrass beds, and river deltas. This category also includes saltwater fisheries;
- Smallholder agriculture and livestock breeding;
- Aquaculture and fisheries in freshwater systems.

We also categorise outcomes into the following two groups:

- Environment, including downstream biodiversity and climate mitigation outcomes, as well as intermediary outcomes that affect one (or both) of the former sub-groups through direct or indirect causal pathways;

- Human welfare, including climate adaptation and intermediary outcomes that shape downstream adaptation measures.

Given the large potential scope of this work, the proposed framework is restricted to interventions that explicitly relate to climate mitigation, adaptation, biodiversity protection, conservation, and land restoration. We have excluded from the framework general agricultural, fishery, environmental, or livelihood-enhancing interventions that do not include such explicit focus.[2]

A large number of interventions and policy instruments can be leveraged to disseminate climate or biodiversity innovations across different natural and productive systems. Regulatory frameworks and policies such as **protected areas, wildlife conservation policies, and other land and marine conservation policies** aim to regulate access and use of natural resources, incentivise nature protection and conservation (e.g., timber harvesting regulation and fishery quotas), and de-incentivise harmful behaviours (e.g., fines for crop burning or ocean oil spillages). A relatively large body of work has studied land-based protected areas (e.g., Pullin et al., 2013; Samii et al., 2015a). However, early scoping provided few examples for interventions such as protected seascape or marine reserves (e.g., Costello & Ballantine, 2015). Wildlife conservation policies may include policies such as permanent bans, temporary moratoriums, or quotas on marine capture (Gonzalez-Lira & Mobarak, 2019), the introduction and enforcement of anti-poaching laws, and penalties for wildlife traffic. Conservation policies may include the design and implementation of policy frameworks for land restoration activities (see IUCN, 2022 for a brief overview of the restoration status quo across multiple geographies).

Another strand of development programming aims to foster **community participation** in natural resource management and decision-making processes (e.g., Coppock et al., 2021; Keane et al., 2019; Rasolofoson et al., 2015). On one end of the spectrum, decentralisation typically involves transferring some degree of responsibility over natural resource management from central governments to other stakeholders (e.g., private sector or local communities or government). Community participation may take the form of fully decentralised land, fishery, or coastal management, monitoring of external managerial authorities, or reporting on natural resource use.

On the other hand, limited **information and knowledge** can constraint the dissemination of familiar and unfamiliar agricultural, land, and water management technologies in L&MICs (Magruder, 2018). **Information and training** interventions targeting local communities, civil servants, and other natural resource stakeholders may also aim to improve knowledge, skills, and foster practice and technology adoption via behavioural change. **Traditional agricultural/fishery extension** models (e.g., Deutschmann et al., 2021) can leverage field agents who, in turn, train lead farmers. These actors are then expected to disseminate knowledge at the local level. However, cultural norms, behavioural biases, and frictions in social learning may slow down the dissemination of improved knowledge and technologies within communities. In turn, **digital agricultural**

[2] We recognise that general livelihood-enhancing interventions, such as cash transfers and "graduation" programmes may have adaptation co-benefits even when interventions do not explicitly target climate adaptation. There are several ways in which this body of work may be incorporated when implementing this map; as such, we may revise this exclusion decision in the future.

and fishery extension models (e.g., Aker & Jack, 2022; Cole & Fernando, 2021; Fabregas et al., 2019) have aimed to partially overcome these challenges by allowing for highly customised information, given low marginal costs at scale. Likewise, adaptation interventions such as localised **weather forecasts and environmental disaster alert and information systems** (e.g., Leffers, 2023) can disseminate information on extreme events such as floods, droughts, landslides, extreme heat, or wildfires, with the objective of increasing preparedness and resilience to climate shocks.

Another strand of development programming focuses on **financial incentives** to disseminate climate mitigation, adaptation, and biodiversity-enhancing technologies. **PES** are specifically designed to overcome liquidity constraints and reward voluntary pro-environmental practices and behaviours (e.g., Jayachandran et al., 2017 evaluated the effect of a PES scheme for deforestation prevention). PES schemes may also be leveraged in agriculture and fisheries, as well as in coastal and marine areas protection and conservation. Similarly, subsidies, credit, and cash transfers can mitigate liquidity constraints and credit market failures. For instance, Beaman and colleagues (2021) studied the returns to agricultural input credit in rural Mali, whereas Oliva and colleagues (2020) assessed the introduction of agroforestry subsidies for the adoption of trees that improve soil fertility in rural Zambia. In addition, Lane (2022) evaluated the effectiveness of a loan product that *guaranteed* credit to households following a flood in rural Bangladesh, while Bulte and colleagues (2018) studied the effectiveness of cash transfers on livelihoods and environmental conservation in Sierra Leone

Other interventions tackling **liquidity and market constraints** may **directly provide in-kind inputs, equipment, and machinery** to farmers, fishery communities, and other relevant actors. For example, Beaman and colleagues (2013) studied the provision of improved rice fertiliser in Mali. Another climate mitigation example is given by Islam and Beg (2019), who evaluated the provision of a novel fertilisation support tool in rural Bangladesh, where nitrogen fertilisation subsidies are high.

Market frictions, such as the lack of awareness and connectivity between key value chain actors – including farmer and fishery communities, agro-dealers, specialised services, and output markets – may also hinder the dissemination of climate and biodiversity programmes. Examples of these interventions may include building producers' capacities, fostering further interconnectedness, encouraging novel productive agreements (e.g., cooperatives, contract farming and fisheries), or providing actors with information on market players, prices, and production standards (Herrero et al., 2010; 2013; Rudder, 2020).

Novel **market shaping instruments**, such as results-based finance (e.g., REDD+) and advanced market commitments are gaining traction as meta-innovations that can pull finance into the development, monitoring, and verification of climate and nature-based solutions. These models follow the success of advanced market commitments in the development and dissemination of pneumococcal vaccination in L&MICs (Kremer et al., 2020). In addition, emphasis has been placed on information systems that track and monitor natural resource status, as well as technology, practice, and behaviour adoption (e.g., Global Forest Watch, July 2023). Big data systems that leverage satellite imagery and systems that rely on crowdsourced localised data seem to have gained traction, although it is unclear whether their use has been rigorously evaluated.

Lastly, our framework includes a **few idiosyncratic interventions** with relevance for climate and biodiversity conservation, albeit being specific to certain natural systems. Weather index insurance is the most common type of farming insurance products in L&MICs (Magruder, 2018). Other environment-specific interventions in our framework include land rights (such as collective land tiling reforms); agricultural and fishery regulations; and coastal adaptation policies aimed to smooth the risks posed by climate change to coastal ecosystems and livelihoods.

2.1 Interventions and outcomes framework

Based on the conceptual framework, research, and policy literature described above, we have developed an interventions and outcomes framework, as presented in *Table 1* and *Table 2*. We developed the framework in consultation with climate and biodiversity experts at Defra, who provided valuable input throughout the process. We have also relied on an advisory group of experts to test and improve the framework (more details on the advisory group are presented in Appendix A).

The contribution of L&MICs to total global GHGs is small, with the exception of CO_2 from land use change, particularly in West and Central Africa (IPCC, 2023; Ritchie et al., 2020). We find this to be a compelling reason to restrict our scope to topics related to land, oceans, agriculture, livestock, and fisheries. With few exceptions (e.g., fines for ocean spillages and crop burning), pollution-reduction instruments are also left out of the framework, as our understanding is that these are more often leveraged in the energy and industry sectors.

Nevertheless, the scope of the proposed framework remains notably large. For this reason, we have also excluded several sectors with relevance for climate change and biodiversity that have been (or will be) covered in previous (forthcoming) 3ie synthesis products. These include the energy, industry, and infrastructure sectors. Finally, whilst our framework includes key climate adaptation interventions (e.g., weather forecasts, disaster alert systems, weather insurance) and outcomes (e.g., climate risk exposure, livelihoods diversification, geographical relocation of productive activities), we are fairly restrictive when it comes to resilience-enhancing interventions given a recent 3ie EGM on the topic (Berretta et al., 2023).

Table 1: List of interventions

Intervention Group	Category	Definition	Examples
Land and Forests *Includes major types of natural land systems in L&MICs, namely (tropical) forests, woodlands, grasslands, savannas, inland wetlands and peatlands*	Protected Areas	Regulatory framework on protected areas such as national parks or reserves, where access and use of resources is either fully restricted or regulated, as per the International Union for Conservation of Nature categorisation (Dudley, 2008). Excludes community-based management or monitoring interventions.	● Public or private protected reserves ● National or regional parks
	Land Rights	Formal registration of land, either through the conversion of communal or non-demarcated rural land to freehold title or the statutory recognition of customary or communal rural land rights. This category also includes other land-tenure types, such as sustainable-use protected areas or indigenous-related tenures (Pacheco & Meyer, 2022).	● Collective land titling reforms
	Other Land Conservation Policy	Policies that regulate or incentivise land protection, conservation, and restoration, or regulate the use of natural resources, such as timber logging quotas. Excludes Protected Areas.	● Agroforestry regulation through logging and timber quotas ● Land reclamation and rejuvenation policies to restore/improve microclimate and degraded areas
	Wildlife conservation policy	Interventions monitoring and protecting wild animal resources, such as anti-poaching laws and monitoring systems for endangered species.	● Anti-poaching laws ● Endangered species monitoring systems ● Human-wildlife conflict monitoring
	Community-based or Decentralised Land Management & Monitoring	Interventions that foster community participation in land management decision-making processes. Decentralisation typically involves transferring some degree of responsibility over land management from central governments to other stakeholders (private sector, local communities, or government). Community participation may take the form of fully decentralised land management, monitoring of external management, or reporting on land use.	● Decentralised forest management ● Community representation in forest managerial organs (e.g., community councils) ● Crowdsourced reporting and monitoring systems (e.g., wildfires, timber tracing)
	Information and	Provision of information and/or training to local communities, civil	● Civil servants capacity building

Intervention Group	Category	Definition	Examples
	Training	servants, and other key stakeholders on technologies, practices, and behaviours related to climate action or land protection, conservation, and restoration.	● Extension services for agroforestry and by-products management
	Weather Forecasts & Environmental Disaster Alerts	Provision, maintenance, or improvement of high-quality localised weather forecasts or extreme weather and environmental disaster alert systems to local communities and other land stakeholders.	● Forest fire alert systems
	Payments for Ecosystem Services	Payments conditional on voluntary pro-environment behaviours. Payments for ecosystem services (PES) are the environmental version of conditional cash transfers and are most commonly associated with forestry protection, conservation, and restoration.	● PES for adoption of pro-environmental practices (e.g., forest cover conservation, deforestation prevention, soil erosion control) ● PES for non-adoption of damaging practices (e.g., poor logging, land burning, poaching)
	Subsidies, credit, and cash transfers	Transfers that mitigate liquidity constraints or market failures to foster the adoption of land protection and climate-relevant technologies and behaviours. Category includes universal or conditional cash transfers that explicitly aim to build community resilience against climate change risks but excludes PES.	● Reforestation subsidies ● Input loans for agroforestry and land management ● Universal or conditional cash transfers for climate change
	In-kind transfers & equipment	Direct provision of inputs, tools, and machinery for agroforestry and land management practices related to land protection, conservation, restoration, or climate action.	● Provision of inputs and machinery for improved land management ● Provision of tree seedlings for planting campaigns
	Market shaping funding	"Pull" funding instruments that align profitability and sustainability objectives by conditioning payouts on performance against predefined climate or biodiversity targets in land systems (e.g., REDD++ results-based payments for forest conservation). Some instruments generate market incentives for the development of not-yet-existing technologies (e.g., advanced market commitments).	● REDD++ results-based payments for forest conservation ● Advanced market commitments for the development of enhanced silicate weathering technology
	Certification and	Interventions that either (a) provide certification related to climate	● Carbon credit certification

Intervention Group	Category	Definition	Examples
	Market Linkages	mitigation, biodiversity-enhancing, or overall sustainable agroforestry and land management, as a pathway to new/premium output markets; or (b) establish linkages across various land stakeholders, such as agroforestry farmers, forest and land managers, and output markets.	● Timber certification from Forest Stewardship Council ● Reduced impact logging certification
	Monitoring & Information Systems	Development and maintenance of systems that track land resource status, stakeholder behaviours, and practices. Information systems may combine big data (i.e., satellite imagery) with micro-data from administrative sources or surveys. Examples include "forest watch" systems tracking tree coverage and land use changes.	● "Forest watch" systems tracking tree cover, land use activities, or extreme events (e.g., wildfires) ● Tracking of land use changes (e.g., forest conversion into cropland)
Agriculture and Livestock *Includes smallholder agricultural production and livestock breeding activities*	Agricultural Regulations	Zoning policies determining areas where agriculture production is permitted, and regulations on the types, amount, and permissible adoption of agricultural inputs and practices. Interventions included as related to climate change and biodiversity enhancement. Excludes protected areas.	● Agricultural zoning regulation ● Input regulation on crop varieties, fertiliser, and pesticide use
	Agricultural Extension and Information Services	Provision of extension services, information, and training to farmers to improve knowledge, skills, and foster practice and technology adoption via behavioural change.	● Information and training delivery via field officers ● Farmer field schools ● Demonstration plots
	Digital Agricultural Extension and Information Services	Digital services providing farmers with information, recommendations, decision-support tools, and/or training via mobile phones or other digital tools to improve knowledge, skills, and influence behaviour change. Digital services can be inbound, outbound, or allow for two-way real-time communication. These typically differ from traditional services by relying on behavioural incentives such as nudges, repetition, timed reminders, information crowdsourcing, and social learning to spur technology adoption.	● Hotlines ● Interactive voice response (IVR)/robot calls, SMS information ● Digital farmer decision support tools (e.g., pest monitoring, market prices)
	Weather Forecasts & Environmental	Provision, maintenance, or improvement of high-quality and localised weather forecasts and information, or extreme weather and	● Rainfall and temperature forecasts ● Drought, flooding and extreme heat alerts

Intervention Group	Category	Definition	Examples
	Disaster Alerts	environmental disaster alerts to farmers.	
	Weather and Climate Insurance	Provision of agricultural insurance products that mitigate weather and climate risk rather than actual crop loss, such as weather-index insurance. Also includes livestock insurance against animal death due to extreme heat and natural calamities.	● Rainfall or temperature-indexed agricultural insurance ● Livestock insurance against animal head from natural calamities
	Payments for Ecosystem Services	Payments conditional on voluntary pro-environment behaviours. Payments for ecosystem services (PES) are the environmental version of conditional cash transfers and may be leveraged in agriculture and livestock production to incentivise adoption of climate mitigation, adaptation, and/or biodiversity-enhancing practices.	● Payments for carbon-sequestration practice adoption (conservation agriculture, enhanced silicate weathering) ● Payments for avoidance of GHG emitting or other environmental harmful practices, such as crop burning
	Subsidies, credit, and cash transfers	Transfers that mitigate farmers' liquidity constraints or market failures to foster the adoption of climate-relevant agricultural technologies and behaviours. Category includes universal or conditional cash transfers that explicitly aim to build farmer resilience against climate change risks but excludes PES.	● Subsidies and credit for climate-adaptive inputs (e.g., drought-resilient crop varieties) ● Credit for improved machinery (e.g., mechanical no-tillage seeders)
	In-kind transfers & equipment	Direct provision of inputs, tools, and machinery for agriculture and livestock breeding as related to climate action and sustainable production.	● Provision of climate-resilient seeds ● Provision of agricultural lime to decrease soil acidity ● Provision of livestock vaccination
	Market shaping funding	"Pull" funding instruments that align profitability and sustainability objectives by conditioning payouts on performance against predefined climate or biodiversity targets in agriculture (e.g., results-based payments for farmer technology adoption). Some instruments generate market incentives for the development of not-yet-existing technologies (e.g., advanced market commitments for climate-adaptive crop varieties).	● Advanced market commitments for adaptation technologies (e.g., climate resilient crop varieties) ● Results-based finance for farmer technology adoption

Intervention Group	Category	Definition	Examples
	Irrigation Infrastructure	Supply, maintenance, or improvement of small-scale agricultural irrigation systems. Includes rural public goods infrastructure (e.g., drainage canals, dams, public wells) and private irrigation equipment such as pump sets and water tanks.	● Rural irrigation infrastructure supply (e.g., drainage canals, dams, public wells and water tanks) ● Private irrigation equipment (e.g., pump sets and private or cooperative-owned water tanks)
	Certification and Market Linkages	Interventions that either (a) provide certification related to climate mitigation, biodiversity-enhancing, or overall sustainable agriculture and livestock production as a pathway to new/premium output markets; or (b) establish linkages across value chain actors, such as farmers, agro-suppliers, specialised services, and output markets.	● Establishment of farmer cooperatives ● Physical or digital phonebook interventions (agro-dealers or downstream output buyers) ● Access to specialised livestock services (e.g., veterinary and artificial crossbreeding) ● Crop production sustainability certification (e.g., Better Cotton Initiative)
	Monitoring & Information Systems	Development and maintenance of systems that monitor cropland status, farmer behaviours, and practices. Information systems may combine big data (i.e., satellite imagery) with micro-data from administrative sources or surveys. Examples include big data systems tracking cropland health and farming practices.	● Big data monitoring systems on farming practices (e.g., intercropping) ● Monitoring of soil health and irrigation water status
Aquaculture and Fisheries *Includes smallholder aquaculture and fishery activities in freshwater systems*	Fishery Quotas and Regulation	Permanent quotas or temporary moratoriums on fisheries, and regulations on fishery practices and timing.	● Fishery quotas and moratoriums ● Regulations on fishery timings based on reproduction and growth cycles
	Community-based or Decentralised Fisheries Management & Monitoring	Interventions that foster community participation in fisheries' managerial decision-making processes. Participation may take the form of fully decentralised fisheries, monitoring of external fishery management, or reporting on fishery status.	● Fully decentralised fisheries ● Crowdsourced fisheries information and monitoring (e.g., fish stocks and health)
	Aquaculture	Provision of extension services, information, and training to	● Field Officers' training visits

Intervention Group	Category	Definition	Examples
	Extension and Information Services	fishery/aquaculture farmers to improve knowledge, skills, and foster practice and technology adoption via behavioural change.	● Government agricultural/fishery departments' information services
	Digital Aquaculture Extension and Information Services	Digital services providing fishery/aquaculture farmers with information, recommendations, decision-support tools, and/or training via mobile phones or other digital tools to improve knowledge, skills, and influence behaviour change. Digital services can be inbound, outbound, or allow for two-way real-time communication. These typically differ from traditional services by relying on behavioural incentives such as nudges, repetition, timed reminders, information crowdsourcing, and social learning to spur technology adoption.	● Hotlines ● Interactive voice response (IVR)/robot calls, SMS information
	Weather Forecasts & Environmental Disaster Alerts	Provision, maintenance, or improvement of high-quality localised weather forecasts or extreme weather and environmental disaster alert systems to fishing communities.	● Risk of flooding and droughts alerts
	Payments for Ecosystem Services	Payments conditional on voluntary pro-environment behaviours. Payments for ecosystem services (PES) are the environmental version of conditional cash transfers and may be associated with aquaculture and fisheries protection, conservation and management, as well as climate mitigation and adaptation behaviours.	● Compensation for adherence to fishing quotas ● Payments for flood protection behaviours, such as construction of enclosures for aquaculture ● Payment for biodiversity-enhancing polyculture practices
	Subsidies, credit, and cash transfers	Transfers that mitigate fishery farmers' liquidity constraints or market failures that hinder the adoption of climate-relevant agricultural technologies and behaviours. Category includes universal or conditional cash transfers that explicitly aim to build resilience against climate change risks but excludes PES.	● Input subsidies for ponds, improved fish feeding, species restocking, and nurseries ● Transfers for pond flooding prevention
	In-kind transfers & equipment	Direct provision of inputs, tools, and machinery for aquaculture and fisheries as related to climate action and sustainable production.	● Provision of fish fingerlings during monsoon seasons
	Market shaping funding	"Pull" funding instruments that align profitability and sustainability objectives by conditioning payouts on performance against	● Advanced market commitments for fishery adaptation technologies (e.g.,

Intervention Group	Category	Definition	Examples
		predefined climate or biodiversity targets in aquaculture and fisheries (e.g., results-based payments for fishery technology adoption). Some instruments generate market incentives for the development of not-yet-existing technologies (e.g., advanced market commitments for fishery flood prevention technology).	flood prevention)
	Certification and Market Linkages	Interventions that either (a) provide certification related to climate mitigation, biodiversity-enhancing, or overall sustainable aquaculture and fishery production as a pathway to new/premium output markets; or (b) establish linkages across various fishery value chain actors, such as fishery communities, suppliers, specialised services, and output markets.	● Fishing cooperatives ● Access to new/premium output markets related to sustainable production
	Monitoring & Information Systems	Development and maintenance of systems that track aquaculture and fisheries' resource status, fishery farmers' behaviours, and practices. Information systems may combine big data (i.e., satellite imagery) with micro-data from administrative sources or surveys. Examples include "forest watch" systems tracking tree cover, land use activities, or harmful practices such as land burning.	● Monitoring of fishery practice adoption (e.g., adherence to quotas, fishery restocking)
Coasts and Oceans *Includes major types of coastal and marine natural systems in L&MICs, namely coastal areas, wetlands (mangroves, salt marshes), oceans, coral reefs, seagrass beds, and river deltas. Also includes*	Protected Areas	Regulatory framework on areas such as protected seascapes or marine reserves, where access and use of resources is either fully restricted or regulated, as per the International Union for Conservation of Nature categorisation (Dudley, 2008). Excludes community-based management or monitoring interventions.	● Protected seascape ● Marine reserves ● Coral reef reserves
	Coastal Adaptation Policies	Policies and regulations outlining principles and activities for coastal livelihoods adaptation to climate change. Coastal management for adaptation includes three main pillars: (1) adaptation of human activity to sea-level rise; (2) adaptation to saltwater intrusion into coastal aquifers; (3) management of coastal access of freshwater, such as regulating water withdrawal from rivers to manage water salinity.	● Public protocols on sea-level rise adaptation ● Mitigation of saltwater/sediment intrusion in coastal aquifers ● Erosion control interventions to reduce sedimentation loads in coastal habitats

Intervention Group	Category	Definition	Examples
saltwater fisheries.	Marine and Coastal Conservation Policy	Policies that regulate or incentivise coasts and ocean protection, conservation, and restoration, such as oil spillage fines.	● Fines on ocean pollution via spillage, leakage, or trash deposits ● Public protocols for oil spillage cleanup
	Saltwater Fishery Quotas and Wildlife Conservation Policy	Permanent quotas or temporary moratoriums on saltwater fisheries, and regulations on fishery practices. Interventions also include monitoring and protecting marine wild animal resources, such as monitoring systems for endangered species.	● International treaties and laws on species preservation ● Prohibition of dynamite fishing (coral reef and sea grass protection) ● Regulations on saltwater fishing net size ● Marine wildlife monitoring
	Community-based Monitoring	Interventions that foster community monitoring of coastal and ocean status and natural resource use, such as saltwater fishery activities.	● Crowdsourced reporting on ocean water status
	Information and Training	Provision of information and/or training to local communities, civil servants, and other key stakeholders on technologies, practices, and behaviours related to climate action or coasts and ocean protection, conservation, and restoration.	● (Saltwater) Fishery Extension Services ● Public awareness campaigns on marine and coastal biodiversity protection
	Weather Forecasts & Environmental Disaster Alerts	Provision, maintenance, or improvement of high-quality localised weather forecasts or extreme weather and environmental disaster alert systems to coastal and saltwater fishery communities.	● Coastal landslide alerts ● Information on ocean currents to fishery communities
	Payments for Ecosystem Services	Payments conditional on voluntary pro-environment behaviours. Payments for ecosystem services (PES) are the environmental version of conditional cash transfers and may be associated with coastal areas and marine protection, conservation, and restoration practices, as well as climate mitigation and adaptation behaviours.	● Payments for adherence to saltwater fisheries quotas (loss revenue compensation) ● Payment for improved saltwater fishery management
	Subsidies, credit, and cash transfers	Transfers that mitigate coastal or saltwater fishery communities' liquidity constraints or market failures to foster the adoption of climate-relevant technologies and behaviours. Category includes universal or conditional cash transfers that explicitly aim to build resilience against climate change risks but excludes PES.	● Climate adaptation transfers (e.g., for relocation of fishery activities) ● Input subsidies for saltwater fisheries
	In-kind transfers &	Direct provision of inputs, tools, and machinery for saltwater fishery	● Inputs and machinery for the

Intervention Group	Category	Definition	Examples
	equipment	and oceans and coasts management practices related to resource protection, conservation, restoration, and climate action.	implementation of coastal management for adaptation protocols (e.g., sea wall construction)
	Market shaping instruments	"Pull" funding instruments that align profitability and sustainability objectives by conditioning payouts on performance against predefined climate or biodiversity targets in coasts and oceans (e.g., results-based payments for marine species conservation). Some instruments generate market incentives for the development of not-yet-existing technologies (e.g., advanced market commitments).	● Results-based payments for marine species conservation
	Certification and Market Linkages	Interventions that establish linkages across various saltwater fishery value chain actors, such as local communities, input suppliers, and output markets.	● Saltwater fishery cooperatives ● Information on output markets
	Monitoring & Information Systems	Development and maintenance of systems that track coastal and marine resource status, and saltwater fishery communities' behaviours and practices. Information systems may combine big data (i.e., satellite imagery) with micro-data from administrative sources or surveys. Examples include big data systems tracking ocean oil leakages and mangrove spot deposits.	● Ocean water quality monitoring ● Big data monitoring systems for ocean oil leakages and mangrove spot deposits

Table 2: List of outcomes

Outcome Group	Sub-group	Category	Definition
Environment *Downstream biodiversity and climate mitigation measures and intermediary (pathway) measures that affect one or both downstream outcome sub-groups*	Intermediary Outcomes	Land Use	Measures of land use activities undertaken for the purpose of economic production (e.g., cropland, livestock grazing, human settlements), as well as for the maintenance and restoration of environmental functions. Also includes land use conservation, activity spillage, and leakage metrics.
		Land Cover	Measures of the physical land type such as forest, grassland, or open water. Includes metrics such as tree and vegetation density and biomass cover.
	Biodiversity	Environment Status & Health	Measures of the condition of any type of land, water, or mixed environments, such as soil health, ocean and freshwater quality.
		Species complexity	Measures of the stock and changes in population size (abundance) and demographic attributes, along with diversity of species within a particular area and seasonal fluctuations (e.g., within-year variation). Also includes measures of illegal wildlife trade across all applicable natural systems.
		Habitat structural complexity	Measures of habitat structural complexity (e.g., connectivity and lack thereof) and processes (e.g., productivity, trophic chain diversity), that determine ecosystem functions to maintain healthy plant and animal populations and ecosystem processes (e.g., refuge for migratory species).
	Climate Mitigation	GHG emissions	Measures of GHG emissions including changes in amount emitted, avoided, or leaked to another area. May also include measures of GHG intensity per productive unit (e.g., methane intensity in livestock production).
		Carbon storage and sequestration	Measures of carbon stocks and flows in biomass and above and below ground organic matter. Includes both soil organic carbon (temporary sequestration) and permanent carbon elimination measures.
Human Welfare *Human welfare climate adaptation measures and intermediary outcomes that shape*	Intermediary Outcomes	Knowledge acquisition	Measures of knowledge of land, forestry, and oceans management, agriculture, and aquaculture behaviours and technologies related to climate change and biodiversity enhancement.
		Practice and technology adoption	Measures of adoption and dissemination of practices and technologies related to climate change mitigation, adaptation, and biodiversity protection, conservation, and restoration. Includes measures of the frequency, intensity, and quality of practice implementation. Category also includes input usage efficiency in agriculture, livestock, aquaculture and fisheries.

Outcome Group	Sub-group	Category	Definition
downstream adaptation effects		Productivity	Measures of productivity in land, agriculture, livestock breeding, and aquaculture. Outcomes may include crop yields, land productivity, and livestock by-product yields (e.g., dairy) in agriculture; pond productivity and fish catches in aquaculture and fisheries.
		Water Access	Measures of clean water availability, disbursement, and reliability through rural-setting infrastructure.
		Clean Air	Measures of access to clean air and air quality indicators.
	Climate Adaptation	Climate risk exposure	Measures of individual, household, or community exposure to climate shocks, including extreme weather and natural disasters (e.g., floods, droughts, heat waves, wildfires). Also includes risk-sharing measures.
		Food security	Measures of food security across the four dimensions included in the Declaration on Food Security (FAO, 2009): food availability, access, utilisation, and stability. These are typically measured using a range of indicators such as food consumption and expenditure.
		Nutrition	Measures of individual or community nutritional status and food bio nutrition characteristics. Measurements include diet nutritional content, vitamin and micronutrient status and deficiencies. Category includes diseases directly caused or strictly associated with nutrient status.
		Health	Measures of health status, disease prevalence and access to health care. Category excludes diseases directly caused or strictly associated with nutrient status.
		Income	Measures of household or individual income or proxy indicators, such as agricultural profit and revenues and assets. Includes income proxies that include food and non-food consumption.
		Employment & livelihoods	Measures of individual or household employment status, revenue-generating activities, and income sources (including external sources, such as remittances or transfers). Also includes measures of livelihoods and productive activity diversification or geographical relocation.

3. Conclusion

Defra have funded 3ie to scope the latest research and develop a much-needed interventions and outcomes framework to map the rigorous evidence available related to climate change and biodiversity protection, conservation and restoration in L&MICs. After reviewing strategy documents of key funders and implementing agencies (HM Government, 2023; Defra, 2018; 2023; Green Climate Fund, 2023; IPCC, 2023; IPBES, 2019; 2022; UNCCD, 2022; IUCN, 2022), as well as the academic literature, and collaborating with subject experts, we have arrived at a framework that we believe to be mutually exclusive and collectively exhaustive of key interventions in these thematic areas.

Mapping the evidence through this framework can provide a valuable contribution to the development community by displaying how the evidence base is distributed and where there are evidence gaps. With pledges of USD 100 billion in climate finance ahead of COP28, the uptake of rigorous evidence to increase development effectiveness in the sector has a critical role.

As next steps, 3ie will aim to convene an advisory group with key stakeholders – including practitioners, policymakers, and donors in the climate and biodiversity conservation spaces – with two main objectives: validate and expand the policy relevance of this work and build a coalition of organisations concerned with the production and use of rigorous evidence to inform decision-making. Once the evidence on climate change and biodiversity is mapped, relevant synthesis efforts can be undertaken to understand what works to address climate change, for whom, at what cost and under what conditions. Subsequently, this can inform the prioritisation of investments in programming and research around climate, including commissioning primary studies to fill in evidence gaps.

Appendixes

Appendix A: Advisory group

The following members of our current advisory group of experts contributed to this work by revising and commenting on the framework:

- Andreas Kontoleon, Professor of Environmental Economics and Public Policy, University of Cambridge Department of Land Economy
- Jennifer Alix-Garcia, Professor of Applied Economics, Director, Sustainability Double Degree Program, Oregon State University

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