Is ecosystem-based adaptation effective?

Perceptions and lessons learned from 13 project sites

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Acronyms

ANDES	Asociación para la Naturaleza y el Desarrollo Sostenible
BMU	German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety
CRiSTAL	Community-based Risk Screening Tool – Adaptation and Livelihoods
CVCA	Climate Vulnerability and Capacity Analysis
EbA	ecosystem-based adaptation
IIED	International Institute for Environment and Development
IKI	International Climate Initiative
INDCs	intended nationally determined contributions
InVEST	Integrated Valuation of Environmental Services and Trade-offs
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
NPV	net present value
UNEP-WCMC	UN Environment World Conservation Monitoring Centre

Summary

The global climate is changing rapidly. Nations and the international and bilateral organisations and processes that support them need clear direction on how best to adapt. Ecosystem-based adaptation (EbA) is an increasingly popular strategy for addressing the linked challenges of climate change and poverty in poor countries, where dependence on natural resources for lives and livelihoods is high. But EbA is neither widely nor consistently implemented. It is not sufficiently mainstreamed into national and international policy processes and receives a small proportion of adaptation finance. This is in part due to a weak or poorly consolidated evidence base on EbA effectiveness.

To address this gap, we conducted research on EbA effectiveness at 13 case study sites in 12 countries, assessing how effectively the initiatives:

1. Support local peoples' adaptive capacity or resilience, or reduce vulnerability
2. Help ecosystems produce services for local people and allow them to withstand climate change impacts and other stressors, and
3. Are financially and economically viable.

We also assessed political, institutional and governance-related conditions that facilitate or inhibit effective EbA at each site. Our research involved collecting perceptions through interviews with a range of stakeholders at each site, and a review of project documentation.

The results show that stakeholders perceive EbA as able to improve the resilience or adaptive capacity of local communities or reduce their vulnerability to climate change. This was the case at all project sites, even though not all project activities contributed directly to this. All case studies were thought to provide a multitude of social co-benefits, including livelihood or health improvements and provision of water for productive use. These could deliver on several national and international development-related priorities, including the Sustainable Development Goals; they could also contribute indirectly or provide a positive feedback effect to adaptation. Perceived improvements in resilience, adaptive capacity and vulnerability arising specifically from EbA project activities tended to accrue among particularly vulnerable groups of people, notably women. This is important as the world's poorest have contributed least to the problem of climate change and tend to rely heavily on natural resources.

Stakeholders in all case studies saw adopting participatory processes and valuing indigenous or local knowledge as major contributors to building adaptive capacity. For example, many project activities in China and Peru's Potato Park were founded on participatory plant breeding processes. In Bangladesh, some thought that greater levels of participation could have improved project interventions.

Perceptions related to maintaining, restoring or enhancing some ecosystem services after EbA project implementation were also positive across all sites (but again, not all project activities led to these). Stakeholders at 11 sites reported perceived or expected improvements in ecosystem service delivery in all four categories – provisioning, regulating, cultural and supporting – including improvements in water provision for domestic and agricultural purposes, disaster risk reduction, soil quality improvements and conserving national heritage. At eight sites, they considered the watershed or catchment area an important level for implementing EbA activities, reporting that interventions at this level (as opposed to more localised interventions) benefited ecosystem resilience. Stakeholders also considered interventions at the wider landscape level important in this context.

Several case studies reported social and/or environmental trade-offs and unequal benefit distribution. In all cases, some groups accrued more adaptation-related benefits than others. This was also true for social co-benefits at most case study sites. While some case studies reported no trade-offs in terms of who accrued adaptation-related benefits and social co-benefits, eight reported that one group accrued adaptation-related benefits at the expense of others and six reported that one group had accrued, or could accrue in the future, social co-benefits at the expense of others. Five also reported trade-offs or potential trade-offs between ecosystem service provision at different geographical scales or sites. Acknowledging and understanding these differential benefits and trade-offs is the first step towards tackling them.

Some adaptation-related benefits or improvements to ecosystem service provision took time to materialise. For example, rangeland restoration in Namaqualand, South Africa, will probably take 20 years or more. Short-term costs sometimes accrued – for example, for people excluded from grazing areas – while waiting for longer-term benefits to emerge. We observed potential trade-offs between ecosystem service delivery across different timescales at three sites. Some case study projects also resulted in short-term economic benefits; in others, these took substantially longer to materialise. For example, economic studies suggest it will take 20 years for *timur* plantations to break even in Nepal. Temporary incentives can help shift such short-term burdens and some case studies showed how EbA projects had tackled this challenge by providing incentives to offset short-term losses until longer-term benefits emerged. In Bangladesh, for example, the government distributed rice to fishers in return for their abidance by fishing restrictions. Future EbA project design should factor the potential need for such incentives into planning.

Of the 13 EbA projects, stakeholders perceived 11 as delivering cost-effective EbA measures and 11 as more cost-effective than alternatives. However, two studies reported that EbA was not cost-effective or that they lacked enough information to support such a statement. EbA projects tended to fare worse against alternative options when:

- They required high initial investments — for example, in heavily degraded areas
- They were evaluated using high discount rates which penalise benefits that accrue in the long term, and/or
- Many of the co-benefits were non-monetary or not accounted for in the assessments.

Most case studies emphasise the challenges of fully measuring financial and economic costs and benefits and highlight the need to go beyond monetary values to better reflect the benefits of EbA.

Monetary cost-benefit analysis in six projects demonstrated how financial or economic benefits as a result of EbA activities at one location led to follow-on or spillover financial or economic benefits elsewhere. Many projects also reported broader economic costs (beyond implementation costs), especially opportunity costs. Analysis at two sites showed that costs and benefits were different for different stakeholder groups and five projects demonstrated trade-offs or possible trade-offs, whereby one group benefited (or was expected to benefit) financially or economically at the expense of others.

In conclusion, our research shows that EbA can provide a variety of important wide-reaching and potentially long-lasting adaptation-related benefits, social co-benefits and ecosystem-related benefits, albeit with various trade-offs and associated challenges such as the time sometimes taken for benefits to emerge. EbA is also often cost-effective and can be more so than alternative approaches to adaptation such as investment in infrastructure. Countries should therefore consider EbA when planning for climate change adaptation.

Analysis of barriers and enabling factors showed that a number of political, policy and governance-related factors common to many of the case studies helped realise EbA benefits at the sites and more broadly in each case study country. These included government prioritisation of and capacity to support EbA, EbA champions, working with or strengthening local organisations, strong policies relating to climate change and

other issues, the provision of incentives and strong knowledge generation and sharing. However, various challenges — including insufficient or weak political and legal support for EbA and insufficient collaboration across a range of government levels — also inhibited the realisation of EbA benefits across case study sites and countries. Many of these challenges are not unique to EbA; they are also apparent in programmes addressing poverty reduction or environmental management improvements. Other challenges also apply to business as usual or taking no action. To overcome some of the barriers, governments need to prioritise EbA in climate change and development policymaking and facilitate collaboration across a range of departments and sectors, from local to national levels.

Scaling up EbA is important if benefits are to extend beyond the project level and reach the large number of poor and marginalised people who are particularly vulnerable to its impacts. We must therefore explore models for funding EbA at scale — for example, through existing or new social protection programmes.

1

Introduction

The global climate is changing rapidly and a failure of climate change mitigation and adaptation has been ranked in the top five global risks in terms of impact since 2015 (World Economic Forum 2019). As nations and the international and bilateral organisations and processes that support them plan how best to adapt to climate change, they need clear direction based on evidence from the field to focus their efforts.

Ecosystem-based adaptation (EbA) is "the use of biodiversity and ecosystem services to help people adapt to the adverse effects of climate change as part of an overall adaptation strategy" (CBD 2009). It falls under the umbrella of nature-based solutions that work with and enhance nature to support biodiversity and help address societal challenges (Seddon et al. 2019). EbA is an increasingly popular and tested strategy for addressing the linked challenges of climate change and poverty in developing countries, where people are more dependent on natural resources for their lives and livelihoods. Ecosystem-based approaches to adaptation and disaster risk reduction have been endorsed at the highest levels by the IPCC (IPCC 2018), in the Sendai Framework for Disaster Risk Reduction (UN 2015) and by the United Nations Environment Assembly (UNEA 2014).

A growing number of organisations and countries are implementing EbA and integrating it into their emerging climate change policy responses (Seddon 2018; Seddon et al. 2019). For example, of the 141 countries with adaptation plans in their intended nationally determined contributions (INDCs), 49% refer to EbA actions (Seddon 2018).[1]

[1] Nature-based Solutions Policy Platform. http://nbspolicyplatform.org/

There are many site-based examples of EbA interventions, which involve:

- Restoring coastal ecosystems such as coral reefs, mangrove forests, dune systems and salt marshes to dissipate the energy of powerful tropical storms (Spalding et al. 2014; Colls et al. 2009)
- Wetland and floodplain management to buffer floods and maintain water flow and quality in the face of changing rainfall regimes (Colloff et al. 2016; Iacob et al. 2014)
- Conservation and restoration of forests and other natural vegetation to stabilise slopes, prevent landslides and regulate water flow, preventing flash flooding (Pramova et al. 2012; Renaud et al. 2016), and
- Establishing diverse agroforestry systems to cope with increasingly variable climatic conditions (Matocha et al. 2012; Pramova et al. 2012).

But EbA is neither widely nor consistently implemented. It is not sufficiently mainstreamed into national and international policy processes and it receives a small proportion of adaptation finance when compared to hard infrastructural options (Chong 2014). This is for a number of reasons: uncertainty on how to finance EbA, a mismatch between long-term climate change impacts and short-term governance and decision making, governance challenges relating to the cross-sectoral and multi-scale nature of EbA, not knowing how to deal with ecosystem and climate uncertainty, and a weak or poorly consolidated evidence base on EbA effectiveness (Seddon et al. 2016c; Ojea 2015). Much evidence is anecdotal and comes from single case studies. The costs, challenges and negative outcomes of EbA activities are not always well understood or reported. Similarly, little is known about effective pathways for implementation (Wamsler and Pauleit 2016), the scale of application needed to maximise benefits and thresholds beyond which ecosystems can no longer support adaptation to a specific hazard (Doswald et al. 2014). Several authors have stressed the need for more robust quantitative or at least consistently collated qualitative evidence on the ecological, social and economic effectiveness of EbA projects relative to alternative approaches (Seddon 2018; Nalau et al. 2018; Doswald et al. 2014; Reid 2011, 2014a and 2015; UNEP 2012; Travers et al. 2012; UNFCCC 2017; Rizvi et al. 2015).

In response to this need, we conducted research to assess three components of EbA effectiveness — for people, ecosystems and the economy — at 13 case study sites in 12 countries where EbA projects have been implemented.[2] This paper describes the results of this research.

[2] This research was under the 'Ecosystem-based approaches to adaptation: strengthening the evidence and informing policy' project led by IIED, IUCN and UNEP-WCMC and supported by the International Climate Initiative (IKI). The German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) supports this initiative on the basis of a decision adopted by the German Bundestag.

The Las Trancas Valley in Chile, November 2014 (IUCN/Marcelo Vildósola Garrigó)

2 Methods

We based our research framework for assessing EbA effectiveness on a review of EbA literature that included:

- Academic publications and grey literature identifying several key characteristics of effective EbA interventions (see Box 1)
- Adaptation best practice and lessons learned from implementing national adaptation programmes of action (NAPAs) (LDC Expert Group 2011), and
- An IUCN learning framework for capturing common lessons from its EbA project portfolio (Barrow et al. 2013).

The research framework has three broad criteria for assessing EbA effectiveness. These are whether an initiative:

1. Supports local peoples' adaptive capacity or resilience, or reduces vulnerability
2. Helps ecosystems produce services for local people and allows these ecosystems to withstand climate change impacts and other stressors, and
3. Is financially and economically viable (Reid et al. 2017; Reid, Bourne et al. 2018).

Box 1. Key characteristics of effective EbA

Human-centric: EbA emphasises human adaptive capacity or resilience in the face of climate change.

Harnesses nature's capacity to support long-term human adaptation: EbA involves maintaining ecosystem services by conserving, restoring or managing ecosystem structure and function, and reducing non-climate stressors. This requires an understanding of ecological complexity and how climate change will impact ecosystems and key ecosystem services.

Draws on and validates traditional and local knowledge: Humans have used nature to buffer the effects of adverse climatic conditions for millennia. So, we should draw on traditional knowledge about how best to do this when implementing EbA.

Based on best available science: An EbA project must explicitly address an observed or projected change in climate parameters and so should be based on climatic projections and relevant ecological data at suitable spatial and temporal scales.

Benefits the world's poorest, many of whom rely heavily on local natural resources for their livelihoods.

Community-based and incorporating human rights-based principles: Like community-based adaptation, EbA should use participatory processes for project design and implementation. People should have the right to influence adaptation plans, policies and practices at all levels and to be involved with framing the problem and identifying solutions. EbA initiatives should be accountable to those they are meant to assist and not simply the donors and governments providing support. EbA should consistently incorporate non-discrimination, equity, the special needs of poor, vulnerable and marginalised groups, diversity, empowerment, accountability, transparency, and active, free and meaningful participation.

Cross-sectoral and intergovernmental collaboration: Ecosystem boundaries rarely coincide with those of local or national governance. Moreover, ecosystems deliver services to diverse sectors. As such, EbA requires collaboration and coordination between multiple sectors (such as agriculture, water, energy and transport) and stakeholders. EbA can complement engineered approaches — for example, combining dam construction with floodplain restoration to lessen floods.

Operates at multiple geographical, social, planning and ecological scales: EbA can be mainstreamed into government or management processes, such as national adaptation or watershed-level planning, provided that communities remain central to planning and action.

Integrates decentralised flexible management structures that enable adaptive management.

Minimises trade-offs and maximises benefits with development and conservation goals to avoid unintended negative social and environmental impacts. This includes avoiding maladaptation, whereby adaptation 'solutions' unintentionally reduce adaptive capacity.

Provides opportunities for scaling up and mainstreaming to ensure the benefits of adaptation actions are felt more widely and for the longer term.

Involves longer-term transformational change to address new and unfamiliar climate change-related challenges and the root causes of vulnerability, rather than simply coping with existing climate variability and climate-proofing business-as-usual development.

Sources: Reid et al. (2009); Andrade et al. (2011); GEF (2012); ARCAB (2012); Girot et al. (2012); Ayers et al. (2012); Travers et al. (2012); Jeans et al. (2014); Reid (2014a and 2014b); Anderson (2014); Faulkner et al. (2015); Bertram et al. (2017).

Based on this framework, we designed a questionnaire to improve understanding of EbA effectiveness by collecting perceptions through interviews with a range of stakeholders (see Appendix 2). We asked about changes in adaptive capacity, resilience and vulnerability, because all three terms, while not interchangeable, are used to describe adaptation-related benefits. Questions also addressed the political, institutional and governance-related conditions that facilitate effective EbA. We emphasised qualitative data collection because of the lack of available scientific or quantitative data relating to some effectiveness criteria, particularly those relating to human societies and ecosystems. However, this approach also has its limitations. For example, views expressed may perpetuate false narratives or contradict evidence, and the capacity to assess complex notions such as ecosystem resilience based on the perceptions of those interviewed is also likely to be limited.

We included 13 EbA projects for our study, partly because of their wide geographical spread across 12 countries in Asia, Africa and Central and South America (see Appendix 3). All were in areas that are particularly vulnerable to climate change and represented a range of ecosystem types, including coastal, riverine, wetland, dryland and mountainous. Some — in Nepal, South Africa, Uganda, Burkina Faso, Senegal, Peru (the mountain EbA project), Chile, Costa Rica/Panama and El Salvador — had been designed specifically as EbA projects and as such met the defining characteristics of EbA (CBD 2009 and 2010; Martin 2016). Others — in Kenya, China and Peru (Potato Park) — met the defining characteristics of EbA but were not labelled as such during planning and implementation. The project in Bangladesh was retrospectively categorised as EbA because it has not directly considered climate change during planning and implementation. Several projects initiated a number of different EbA measures as part of their planned activities. For example, the Senegal project involved traditional salt bund construction, nursery establishment, applying land regeneration techniques, reforestation, introducing new roosters, vegetable gardening and governance improvements to better manage natural resources. The study chose projects seen to be applying good practice in rural areas and developing countries. This may have led to a positive bias in results.

For each case study, in-country partner organisations conducted semi-structured interviews and focus group discussions during 2017 and 2018, following the structure detailed in Appendix 2. Semi-structured interviews gave informants the freedom to express their views on their own terms while providing comparable qualitative data. They also held opportunistic focus group discussions to secure additional perspectives from people within a stakeholder group.

Interviewers understood the technicalities of climate change. We also provided a glossary to ensure they had a shared understanding of technical terms and could explain them in the same way to interviewees across sites. This was important, as not all interviewees understood all the terms used in the questionnaire (Appendix 2) and we needed a shared understanding of terms to ensure consistency (for comparative purposes) when collecting responses. For interviewees with less technical understanding of climate change, we developed a set of questions using layman's language that were easier to understand (Appendix 4). Where necessary, we translated questions into local languages.

In-country partners determined who to interview with guidance from local stakeholders. They used the framework in Table 1, which ensured we captured perspectives across a range of stakeholders whose views may have differed. The Potato Park in Peru was the exception. We did not interview a wide range of stakeholders there, so results and conclusions relating to this project site are less robust. And in Chile, no local community project beneficiaries were interviewed because the project did not involve the implementation of EbA measures on the ground. Appendix 5 details those interviewed for each case study. We did not pose all questions to all interviewees; rather, researchers asked interviewees questions relating to their area of expertise. For example, community members were best placed to assess whether expected improvements in adaptive capacity or resilience had materialised, and what the local costs and trade-offs were.[3] Extra weighting was given to some interviewees' responses in this way.

Table 1. Stakeholder groups interviewed

National level	Key policy and decision makers connected to the EbA project/programme, particularly those in government related to a national climate change adaptation committee or similar institutional arrangement. Although these people might not have detailed project implementation knowledge, they are an important target group for understanding the context within which EbA projects operate and opportunities for bringing the lessons to scale.
Local level	Key government and/or local authority officials who are involved with the project (or make local-level decisions related to it) at the field level.
Implementing partners	Staff of the bodies responsible for implementing the project on the ground — NGOs, civil society organisations, local government or project partners.
Community level	Members of the communities involved with the project and targeted for benefits, disaggregated by gender (and/or other forms of important social differentiation in the local context) where appropriate and possible. Communities are rarely homogenous, and some people are more vulnerable than others, or vulnerable in different ways. Community composition also changes over time. It was therefore important to identify and capture the views of different groups, especially the poorest and most vulnerable — often pastoralists, women, children/youth, the elderly or indigenous peoples — many of whom are particularly affected by the impacts of climate change.

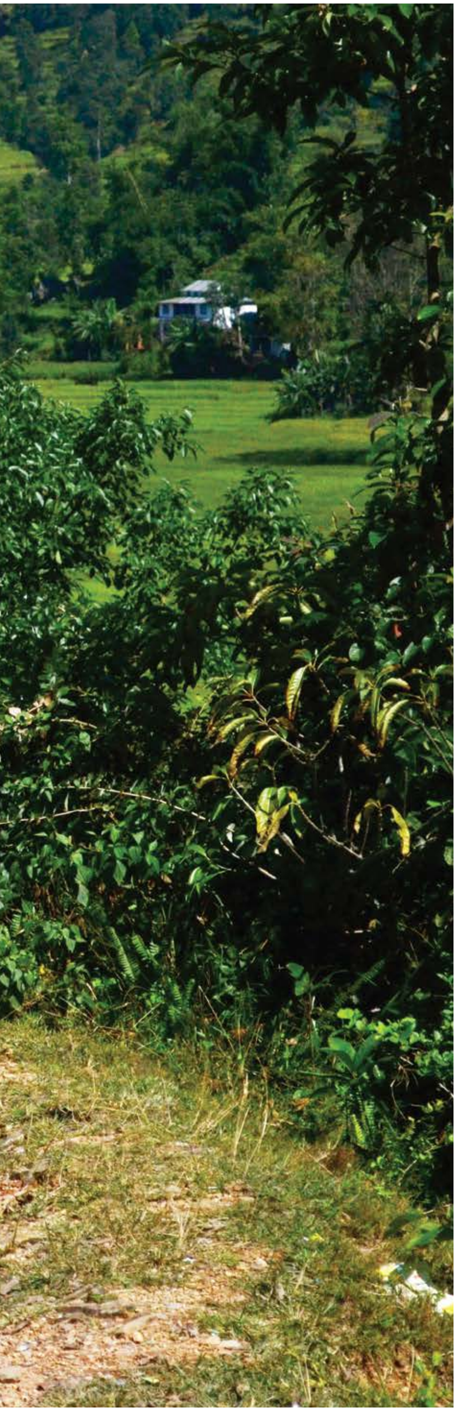
Source: Reid et al. (2017)

[3] For details on the project methodology, see Reid et al. (2017).

We collated and organised interview data for each project according to the research framework structure. This enabled comparison and analysis across sites.

We reviewed formally published and other project documentation for each case study site to source additional information relating to the questions in Appendix 2. Triangulating the data in this way complemented interview and focus group discussion results, strengthening the overall research results.

Fodder collection, Panchase region of Nepal (Mountain EbA project, IUCN)



3 Results

This section describes the results of applying the research methodology to secure comparable information from all 13 case study sites. All references to countries in the sections below refer to the specific EbA project in each country.

3.1 Effectiveness for people

There was strong evidence of improvements in local communities' resilience or adaptive capacity or reduced vulnerability to climate change impacts as a result of the EbA projects. Table 2 shows that at all 13 sites, stakeholders – most importantly including the community members targeted by project interventions – consistently and strongly voiced the opinion that project outcomes had increased their ability to cope with climate change impacts. Project documentation at ten of the 13 sites also referred to improvements in resilience or adaptive capacity or to reduced vulnerability. People attributed these changes to: livelihood improvements, livelihood and crop diversification, knowledge and capacity improvements, reduced disaster risk and stronger governance (see Table 3).

Table 2. Perceived EbA effectiveness for society, ecosystems and the economy

Project	Perceived EbA effectiveness for:					
	Human societies		Ecosystems		Economy	
	Project improves local communities' resilience and adaptive capacity and reduces vulnerability	Project leads to negative or neutral impacts on local communities' resilience, adaptive capacity or vulnerability	Project improves ecosystem service provision	Project improves ecosystem resilience	Project is cost-effective	Project is more cost-effective than alternative approaches
China	yes	no	yes	yes	yes	yes
Nepal	yes	yes	yes	yes	yes (7 sites): 3 EbA measures with associated monetary cost-benefit studies 4 additional measures	yes for 3 EbA measures
Bangladesh	yes	no	yes	yes	yes for government but perhaps not fishers	yes
Kenya	yes	yes	yes	yes	yes	yes
South Africa	yes	no	yes	yes at wetland site; not at rangeland site	not at rangeland site, although perceptions were positive	not at rangeland or wetland site
Uganda	yes	yes	yes	yes	yes	yes

Project	Perceived EbA effectiveness for:					
	Human societies		Ecosystems		Economy	
	Project improves local communities' resilience and adaptive capacity and reduces vulnerability	Project leads to negative or neutral impacts on local communities' resilience, adaptive capacity or vulnerability	Project improves ecosystem service provision	Project improves ecosystem resilience	Project is cost-effective	Project is more cost-effective than alternative approaches
Burkina Faso	yes	no	yes	yes	yes	yes
Senegal	yes	no	yes	yes	yes	yes
Potato Park (Peru)	yes	no	yes	yes	possibly	unknown
Peru (mountain ecosystems)	yes	no	yes	yes	yes at three sites	yes at three sites
Chile	yes	no	yes (possible in future)	yes (possible in future)	no data	yes
Costa Rica/ Panama	yes	no	yes	yes	yes	yes
El Salvador	yes	no	yes	yes	yes	yes

Key:
blue = stakeholder perceptions voiced by majority of interviewees
green = stakeholder perceptions supported by project documentation, including published literature, project reports and formal assessments

Table 3. Perceived improvements in local resilience, adaptive capacity or vulnerability to climate change from EbA projects

Type	Details and examples as reported in EbA case studies
Livelihood improvements	Climate-smart farming practices using biodiversity and ecosystem services have built the resilience of agriculture ecosystems and increased crop productivity and farm income. For example, anti-salt bunds, assisted natural regeneration and other techniques improved soil quality, water availability and crop yields in Senegal (Monty et al. 2017). New crops and improved seed varieties have increased resilience. For example, new maize varieties developed through participatory plant breeding in China have higher drought and pest resistance and 15–30% higher yields than other landraces (Song et al. 2016). Market access was also improved at some sites — for example, due to roadside stabilisation in Nepal. This also included improvements in ecosystem service provision such as water availability for agriculture/pastoral and/or household use at various sites despite droughts or greater rainfall variability.
Diversification of livelihoods and crops	Livelihood diversification has improved perceived adaptive capacity and provided a buffer against changing environmental conditions. For example, diversifying activities in Burkina Faso improved productive capacity despite inadequate rainfall; and diversifying the economy into educational ecotourism boosted resilience in the Potato Park. Crop diversification reduced the risk of crop losses, improving the resilience of agricultural systems. For example, at the Potato Park, some farmers plant as many as 200 different potato varieties, reducing the risk of crop failure. Potato yields have increased since 2002 despite severe climate change impacts (Asociación ANDES 2016).
Knowledge and capacity improvements	This included knowledge about what climate change impacts to expect, new farming or sustainable land management techniques, disaster risks and the importance of ecosystems in the context of building local resilience. Stakeholders acquired new knowledge and capacity through community seed exchanges in China, agrobiodiversity and seed fairs in Costa Rica, EbA learning groups in Nepal, exchange visits/tours in Nepal, Burkina Faso and Senegal, training on farming techniques in South Africa and Burkina Faso, practical demonstration sites and model farms in Uganda, local radio broadcasts sharing climate and other development-related information in Kenya and Nepal, strengthened links between scientific and indigenous knowledge and a biocultural heritage register at the Potato Park.

Type	Details and examples as reported in EbA case studies
Reduced disaster risk	Improved ecosystem service maintenance/provision through slope management reduced landslide risks at some sites, and in Chile, healthy forest ecosystems were shown to protect infrastructure and communities from avalanche and landslide hazards (Monty et al. 2017). Drought risks were often reduced due to adjusted farming or pasture management techniques and strategies or improved water management. For example, unlike neighbouring counties with similar rainfall conditions, Isiolo County in Kenya did not reach the alarm level of National Drought Management Authority drought management warnings in 2014 due to improved local natural resource management (Tari et al. 2015). Pond restoration, enhanced tree cover, soil conservation measures, riverbank reforestation and mangrove restoration also reduced flood risks. For example, community pond restoration in Nepal buffered against flooding. Vulnerability to strong winds, sandstorms or fire also decreased at some sites, such as Burkina Faso. EbA projects also enhanced disaster recovery following extreme events. For example, the Stone Village community seed bank in China has 108 seed varieties, which enables recovery following extreme events (Reilly and Swiderska 2016).
Strengthened governance	New or strengthened institutions improved local governance and thus increased resilience at some sites. This included transboundary institutions such as the Binational Commission for the Sixaola River in Costa Rica/Panama, and local institutions such as seed guardian groups at the Potato Park and customary range management institutions in Kenya. New or adjusted natural resource use plans also facilitated greater resilience. This includes, for example, management plans developed for the Steinkopf and Leliefontein commonage in South Africa, where 166 conservation agreements are helping improve land management practices.

Only three case studies — in Uganda, Nepal and Kenya — reported negative or neutral impacts on resilience, adaptive capacity or vulnerability from some of the EbA project activities. This was sometimes due to a lack of clear links between project activities and climate change. Unbaked brick production in Uganda and ecotourism in Nepal were not directly linked to climate change but may have contributed indirectly to adaptive capacity by diversifying livelihoods and spreading risk (UNDP 2015). Poor implementation — for example, inappropriate beehive siting and limited community sensitisation about hive dangers in Uganda — also meant that the adaptive capacity benefits envisioned did not always materialise (UNDP 2015). Elsewhere, we attributed the lack of positive impacts to the long timeframes needed for positive impacts to emerge. In Kenya, for example, the six-month period between proposal development and funding disbursement from the Isiolo County Climate Change Fund was too long to support fast responses to emergency needs.

3.1.1 Who experienced adaptation-related benefits?

In eight of the 13 EbA case studies, stakeholders felt adaptation-related benefits accrued to a broad spectrum of people (see Table 4). This was particularly apparent when projects worked closely with local organisations, such as Istatén in El Salvador, or with collective institutions and customary laws as they did in China and the Potato Park in Peru, which ensured benefits were shared more equally. It was also apparent when they targeted widely practised livelihood options such as agriculture (China, Costa Rica/Panama, Burkina Faso or Peru) or pastoralism (Kenya or South Africa), ensuring benefits were spread widely among poor communities.

At 12 out of 13 sites, stakeholders perceived improvements in resilience, adaptive capacity and vulnerability as a result of EbA project activities as accruing among particularly vulnerable groups, especially those that rely on ecosystems and ecosystem services for their livelihoods and wellbeing. This was partly due to project targeting. For example, the Mountain EbA programme in Nepal, Uganda and Peru specifically targeted mountain communities, who are particularly vulnerable to climate change (UNDP 2015; Reilly and Swiderska 2016); and project sites in Burkina Faso and Senegal were selected because of high levels of poverty in the area (Somda et al. 2014; Monty et al. 2017). The exception was the project in Chile, which did not work directly with biosphere reserve communities, but with a range of stakeholders involved in reserve management.

At nine sites, they also noted that women accrued adaptation-related benefits, sometimes because they had more natural resource management responsibility than men. For example, women owned most of the degraded land being restored in Senegal and benefited from mangrove-related activities in El Salvador because they were in charge of fishing in the project area. In China, the Potato Park and Nepal, male migration to cities meant that women were left in charge of activities. Stakeholders at several sites also felt improvements accrued to particularly vulnerable groups, including the elderly, children, poor people and indigenous groups, such as the Quechua people (Peru) and indigenous farmers (Costa Rica's Bribri territory).

At some sites, stakeholders thought that groups perceived as less vulnerable also experienced improvements in resilience, adaptive capacity and vulnerability as a result of EbA project activities. These included wealthier livestock owners in Kenya and South Africa and fish traders, wholesalers, credit providers and ice suppliers in Bangladesh's fisheries supply chain.

Table 4. Perceived effectiveness of EbA projects for human societies: analysis of key characteristics

Project	Stakeholder groups experiencing notable improvements in resilience, adaptive capacity or vulnerability as a result of the project	Trade-offs or synergies in terms of who experiences changes and/or where they experience them	Trade-offs or synergies in terms of when changes occur	Social co-benefits	Distribution and trade-offs relating to social co-benefits	Role of local or indigenous knowledge and/or participation in the context of changes
China	Broad spectrum of people; particularly vulnerable groups (elderly); women	Trade-offs: land use/ livelihood options Synergies: down the supply chain	No trade-offs Benefits are long term	Multiple	Distribution widespread No trade-offs	Local/indigenous knowledge used and important Participatory processes essential for building adaptive capacity
Nepal	Particularly vulnerable groups (mountain communities, poorest, children, indigenous communities); women	Trade-offs: upstream/ downstream	Possible trade-offs	Multiple	Distribution widespread No trade-offs	Local/indigenous knowledge used and important Participatory processes essential for building adaptive capacity
Bangladesh	Particularly vulnerable groups (fishers); people in fishing industry	Trade-offs: different fisher groups Synergies: downstream; down supply chain	Higher initial costs for some, but longer-term, sustained benefits likely if programme continues	Multiple	Distribution widespread Trade-offs noted	Local/indigenous knowledge used Participatory processes important for building adaptive capacity but more is needed
Kenya	Broad spectrum of people; particularly vulnerable groups (dryland communities); women; livestock owners	Trade-offs: land use/ livelihood options; locals/outsiders	Some benefits take years to accrue	Multiple	Distribution widespread Trade-offs noted	Local/indigenous knowledge used Participatory processes essential for building adaptive capacity
South Africa	Broad spectrum of people; particularly vulnerable groups (poorest, children, elderly, indigenous groups); women; livestock owners	No trade-offs Synergies: benefits to communities outside project area	Benefits take years to accrue	Multiple	Distribution widespread Trade-offs possible from livestock exclusion	Local/indigenous knowledge used Participatory processes essential for building adaptive capacity

Project	Stakeholder groups experiencing notable improvements in resilience, adaptive capacity or vulnerability as a result of the project	Trade-offs or synergies in terms of who experiences changes and/or where they experience them	Trade-offs or synergies in terms of when changes occur	Social co-benefits	Distribution and trade-offs relating to social co-benefits	Role of local or indigenous knowledge and/or participation in the context of changes
Uganda	Particularly vulnerable groups (poor mountain communities)	Trade-offs: men/women; different livelihood options Synergies: benefits to communities outside project area	Some benefits take years to accrue Some trade-offs Benefits are long-term	Multiple	Distribution widespread	Local/indigenous knowledge used Participatory processes essential for building adaptive capacity
Burkina Faso	Broad spectrum of people; particularly vulnerable groups (very poor, indigenous groups); women	No trade-offs	Some benefits take years to accrue	Multiple	Distribution widespread	Local/indigenous knowledge used Participatory processes essential for building adaptive capacity
Senegal	Broad spectrum of people; particularly vulnerable groups (very poor); women	No trade-offs	Benefits are long term if EbA methods sustained	Multiple	Distribution widespread Trade-offs possible	Local/indigenous knowledge used Participatory processes essential for building adaptive capacity
Potato Park (Peru)	Broad spectrum of people; particularly vulnerable groups (indigenous communities, widows, orphans, elders, youth); women	No trade-offs Synergies: benefits to communities outside project area	Benefits take years to accrue. Benefits are long-term	Multiple	Distribution widespread No trade-offs	Local/indigenous knowledge used and important Participatory processes essential for building adaptive capacity
Peru (mountain ecosystems)	Particularly vulnerable groups (mountain communities); livestock farmers	Trade-offs: between grazing areas	Trade-offs: from early grazing restrictions Benefits take time to accrue and are long-term	Multiple	Distribution widespread Trade-offs possible but not yet observed	Local/indigenous knowledge used and important Participatory processes essential for building adaptive capacity

Project	Stakeholder groups experiencing notable improvements in resilience, adaptive capacity or vulnerability as a result of the project	Trade-offs or synergies in terms of who experiences changes and/ or where they experience them	Trade-offs or synergies in terms of when changes occur	Social co-benefits	Distribution and trade-offs relating to social co-benefits	Role of local or indigenous knowledge and/or participation in the context of changes
Chile	Project participants at study site	Trade-offs possible: land use/livelihood options	Benefits potentially long term No trade-offs expected	Multiple	Distribution widespread	Local/indigenous knowledge used Participatory processes essential for building adaptive capacity
Costa Rica/ Panama	Broad spectrum of people; particularly vulnerable groups (indigenous communities); women; farmers	No trade-offs	Some benefits take years to accrue	Multiple	Distribution widespread	Local/indigenous knowledge used Participatory processes essential for building adaptive capacity
El Salvador	Broad spectrum of people; poor and vulnerable people; women	Trade-offs possible: outsiders and community institution members/locals Synergies: benefits to communities outside project area	Some benefits take years to accrue	Multiple	Distribution widespread Trade-offs noted between livelihood sources	Local/indigenous knowledge used Participatory processes essential for building adaptive capacity

Key:
blue = stakeholder perceptions
green = stakeholder perceptions supported by project documentation including published literature, project reports and formal assessments

3.1.2 Trade-offs and synergies in adaptation-related benefit accrual

In all 13 case studies, stakeholders perceived that some groups accrued more adaptation-related benefits than others. In some cases, this was because project activities targeted certain groups or livelihood sectors. In others, there were differing levels of local interest in participating or some groups were less able to participate/benefit because of their remote location, locally established gender discrimination or challenges related to engaging the most vulnerable groups.

Several case studies reported no trade-offs in terms of who accrued adaptation-related benefits, but stakeholders from eight studies indicated that they thought one group received (or could receive) adaptation-related benefits at the expense of another. These involved trade-offs between:

- **Different land uses** (and the people depending on them) – for example, logging and some types of cultivation in China, pastoralism and wildlife conservancies in Kenya or skiing infrastructure/slopes and forest management to reduce avalanches/landslides in Chile
- **Different population groups** – for example, men and women in Uganda, who have different preferences for using wood from project tree-planting activities; or local people and outsiders, who can no longer collect natural resources where they used to due to new management regimes in Senegal and Kenya
- **Upstream and downstream areas** – for example, upstream forest management or activities to recharge groundwater levels in Nepal provide benefits around agriculture or water provision that largely accrue downstream, and
- **People using different parts of a connected ecosystem or under different management regimes** – for example, poor Bangladeshi fishers affected by fishing restrictions and fishers elsewhere, even in neighbouring countries.

Six case studies also provided examples of perceived synergies, or ways in which adaptation-related benefits accrued to people outside the project area. These included people working further along fishing or agricultural supply chains in Bangladesh and China respectively and those coming into the area to access improved resources, such as water or improved pastures in South Africa. Upstream activities controlling soil erosion improved downstream ecosystems and water supplies in Uganda; in Peru, disseminating resilient seeds to communities neighbouring the Potato Park meant they shared adaptation benefits.

In terms of when adaptation-related benefits accrued, stakeholders perceived that seven projects were providing – or would be able to provide, should enabling conditions such as a supportive policy framework continue – adaptation-related benefits that could continue to accrue over the long term.

In ten case studies, however, perceived adaptation-related benefits often took several years to materialise, with short-term costs accruing while waiting for longer-term benefits to emerge. This was because it takes time to establish strong local institutions, embed new management regimes, accrue new knowledge and skills and adjust human behaviour. It also takes time for ecosystem service provision to improve following an intervention – for example, fish populations (Bangladesh) and crab populations (El Salvador) take time to recover; sand dams (Kenya) can take a few years to accumulate water; and rangeland restoration (Kenya), tree-planting (Uganda, Costa Rica and Burkina Faso), riverbank greening (Burkina Faso) and grassland restoration (Peru) are all long-term processes.

Some projects provided incentives to offset short-term losses in income or reduced access to natural resources. The Mountain EbA projects in Nepal, Peru and Uganda, for example, adopted a phased approach to ensure communities saw short-term benefits before longer-term adaptation-related benefits could accrue (UNDP 2015; IUCN 2012; Dourojeanni et al. 2016). Similarly, short-term detrimental impacts from fishing restrictions in Bangladesh (from the fishing ban itself and also shortly afterwards, as fish prices became depressed when fish flooded the market) were partly offset by providing rice and alternative income-generating strategies.

3.1.3 Social co-benefits from EbA

All 13 EbA case study projects were perceived as providing a multitude of co-benefits at each project site. We can categorise these as: water provision; livelihood improvements; improved market access; health improvements; strengthened culture and intellectual property rights; strengthened capacity, knowledge or awareness; food security and self-sufficiency; strengthened community relations and cohesiveness; governance improvements; disaster risk reduction; and climate change mitigation (see Table 5). Similarities between these categories and the adaptation-related benefits in Table 3 are apparent, but this was how stakeholders categorised these perceived social benefits.

Table 5. Perceived social co-benefits from EbA projects accrued across project sites

Social co-benefit	Details and examples as reported in EbA case studies
Water provision for productive use	Includes more sustainable water provision due to support for customary landscape use, reviving sustainable community water management systems and new grey-green water infrastructure. For example, sustainable water provision has improved in the Potato Park, and there is better access to water from high-altitude lakes.
Livelihood improvements	Farm, livestock or fish productivity increases and subsequent income increases apparent at many project sites due to: EbA measures that included new integrated farming methods, agroforestry, mangrove restoration, fish conservation activities, organic manure use, better dryland management; alternative livelihoods such as broom grass cultivation and ecotourism; other economic collectives; or government public works programmes. For example, in China, crop staple food yields have experienced productivity increases of 15–20%, and incomes have increased by around a factor of three.
Improved market access improved	Access improved by: enhanced physical access such as stabilised road infrastructure (Nepal); soft improvements which helped farmers find new market channels for their goods or whereby traditional varieties secured premium market prices (China); and improved use of information and communication technologies (the Potato Park).
Health improvements	Better nutrition as a result of: consuming healthier livestock and livestock products (Nepal and Kenya); more dietary diversity following vegetable cultivation, integrated soil-management activities, higher crop diversity and community-led plant breeding activities (China); higher protein intake due to increasing fish populations (Bangladesh) and improved pastoral production systems (Kenya). Improved water supply quality and quantity have reduced water-borne diseases — affecting humans and livestock — in water pans, ponds and natural springs. Other benefits from: renewed use of medicinal plants, reduced pesticide-related health problems (China) and reduced indoor air pollution (Nepal and Uganda).
Strengthened culture and intellectual property rights	Traditional knowledge and plant varieties in seed parks and community-based seed banks protected, groups sharing knowledge on vegetables established and/or local culture and traditions nurtured by setting up folk music and dancing groups and traditional community organisations revived. In Peru, the Potato Park hosts a protected culinary sanctuary and a restaurant dedicated to native food. Two projects have also worked to formally recognise and protect of farmers' rights to different plant varieties and ensure farmers are rewarded for using them.
Capacity, knowledge or awareness strengthened	Knowledge on the environment, ecosystems, conservation, sustainable development and sustainable biodiversity use improved through organised training sessions and work with schools/students. In Uganda, school attendance has improved since the project began.
Food security and self-sufficiency	More reliable local food supplies in seven sites due to production increases, agrobiodiversity and seed fairs. For example, villages with organic farmer groups in China are now more self-sufficient than neighbouring villages.

Social co-benefit	Details and examples as reported in EbA case studies
Strengthened community relations and cohesiveness	Reduction in conflict and more harmonious community relations due to improvements in governance and an increase in available resources. Less time away from home among men or young people looking for work (China and Burkina Faso) and pastoralists looking for water and pasture (Kenya) also strengthened community relations and cohesiveness. Increased income also meant people could spend more money on important events such as weddings (Kenya) contributing to community cohesion.
Governance improvements	Strengthened local governance and institutions improving natural resource management by facilitating agreement on — and enforcement of — local plans and rules relating to water and rangeland management. Regional land-use plans (Chile), protected area (Chile) or bi-national river basin management plans (Costa Rica/Panama).
Disaster risk reduction	Risk of disaster events reduced, including: landslides (Potato Park); flooding and erosion; crop failure (Potato Park). Fewer economic crises among those dependent on livestock or fishing.
Climate change mitigation	Carbon sequestration and storage increased or emissions reduced through measures such as reducing deforestation. For example, the Andean pastures in Peru now store more carbon because traditional grazing practices have been maintained.

3.1.4 Social co-benefit distribution and trade-offs

Stakeholders in all case studies thought social co-benefits reached a broad spectrum of beneficiaries, in some cases extending outside the project area. As with adaptation-related benefits, social co-benefits reached particularly vulnerable groups at many project sites, sometimes due to project targeting. Women accrued social co-benefits from some project activities at six sites.

As with adaptation-related benefits, many case studies noted that some groups accrued more social co-benefits than others, because:

- Project activities targeted specific stakeholder groups or livelihood sectors
- Some locals could capture project benefits better than others, and/or
- Some local people were more interested in participating than others.

In some cases, stakeholders perceived that less vulnerable groups accrued more social benefits than others. For example, those further along the fishing supply chain in Bangladesh accrued more income increases than the fishers themselves.

In three projects, as with adaptation-related benefits, stakeholders also perceived that certain stakeholder groups experienced negative social impacts or one group accrued social co-benefits at the expense of another. These trade-offs related to the distribution of incentives introduced to support compliance with new natural resource management regimes in Bangladesh (Dewhurst-Richman et al. 2016). There were also trade-offs between livelihood options supported (or not) by the EbA project. For example, new natural resource management regimes in El Salvador led to conflict with people who wanted to cut down the mangroves for their livelihoods, and in Kenya, people who rely on pastoralism may benefit from the project at the expense of those who rely on wildlife conservancies. Stakeholders noted possible future trade-offs at three more sites, including from the exclusion of livestock from some areas in South Africa.

3.1.5 The role of local or indigenous knowledge

Stakeholders perceived indigenous or local knowledge as making an important contribution to adaptive capacity and thus to the effectiveness of EbA interventions. All 13 case studies highlighted how the EbA projects had valued such knowledge, incorporating it to some extent into their activities. For example, in China's Stone Village, a 1,000-year-old irrigation system lessened the impacts of climate change, particularly drought, and customary laws ensured fair water allocation to all households (Swiderska 2016a). Similarly, strengthened Andean cultural values and identity built high levels of agrobiodiversity and resilient ecosystems at the Potato Park.

The indigenous or local knowledge used across the case studies included knowledge relating to pond conservation, farming methods, soil and water conservation techniques, forest protection, local climate, local water and rangeland management, local plant or tree species, ways of differentiating degraded from productive land, local practices addressing land degradation, fish habitats, migration routes and spawning areas and periods. Stakeholders at four projects viewed combining local or indigenous and scientific knowledge and practices as important for building adaptive capacity (Senegal, El Salvador, Kenya and Potato Park).

3.1.6 The role of participation

The extent of local community participation varied between case studies. In the studies, we asked respondents about the participatory approaches used in each project (see the glossary in Appendix 1). In China, Kenya and the Potato Park, interviewees reported that activities were closer to the self-mobilisation end of the spectrum — in other words, they were driven more by communities themselves. Activities in Bangladesh were closer to the passive end of the typology, where project planning and implementation was largely externally driven. Table 6 shows examples of the participatory approaches the projects adopted.

Table 6. Participatory approaches adopted by EbA projects

Type of participatory approach (in roughly decreasing levels of participation)	Details and examples as reported in EbA case studies
Participatory plant breeding	Farmers used participatory action research methods to select crop plants for resilience traits, including drought, frost and pest resistance.
Working with new or established local institutions	Institutions involved in project implementation included: farmer groups, a group led by women focusing on social work, devolved climate finance distribution entities, climate change planning committees, village committees, a tourism committee, a water committee, an agency to promote ecotourism and conservation and a communal land ownership entity.
Peer-to-peer learning	Mutual learning between farmers to share knowledge and experiences on farming methods and train others included exchange visits between farmers in different countries.
Joint planning meetings or workshops	Local stakeholder workshops assessed vulnerabilities, shaped, co-designed and implemented projects and identified project goals.
Use of participatory tools	These included: participatory vulnerability impact assessments; 'Let's Respond' toolkit to mainstream climate change into municipal government development planning (DEA 2012); Climate Vulnerability and Capacity Analysis (CVCA) and the Community-based Risk Screening Tool – Adaptation and Livelihoods (CRiSTAL) to identify challenges and select project interventions (Rizvi et al. 2014; Mumba et al. 2016); community mapping techniques; and the Promoting Local Innovation Toolkit and Climate Resilience Evaluation for Adaptation through Empowerment tool (Buyck 2017; Monty et al. 2017; Rivzi et al. 2014).
Consultation, interviews and surveys	To identify community knowledge, priorities, suggestions, interests and skills; to inform project planning.
Discussion forums	To address key local issues, share knowledge and conduct group decision making and problem solving.
Provision of incentives	Important in two projects to compensate for reduced access to natural resources.
Training	On climate change, adaptation, EbA, governance, legislation and policy, financial and project management, project implementation, mangrove reforestation, water management, integrated farming, forest conservation and tourism.
Awareness raising measures	Including meetings and media-based activities to raise awareness about the project.
Provision of labour	As a voluntary or paid local contribution to EbA initiative implementation.

Perceptions and published reports from all projects, without exception, were very clear that adopting participatory processes was essential for building adaptive capacity and thus contributed to the effectiveness of the interventions. Target groups for engagement included local communities and other local stakeholders such as protected area managers and local government officials. Interviewees stated that participation ensured project activities responded to local needs and vulnerabilities, were aligned with local capacities, secured local commitment, capacitated and empowered local people, raised awareness and created a sense of ownership, which subsequently facilitated sustainability. Where projects were highly participatory, local communities often organised themselves, sustaining project activities independently from external support. For example, the Potato Park, established in 2000, is not run by government. Rather, it is run by communities on the basis of customary laws. Outside agencies provide some support, but park activities are largely self-determined.

Some interviewees commented that greater levels of participation would have improved a project. In Bangladesh, for example, there was a view that greater fisher involvement could have improved fish production and the performance of sanctuaries.

3.2 Effectiveness for ecosystems

All 13 sites, projects demonstrated or stakeholders perceived improvements in maintaining, restoring or enhancing ecosystem services and in ecosystem resilience after EbA project implementation (see Table 2). The same goes for all ecosystem types (agricultural/cropland, forest, riverine, coastal, dryland, wetland and grassland). But not all project activities were reported to result in improvements. Stakeholders interviewed in South Africa, for example, had not yet noticed improvements in ecosystem resilience and service provision from rangeland restoration activities, presumably because of the short project duration. The growing rate of species in the Succulent Karoo is notoriously slow, and rangeland restoration methods in the ecoregion are not yet well understood. In Nepal, some stakeholders felt it was too early to observe improvements in ecosystem service provision and perceived ecosystem resilience as a result of certain project activities.

Stakeholders reported examples of ecosystem services that they perceived the EbA projects had helped maintain, restore or enhance in all four ecosystem service categories (see Table 7) (MEA 2005; TEEB 2010):

- **Provisioning services**: water for domestic, livestock or agricultural purposes, crop yields, livestock productivity, wood provision, fish and crustacean production, forage availability, medicinal plant availability and animal fibre production
- **Regulating services**: invasive species control, soil erosion control (next to roads and rivers, on hillsides and in wetlands), reducing land degradation, improving water quality and sedimentation control (for example, by reducing water body nutrient loads and

soil erosion), regulating water flow (in channels, canals and rivers), reducing landslide, avalanche and fire risk and pollination (due to bee-keeping activities in Nepal)

- **Cultural services**: conserving national heritage and increasing conservation awareness, tourism values and the availability of cultural goods, and
- **Supporting services**: recharging groundwater, improving soil quality (fertility and structure, moisture levels, water-holding capacity and water infiltration capacity), conserving biodiversity, enhancing genetic resources, sequestering carbon sequestration and reducing carbon emissions.

Table 7. Perceived improvements to ecosystem services from EbA projects

Country/project	Ecosystem service category			
	Provisioning	Regulating	Cultural	Supporting
China	√	√	√	√
Nepal	√	√	√	√
Bangladesh	√	√	√	√
Kenya	√	√	√	√
South Africa	√	√	√	√
Uganda	√	√	√	√
Burkina Faso	√	√	√	√
Senegal	√	√	No data	√
Potato Park (Peru)	√	√	√	√
Peru (mountain ecosystems)	√	√	√	√
Chile	√ (possible)	√ (possible)	√ (possible)	No data
Costa Rica/Panama	√	√	√	√
El Salvador	√	√	√	√

3.2.1 Boundaries influencing interventions for enhancing ecosystem resilience

The watershed or catchment area was viewed as a suitable level for implementing EbA activities in eight case studies, due to strong connections between upstream and downstream areas (Table 8).

Table 8. Perceived effectiveness of EbA projects for the ecosystem: analysis of key characteristics

	Boundaries/scales that influence interventions for ecosystem resilience	Factors relating to thresholds or tipping points that influence ecosystem service provision	Scale of change to ecosystem service provision	Identified trade-offs or synergies between geographical scales	Timeframe for improvements in ecosystem services	Identified trade-offs or synergies between timeframes
China	Watershed; wider landscape	Water availability affected by climate change; soil loss/ erosion; forest degradation/loss; loss of traditional knowledge	Landscape; land/ resources used by villages	Trade-offs: more crop-raiding synergies: sharing knowledge and/or resources with different locations	Starting after 1 year Lasting 8+ years	Unclear
Nepal	Watershed; wider landscape	Excessive rainfall leading to landslides; high temperatures; pollution; land degradation	Watershed or sub-catchment; wider landscape	Trade-offs: more crop raiding; upstream/ downstream; conservation/ agriculture Synergies: water availability and quality elsewhere; reduced disaster risk	Immediate to long term Benefits sustained if enabling environment continues	Possible trade-offs
Bangladesh	Watershed	Over-exploitation; climate change-induced changes to salinity, temperature or rainfall; pollution; siltation; water availability; infrastructure	Throughout river system	Synergies: production improvements elsewhere	Immediate and ongoing Benefits sustained if enabling environment continues	Synergies due to raised awareness and strengthened capacity

	Boundaries/scales that influence interventions for ecosystem resilience	Factors relating to thresholds or tipping points that influence ecosystem service provision	Scale of change to ecosystem service provision	Identified trade-offs or synergies between geographical scales	Timeframe for improvements in ecosystem services	Identified trade-offs or synergies between timeframes
Kenya	Watershed; wider landscape	Water availability affected by climate change; temperature increases; excessive water extraction	County	Trade-offs: water availability	Within 2 years Lasting long term due to rangeland management institutions	Possible trade-offs relating to water extraction
South Africa	None noted	Over-exploitation; water availability affected by climate change; fire regime alteration	Land/resources used by villages	Synergies: water availability and quality elsewhere	Within a year (wetland restoration) Lasting many years (rangeland restoration) Sustained benefits	None noted
Uganda	Watershed; landscape	No data	Watershed or sub-catchment; land/resources used by villages	Synergies: water availability and quality elsewhere; production improvements	2–5 years Sustained benefits	Synergies from tree planting
Burkina Faso	No data	No data	Land/resources used by villages	None noted	Short to medium term Lasting 10+ years	No trade-offs noted
Senegal	Landscape	Soil degradation; forest loss	Land/resources used by villages; watershed or sub-catchment	Synergies: reduced downstream siltation; water availability and quality elsewhere; mangrove ecosystem regeneration	2–10 years Sustained benefits	Synergies from knowledge sharing
Potato Park (Peru)	Landscape	Temperature increases; glacial melt	Landscape; watershed or sub-catchment	No trade-offs	5–10 years (institutions for management) Sustained benefits	No trade-offs noted

	Boundaries/scales that influence interventions for ecosystem resilience	Factors relating to thresholds or tipping points that influence ecosystem service provision	Scale of change to ecosystem service provision	Identified trade-offs or synergies between geographical scales	Timeframe for improvements in ecosystem services	Identified trade-offs or synergies between timeframes
Peru (mountain ecosystems)	Landscape	Over-exploitation	Watershed or sub-catchment; landscape; land/resources used by villages	Possible trade-offs: between grazing areas Synergies: water availability and quality downstream	Immediate to long term Sustained benefits if enabling environment continues	Possible trade-offs: grassland productivity
Chile	Watershed	Over-exploitation; temperature increases	Landscape; possibly watershed or sub-catchment	Trade-offs: disaster risk reduction/potential tourism income Synergies: carbon sequestration; downstream water provision	Sustained benefits if enabling environment continues	No trade-offs noted
Costa Rica/ Panama	Watershed	Pollution; excessive water extraction	Watershed or sub-catchment; land/ resources used by villages	No trade-offs	Benefits take time to emerge but are long term	No trade-offs noted
El Salvador	Watershed	Water availability; salinity	Landscape; watershed or sub-catchment; land/resources used by villages	No trade-offs Synergies: reduced downstream flooding	5 years (mangrove recovery) Long-term benefits	None noted

Key:
blue = stakeholder perceptions
green = stakeholder perceptions supported by project documentation including published literature, project reports and formal assessments

Stakeholders at seven sites viewed the wider landscape — the visible features of an area of land, its landforms and how they integrate with natural or man-made features — as important for interventions because they contain interconnected ecosystems that projects need to consider together to support sustainability. Landscapes are also large scale, so interventions can be more stable and able to cope with stress better. For example, in Kenya, the communal management of large dryland areas supported the seasonal mobility of pastoralists; and pooling land at the Potato Park sustained higher levels of genetic diversity among crops and their wild relatives and supported the testing of different crop varieties in different microclimates or at different altitudes to assess their potential for adaptation.

Watershed or landscape boundaries did not always match with administrative or political boundaries. More than half of the case studies had a watershed, ecosystem or natural resource that crossed local or national administrative boundaries.

3.2.2 Thresholds influencing ecosystem service provision

Interviewees posited various factors that might push ecosystems towards thresholds or tipping points beyond which they could no longer provide key services, or so that their structure and functioning would be irreversibly altered (Table 8). In most instances, however, interviewees were uncertain whether such thresholds existed, or if they were important at the case study sites. The suggested factors related to:

- **Changes in water availability** due to temperature increases, reductions in rainfall and droughts, which could make agriculture non-viable, destroy biodiversity, alter water salinity and flow rates and thus impact fish populations, affect whether dryland areas could support livestock such as cows and sheep, and precipitate shifts from semi-arid to desert regimes.
- **Soil degradation, loss or erosion** due to temperature increases and drought, which could make agriculture non-viable. For example, land in Senegal and El Salvador could be abandoned due to salinisation or acidification.
- **Over-exploitation** of the land. Some areas of South Africa's Succulent Karoo may have exceeded thresholds in land degradation, with the land considered unable to return to its original state, even if left undisturbed for several decades (Bourne et al. 2017; Van der Merwe and van Rooyen 2011). Elsewhere, over-exploitation of native forests (Senegal, Chile), overgrazing (Peru, mountain EbA project) and overfishing (Bangladesh) were also apparent threats to ecosystem service provision.
- **Loss of traditional knowledge** systems, which could irrevocably compromise effective management.
- **Pollution** from intensive agriculture or mining, which could make agriculture non-viable and irrevocably damage waterbodies and fish populations.

- **Excessive rainfall**, which could lead to landslides, destroying hillside environments and causing river sedimentation.
- **Temperature increases**, which could affect fish production levels, plant growth or fire risks. In the Andes, this could lead to glacial melt, causing major changes in downstream water availability.
- **Excessive water extraction** from dam construction, over-drawing from boreholes or other actions, which could reduce water availability and result in land subsidence and saltwater intrusion into aquifers.
- **Fire regime alteration**, which could affect rangelands in South Africa.

3.2.3 Geographical scale of changes to ecosystem service provision and trade-offs or synergies between scales

Maintenance, restoration or enhancement of ecosystem services took place at various geographical scales, including local (land or resources used by villages), county/district, watershed or sub-catchment, landscape and river system.

Five case studies identified trade-offs or potential trade-offs between ecosystem service provision at different geographical scales or sites related to:

- Increased crop raiding by wild animals due to conservation-oriented land and forest management (China and Nepal)
- Hydrological management efforts limiting productive activities upstream while improving ecotourism and water provision and regulation downstream (Nepal)
- Water provision for conservation/agriculture and other economic activities (Nepal and Kenya)
- Upstream water extraction reducing downstream water availability (in Kenya)
- Tree-planting for avalanche/landslide protection and conservation and tree-clearing for new ski tracks (Chile), and
- Grazing regulations or restrictions in some areas increasing grazing in others, leading to degradation elsewhere (Peru — mountain ecosystems project).

Despite these trade-offs, it was more common for stakeholders to link improvements in ecosystem service provision at one location as a result of project to improvements elsewhere. Nine sites reported such synergies, related to:

- **Water availability and quality improvements downstream** from upstream reforestation, conservation and management or applying improved farming techniques (Senegal, Uganda, Peru — mountain ecosystems, South Africa and Nepal).

- **Production improvements** in fish throughout the river system and in neighbouring river systems following the establishment of localised fish sanctuaries (Bangladesh); improvements in crop productivity from bee-keeping activities that improve pollination and soil and water conservation activities that reduce soil erosion (Uganda).
- **Reduced disaster risk** from upstream conservation and land management activities that improve water infiltration, reducing downstream flood risks (Nepal, Uganda and El Salvador).
- **Knowledge and resource sharing to areas outside the project location**, through community seed exchange (China) and project awareness-raising activities (Bangladesh).
- **Carbon sequestration** from tree-planting activities (Chile), which provides global benefits in terms of climate change mitigation.
- **Wood provision** from tree-planting activities (Uganda).
- **Mangrove ecosystem regeneration** (Senegal) due to slowed mudflat siltation resulting from bund construction on arable, pastoral and forested land.

3.2.4 Timeframes for providing ecosystem services, trade-offs and synergies

Some of the reported improvements to ecosystem service provision materialised rapidly (within a year or less). For example, water provision in Nepal improved immediately after project interventions. Others took longer to materialise: restoring rangeland, for example, can take many years. Similarly, expected improvements — such as building strong self-sustaining community institutions that manage natural resources and growing indigenous species such as mangroves and other trees — can take years. Raising awareness and changing human behaviour also takes time; crop production increases due to soil health improvements are also long term.

Stakeholders at all sites expected improvements in ecosystem service delivery to be sustained over the long term, often over a decade and usually beyond the project's lifetime. But we conducted most of the research for this study no more than two years after project completion, so concrete evidence relating to long-term post-project impact was absent (see Appendix 3 for project timelines). Stakeholders felt that establishing sound land management and governance systems and working with children to pass knowledge and values down to the next generation will facilitate sustainability. But sustained improvements will often rely on a continuing enabling framework, such as ongoing community involvement, incentive distribution, awareness-raising activities and government support and institutionalisation.

Three sites reported possible trade-offs between timescales for ecosystem service delivery. For example, water extraction from a new borehole in Kenya could limit future water quality and quantity, potentially contributing to maladaptation in the future; and grazing restrictions under the Mountain EbA project in Peru could cause short-term localised drops in grassland productivity before landscape-level improvements in grassland health deliver long-term productivity gains.

3.3 Economic effectiveness of EbA

3.3.1 Assessing and comparing cost-benefit analysis types applied by projects

Prior to this study, other studies had conducted quantitative cost-benefit analysis of EbA, considering monetary and non-monetary values, for ten EbA measures in six project sites, using various methodologies involving estimating market prices (Peru – mountain ecosystems), experimental plots (South Africa), choice experiments (Bangladesh) and surveys. They also compared EbA and business as usual or alternative land or natural resource management approaches on ten EbA measures across five sites using various time horizons (15, 20 and 50 years) and discount rates (4–9% in Peru – mountain ecosystems; 1.3–8% in South Africa). Studies for the mountain ecosystems project in Peru also adjusted for societal/private values using a correction factor of 0.84 (Alvarado et al. 2015a and 2015b). Table 9 provides a summary of these cost-benefit studies.

Unfortunately, these more data-based, monetary cost-benefit analyses did not share common methodologies to reach fully comparable results. Project staff highlighted several limitations in conducting cost-benefit analysis. These included difficulties using and explaining monetary values in non-cash, remote economies (Costa Rica/Panama) and a lack of methodological understanding around issues such as using shadow prices to value subsistence consumption or household labour or identifying alternatives to business as usual for remote or isolated projects where, for example, engaging in eco-tourism would not be feasible.

Table 9. Quantitative EbA cost-benefit analyses, by case study intervention

Intervention	Alternative approaches used for comparison	Studies by
Nepal Planting broom grass in degraded grasslands; planting timur (bamboo-leaved prickly ash) on private land; gabion wall construction and revegetation to protect against erosion and downstream siltation	Business-as-usual grassland management; maize planting; an alternative forest restoration approach	Kanel (2015a, 2015b) UNDP (2015) Rossing et al. (2015) IUCN Nepal (2014)
Uganda EbA farming practices (such as grass bunds, terraces and drainage channels)	Business as usual	UNDP (2015) MWE (2015)
Kenya Strengthening traditional resource management institutions	Top-down approaches involving macro investment in infrastructure and productive transformation, wildlife conservancies in the context of lease payments and income potential, and other potential water uses (domestic, tourism, irrigated agriculture)	Bedelian and Ogutu (2016) King-Okumu (2016) King-Okumu et al. (2014, 2016) Nicholles et al. (2012) Niemi and Manyindo (2010) Tari et al. (2015)
Peru (mountain ecosystems) EbA livestock and rangeland management practices at three sites	Business as usual	UNDP (2015, 2016) Alvarado (2015[a], 2015b)
Bangladesh Compensation scheme providing fishers with incentives to abide by fishing restrictions	Not compared to other approaches	Dewhurst-Richman et al. (2016) Majumder et al. (2016)
South Africa Wetland and rangeland restoration (proactive scenarios) using various treatments, including direct seeding, mulching with plant material, micro-catchments and brush packing with Galenia Africana	Status quo Reactive scenarios such as farmers purchasing increasing amounts of supplementary fodder Engineered responses involving road upgrading and borehole installation	Bourne et al. (2017) De Villers et al. (2013) Black and Turpie (2013) Black et al. (2016)

All 13 case studies also collected perceptions on whether EbA is cost-effective — whether the project can achieve its objectives at acceptable costs — and economically viable over the long term, using the common methodology we detailed in Section 2. Based on these reported perceptions and analysis of the quantitative cost-benefit studies described above and in Table 9, we summarise evidence on whether EbA was cost-effective and, in some cases, how it compared to alternative approaches in financial and economic terms — for example, whether it was cheaper or generated more benefits. Table 2 provides a summary of key results.

3.3.2 Understanding EbA costs and benefits

The types of costs and benefits considered varied by case study. Examples of those assessed in the quantitative (mostly monetary) cost-benefit analyses include:

- Changes in income potential, based on price and amount of direct use inputs provided by the ecosystem (soil, sediments, siltation, natural fertilisers, grass, water and so on) and final products, such as meat, milk, wool, fish, crops, fruits, timber, non-timber forest products and extracted silt/sand.
- Changes in productivity (grazing capacity, number of livestock, meat production and so on) and/or replacement costs for maintaining existing productivity — for example, having to purchase more or less supplementary fodder — or benefits from risk reduction — in other words, reduced livestock mortality.
- Benefits, subsidies or payments for ecosystem services received — for example, food support, job guarantee or cash for work when implementing EbA.
- Adaptation, transaction and implementation costs, including planning, technical support, convening, transition, equipment, labour — for example, time spent preparing soil, seeding and/or mulching — and infrastructure, such as dams.
- Opportunity costs, often measured as lost wages or land rental fees — for example, giving up mining income for restoration or protection, reduced number of jobs due to restrictions on grazing as a result of rangeland restoration activities, temporary closure of fishing rights or losing cultivable land to riverbank restoration.

Responses to the perception questionnaire also gathered information on income and opportunity costs, among others.

Several case studies also looked at costs and benefits that emerged less directly from EbA, mostly through the perceptions study (see Table 10 for examples of broader economic benefits). Many quantitative cost benefit analyses did not include these additional costs and benefits because of the difficulties in calculating and assessing values.

Table 10. Broader economic benefits from EbA

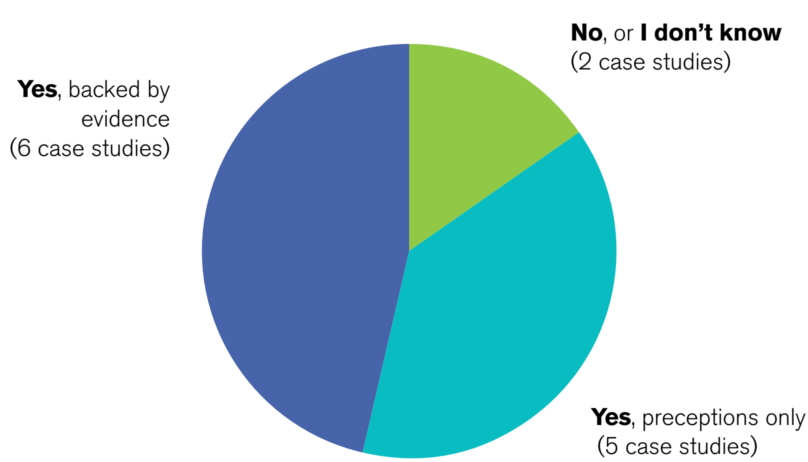
Type of broader economic benefit	Details and examples from EbA projects
Avoided costs	Reduced off-site farm expenses, less dependence on agricultural inputs, reduced household expenditure on charcoal and firewood due to tree planting, no need to bring in water and other forms of relief by tanker/truck during droughts, lower local economic losses from soil erosion and road damage on rangelands, and fewer animal deaths due to improved pasture availability.
Decreased losses from disaster events	Reduced risks to downstream areas from protecting upstream areas, reduced flood damage alongside rivers, reduced landslide impacts and reduced economic impacts of crop losses due to diversification on farms.
Greater self-reliance; less dependence on money lenders	Income increases and alternative income-generating opportunities have helped break the cycle of dependence on money lenders.
Income smoothing	Livestock farming in Africa can contribute to household income levels even where it is not the main source of income, serving as a safety net against unemployment and an income-smoothing strategy. Livestock products are used for food security, income substitution to reduce expenditure, disaster insurance, capital for investment in other sectors and access to credit. Livestock has a bequest and an option value, meaning it can be accessed like a savings account or insurance policy in times of need. Elsewhere, bartering provides a safety net in case of climate-related problems with food production or boom-and-bust cycles of tourism.
Land value increases	Reduced erosion along riverbanks has increased the value of the land where people have gardens.
Service value increases, often leading to increases in local income-earning opportunities	Quantitative project cost-benefit analyses often excluded income increases from improvements in productivity emerging from EbA measures. For example, increased agricultural productivity from soil protection measures such as broom grass cultivation and gully control, introducing drought-resistant seed varieties, riverbank protection activities and soil and water conservation activities such as agroforestry, mulching, grass banks, hedgerows, contours and trenches. Rangeland restoration provided income earning opportunities from game farming, hunting, research, historic and cultural activities, carbon sequestration, tourism and medicinal herbs, while also enhancing productivity through dust control, water infiltration, water regulation and soil erosion control. As well as income from meat and milk, livestock provided draught (pulling) power and transport, and wetlands facilitate pastoralism in dryland areas that could otherwise not support livestock. Beekeeping also provided income.

Type of broader economic benefit	Details and examples from EbA projects
Stimulating the local and national economy	Taxes and fees paid to public institutions for medical certificates, business permits and other fees and licences from meat shops, butcheries and offal dealers in the livestock and meat trade. Income from tourism could also be enhanced at various sites.
New market opportunities	Potential chocolate tours from cocoa agroforestry systems, income from traditional restaurants, artisanal craft centres, tourism and educational visits.
Better market access	Due to roadside stabilisation with plantations.
Short-term employment during project implementation	Several EbA projects created job opportunities or cash-for-work schemes and/or longer-term employment from beekeeping and plantation measures. Both cost-benefit studies conducted in South Africa classified the intensive labour required for wetland and rangeland restoration as a cost, but also pointed out that such job creation could be perceived as a benefit under public works programmes with established employment creation targets (Bourne et al. 2015a; Black et al. 2016).
Enhanced skills	These built income-earning potential.

3.3.3 Is EbA cost-effective?

Eleven case studies reported EbA as cost-effective (see Figure 1). While several projects relied on their own perceptions and experiences, almost half had evidence to back up such statements. This is not a case of perceptions versus reality, but a situation where hard evidence is only slowly catching up with what people in local contexts directly experience.

Figure 1. Is EbA cost-effective? Results from case studies



Although some of the projects used robust methodologies to quantitatively assess costs and benefits, they all reported the need to go beyond monetary values to better reflect the benefits of EbA. For example, standard cost-benefit analysis tends to ignore indigenous valuation methods and priorities, and rarely captures exchanges through bartering. It is often difficult to estimate or quantify the monetary values of ecosystem services and environmental resources; so confidence in the accuracy of methodologies applied and emerging results is relatively low because the reported benefits and costs are partial (Rossing et al. 2015; Wasonga et al. 2016; UNDP 2015; King-Okumu et al. 2014; Tari et al. 2015).

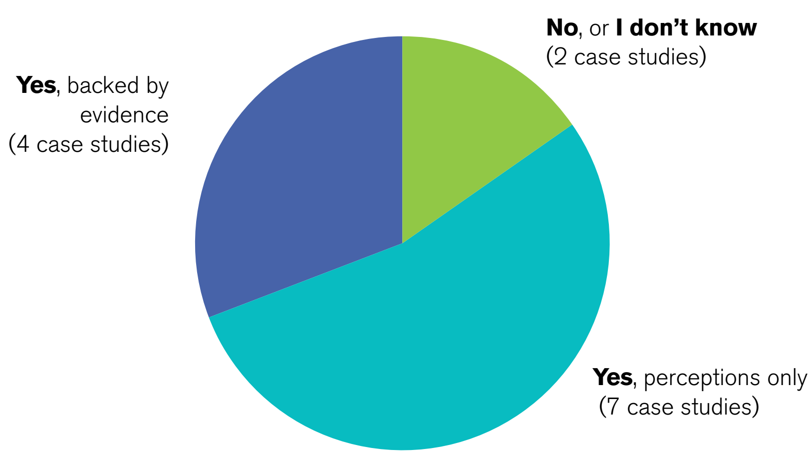
Two of the case studies reported that EbA was not cost-effective, or that they did not have enough information to make the case for cost-effectiveness. A South African monetary cost-benefit analysis, for example, found that rangeland rehabilitation was not cost-effective: it is expensive, requires considerable initial investments and notable positive returns can take decades (De Villiers 2013; Bourne et al. 2017).

Interestingly, perceptions in South Africa did not match the outcomes of the monetary analysis: provincial-level stakeholders felt rangeland restoration was cost-effective even though quantitative studies showed otherwise. In Bangladesh, government reports argued that the incentive-based hilsa conservation programme is cost-effective for fishers, but the fishers felt that the programme's benefits did not outweigh the costs.

3.3.4 Comparing EbA to alternatives

There was a strong perception that EbA is better than alternatives (including business as usual/doing nothing), with 11 of the 13 case studies reporting that EbA was more cost-effective than other measures (see Figure 2). However, seven based these statements on their own perceptions and experiences, and only four had detailed cost-benefit analysis to support these perceptions.

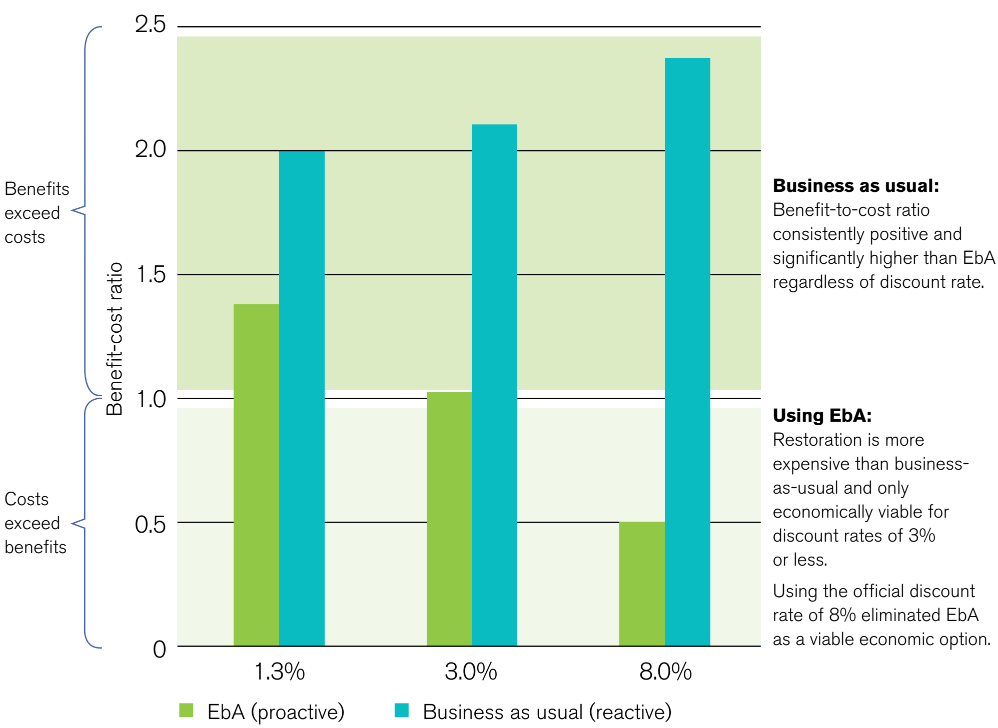
Figure 2. Is EbA more cost-effective than alternatives? Results from case studies



The case studies that had undertaken a cost-benefit analysis and reported that EbA was more effective than other options (including business as usual) included a *timur* plantation in Nepal. This revealed 68% higher yields per hectare when assessed against planting maize (business as usual), with a benefit-cost ratio of 1.3 versus 0.9, even using a large discount rate of 10% (Kanel 2015a). In Uganda, detailed analysis of costs and benefits of the net present value (NPV) of EbA measures versus non-EbA measures in 13 communities showed gains on average of US$80,000 over 15 years (with a discount rate of 12%), with annual values of US$8,000 in year one and US$2,400 in year 15 (MWE 2015). Perceptions from Burkina Faso suggested that EbA was more inclusive, creative and dynamic than other alternatives.

However, EbA measures with high initial intervention costs tended to fare worse against alternative options and when evaluated using high discount rates in monetary cost-benefit analysis. For example, in South Africa, rangeland rehabilitation and wetland restoration (the EbA or proactive scenarios) compared poorly with alternative options such as the status quo or engineered scenarios involving road upgrading and borehole installation alongside fodder or supplementary feed provision, especially when evaluated at the standard South African discount rate of 8% (Bourne et al. 2017) (see Figure 3). Some

Figure 3. EbA versus business as usual: benefit-to-cost ratio for rangeland restoration in South Africa



Source: Prepared with data from Bourne et al. (2017)

of the reasons for EbA's poor modelled economic performance were the steep learning curve for natural restoration, the unpredictability of rainfall patterns affecting survival rates and value chain limitations such as access to seeds or capacity to adopt seed collection on a commercial scale (Kanel 2015a).

There may, however, be other economic reasons for returning degraded areas to a state of ecological functioning that are beyond short-term monetary costs and benefits. These include avoiding the risk of irreversible change, bequest benefits for future generations, the non-use benefits of helping nature and a reduction in flood disaster risk. Such reasons can help justify expenditures and tip the balance towards EbA (De Villiers 2013; Bourne et al. 2017; Black and Turpie 2013; Black et al. 2016).

3.3.5 Distribution of costs, benefits, trade-offs and synergies

Table 11 summarises and illustrates results relating to key characteristics of economic effectiveness that we analysed for this study. They focus on the broader economic benefits and costs of the EbA initiative — that is, those aspects that are often difficult to measure quantitatively — as well as financial and economic trade-offs and synergies at different geographical scales and changes in costs and benefits over time. Observations on the economic synergies and trade-offs are closely correlated to the projects' social and environmental synergies and trade-offs. This is probably partly because interview respondents saw increased economic opportunities and income stability as a key component of adaptive capacity/resilience and many project interventions were aiming to increase the resilience of livelihoods.

Table 11. Perceived economic effectiveness of EbA projects: analysis of key characteristics

EbA project	Broader economic benefits from the EbA interventions	Broader economic costs from the EbA interventions	Financial and economic trade-offs and synergies at different geographical scales	Observed or expected changes to financial and economic benefits and costs over time
China	Income from participatory plant breeding)	None	Trade-offs possible Synergies likely: knowledge and resource exchange	Higher initial costs leading to longer-term sustained benefits
Nepal	Multiple	Opportunity costs	Synergies: from finance generated being invested elsewhere	Higher initial costs expected to lead to longer-term sustained benefits
Bangladesh	Multiple	Various unintended negative socioeconomic consequences	Synergies: due to increased downstream fish populations	Benefits from fish conservation still seen to be rising after 15 years

EbA project	Broader economic benefits from the EbA interventions	Broader economic costs from the EbA interventions	Financial and economic trade-offs and synergies at different geographical scales	Observed or expected changes to financial and economic benefits and costs over time
Kenya	Multiple	None noted	Trade-offs: neighbouring communities lost access to water, reducing income from livestock	Benefits rapid and sustained; benefits from sand dams take a year or more to accrue
South Africa	Multiple	Opportunity costs	Synergies: from water flow maintenance elsewhere	Benefits from rangeland rehabilitation expected to take years to materialise; benefits from wetland rehabilitation expected over medium/long term
Uganda	Multiple	Opportunity costs	No trade-offs noted	Some short-term losses noted. Benefits from tree-planting and EbA farming practices took years to materialise
Burkina Faso	Multiple	None noted	Synergies: reduced flood damage along whole river	Short, medium and long-term benefits noted. Early costs seen as high
Senegal	Multiple	Possible opportunity costs: untapped land use options	No data	Long-term benefits expected if practices sustained
Potato Park (Peru)	Multiple	Possible opportunity costs: mining	No trade-offs Synergies: income earning opportunities	Reported benefits took 5–10 years to materialise but are expected to continue over long term
Peru (mountain ecosystems)	Multiple	Opportunity costs; project costs	Possible trade-offs: grassland productivity in different locations	Higher initial costs seen as leading to longer-term benefits
Chile	Avoided losses from disasters, enhanced tourism income	None noted	Possible trade-offs if reforestation limits tourism infrastructure	Immediate to long-term benefits expected if management changes
Costa Rica/ Panama	Multiple	None noted	Possible trade-offs	Benefits from ecotourism took years to materialise
El Salvador	Multiple	Opportunity costs; project costs	No trade-offs	Benefits almost immediate

Key:
blue = stakeholder perceptions
green = project documentation including published literature, project reports and formal assessments, in most instances supported by stakeholder perceptions

Overall, the case studies identified multiple broader economic benefits (see Tables 10 and 11) and synergies from the interventions, including positive impacts on income and avoided losses from disaster mitigation and synergies from co-financing, water quality and water flows. A significant number of projects also reported broader economic costs, especially opportunity costs (eight projects) and possible trade-offs.

3.3.6 Impacts across stakeholder groups

Some of the quantitative monetary analyses — for example, the Bangladesh study — tried to separate the costs and benefits by stakeholder type to understand projects' distributional implications. For example, impacts on fuelwood availability are more likely to affect women as they tend to collect firewood; and elites are often likely to appropriate the financial benefits of interventions, at least initially, with other stakeholders hoping for a trickle-down effect (Dewhurst-Richman et al. 2016).

Analysis in Kenya and Bangladesh showed that costs and benefits were different for different stakeholder groups. In Bangladesh, for example, the government perceived the project to be cost-effective because it has led to increased tax revenue. But for fishers, the project has led to losses because of lost income after fishing was prohibited in sanctuary areas. Several unintended negative socioeconomic consequences resulted from the incentive-based hilsa conservation programme in Bangladesh (Dewhurst-Richman et al. 2016; Mohammed 2014):

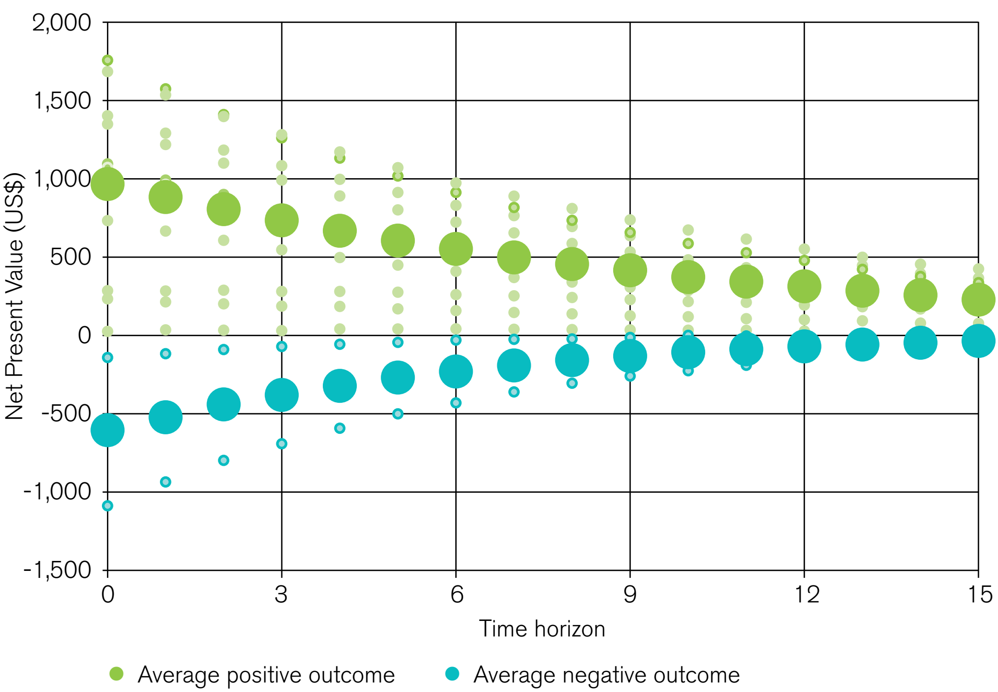
- Compensation in the form of rice did not offset the reduced availability of money for other important costs such as buying or repairing nets and boats, which forced many fishers to seek high-interest loans from money lenders during the fishing ban and the high demand for loans brought interest rates up by 20–30%.
- When rice was distributed during the fishing ban, rice retailers and wholesalers sold less, so compensating fishers in this way put other sections of the community at an economic disadvantage.
- During the fishing ban, many fishers and supply-chain workers sought casual work elsewhere, flooding the local labour market and driving down local labour wages by up to 40%.
- Although increases in hilsa catches reduced fish value, subsequent value chain studies (Porras et al. 2017a; 2017b) also report that the ban has led to the capture of larger fish, which fetch higher prices. But intermediaries who dominate the markets appropriate these price increases and fishers have no control over the prices they receive.

In some cases, certain groups of people accrued more direct financial benefits or broader economic benefits than others, due to their location. For example, communities in remote areas are expected to benefit less from ecotourism such as cocoa tours in Costa Rica and Panama.

Five projects reported trade-offs or possible trade-offs, where one group benefited at the expense of others elsewhere (see Table 11). Reasons given included: tighter control over rangeland resources making access to water more difficult for herders from neighbouring communities; reforestation or improved native forest management to reduce economic losses from avalanches limiting potential income from skiing and ski resort infrastructure; and stricter grazing regimes increasing pressure on resources and overgrazing elsewhere, leading to losses in grassland productivity.

Monetary cost-benefit analysis in six projects also demonstrated synergies — that is, instances where financial or economic benefits from EbA activities at one location were linked to financial or economic benefits elsewhere (see Table 11). In Burkina Faso, for example, reduced flood damage resulting from the EbA project extended beyond the project site along the length of the river; and in South Africa, improved water availability may have produced economic returns from livelihood options relying on this water elsewhere. Detailed monetary analysis in Uganda showed different impacts of EbA across various locations. Figure 4 shows the distribution of the NPV of EbA minus business as

Figure 4. Distribution of NPV of EbA versus business as usual in communities in Mount Elgon, Uganda



Source: Prepared using data from MWE (2015).
Notes: Figures in US$/year at 12% discount rate. Smaller dots indicate the separate communities included in the study; larger dots are the average positive or negative outcomes. Most of the communities have positive benefits throughout the time period (some considerably more than others). The NPV decreases with time for all communities, indicating that financial flows in the future are less valuable to people than in the present (the effect of a discount rate).

usual across time and villages. For example, positive values indicate that EbA generates more benefits than the alternative scenario. Although EbA has an overall positive impact if compared to business as usual, there is significant variability in NPV across the 12 communities, with aggregate positive outcomes of US$8,312 in ten communities but aggregate negative outcomes of US$3,750 in two communities.

3.3.7 Effectiveness across time: variability in benefits and costs accrual and use of discount rates

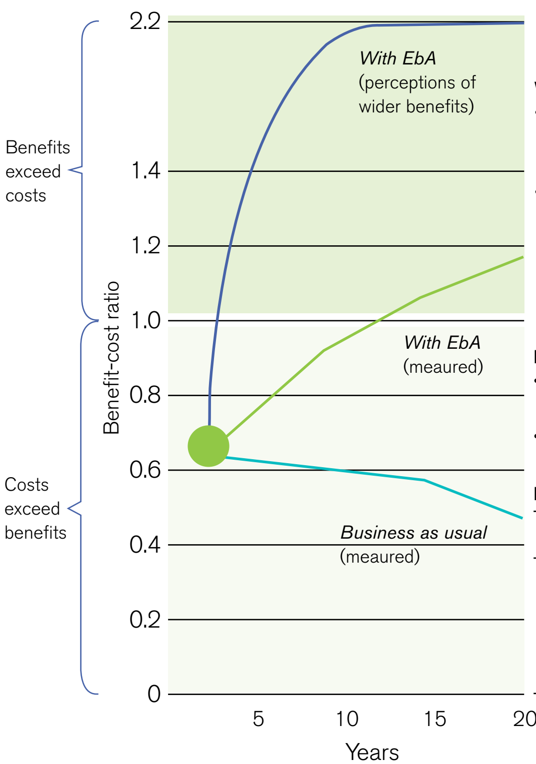
The timing of economic or financial benefit accrual varied across project sites and EbA measures, with some demonstrating short-term benefits and other benefits taking substantially longer to materialise. Rapid financial or economic benefit accrual following EbA project implementation included, for example, almost immediate income increases from agriculture and fishing noted in El Salvador following the clearance of drainage channels. Several case studies provided examples of how it can take longer — sometimes up to 20 years — for benefits from EbA to emerge (see Table 11). Processes that stakeholders observed or expected to take years include:

- Accumulating water in sand dams
- Recovering overexploited and heavily degraded natural resources
- Tree growth
- New institutions, management regimes, grazing or farming practices becoming effective
- Rangeland restoration (thought to take roughly two decades in Namaqualand, South Africa)
- Successful establishment of new businesses, and
- Ecotourism projects: it can take many years of preparation before sites, activities and tours, are included in travel agencies' promotional material.

As shown in Figure 4, discount rates reduce the value of financial flows in the future. Because of this, using high discount rates on cost-benefit analyses can seriously reduce the calculated economic viability of EbA, especially in heavily degraded areas that require long-term investments. A monetary study in South Africa suggests that the costs of trying to restore areas that have been degraded to the extent that they can no longer return to their original state will exceed business-as-usual costs and can be prohibitively expensive, regardless of the discount rate used (see Figure 3).

Economic benefits partly overlap with adaptation-related benefits and social co-benefits. And like them, stakeholders perceived that the economic benefits of EbA could potentially last for a long time if enabling conditions continue and incentives continue to help compensate for or reduce the impact of projects' short-term financial or economic losses. For example, a detailed analysis of EbA activities under the EbA project in Peru's Canchayllo and Miraflores communities (see Figure 5) suggests that introducing EbA was economically beneficial when compared to business as usual, but only over the long term. Benefit-to-cost ratios indicated that the project would become cost-neutral after 10–15 years (Alvarado 2015a and 2015b). Including wider, non-quantifiable, benefits and costs in the analysis (through survey techniques) increased the estimated benefits-to-cost ratio to 2.2, suggesting that local communities' willingness to shoulder some of the short-term costs of switching to EbA measures may be partly due to expected benefits beyond monetary values. However, breaking even after 10–15 years is difficult for Peruvian farmers with low investment ability to manage or accept. Similarly, the *timur* plantations in Nepal are expected to take 20 years to break even (Kanel 2015a). In such cases, stakeholders will need additional support during these periods. Importantly, however, analysis of the scenario of not introducing EbA (so, business as usual) in Peru projected a continuous decline in benefits from livestock activities, leading to negative cultural and social consequences for local communities.

Figure 5. Benefit-cost ratio against business as usual for native grassland management in Canchayllo, Peru



With EbA:

- Benefits exceed costs after about 10-15 years after EbA investment and continue to increase
- Perceived non-quantifiable benefits significantly increase the BC ratio earlier in the project

Business as usual:

- Costs remain higher than benefits throughout the time horizon
- Benefits continually decreasing through time

Relations similar across both communities

	Canchayllo		**Miraflores**	
	No project	With EbA	No project	With EbA
5 years	0.64	0.69	0.96	0.92
10 years	0.60	0.92	0.98	1.23
15 years	0.58	1.06	0.95	1.45
20 years	0.48	1.16	0.91	1.65
Perceptions		2.18		2.25

Source: Alvarado (2015a)
Note: Uses a 4% discount rate and assumes climate change. The trends seen here also hold for the Miraflores community.

3.4 Success factors for implementing EbA

Interviews and project documentation revealed several important factors common to many of the case study sites that stakeholders thought had helped realise EbA benefits. These were also reflected at other sites where stakeholders had relevant experiences to share.

Government prioritisation of EbA and climate change, at national and provincial/regional levels supported EbA implementation at various sites. Many countries have dedicated national-level bodies to address climate change, such as the Climate Change Office in Chile's Ministry of Environment. Some countries have been working to direct more financial resources to climate change — for example, the government of Nepal has been increasing financial resources for addressing climate change and has determined that 80% of adaptation funding must go to the local level.

EbA champions often drove support and implementation. Capable committed leaders can be government officials at various levels or members of civil society. Stakeholders saw members of the Asociación para la Naturaleza y el Desarrollo Sostenible (ANDES) and potato guardians as instrumental in promoting the Potato Park and pushing for legislative change in Peru.

Government capacity: In many cases, local government bylaws and institutions supported EbA implementation. This was partly because local government structures are usually responsible for implementing environmental protection, disaster risk reduction, service delivery, job creation and poverty alleviation activities, often working together across departments, which ensures the cross-sectoral collaboration needed for EbA. Where this level of local government capacity exists, it can support EbA implementation well. Capacity at higher levels is also important — for example, in South Africa, stakeholders see the Department of Environmental Affairs as a strong supporter of EbA, which has helped with implementation and upscaling throughout the country.

Working with or strengthening local organisations and planning processes was also important for facilitating effective EbA implementation. In some instances, this meant creating new institutions such as formalised collective governance bodies, local committees for risk reduction and local climate change planning committees. In others, they existed before the EbA intervention. Established institutions that played a role in EbA implementation included community assemblies, community natural resource management groups, savings and credit groups and women's groups. In all cases, the use of genuine participatory methods when working with local organisations reportedly helped foster a sense of ownership and contributed to sustained EbA success.

Climate change policies are emerging in many countries, at national and subnational levels, and can promote EbA. These include South Africa's policies and legislative arrangements for environmental governance, which provide clear support for EbA; Kenya's constitutional and legal framework provides for county and local level structures to plan for adaptation and channel funding accordingly; and the 2011 National Framework for Local Adaptation Plans for Action in Nepal, which provides for delivering adaptation services to the most climate vulnerable areas and people.

Other non-climate change-related policies that facilitate EbA — particularly those supporting decentralisation — were critical. Other important policies included those that recognise indigenous land rights and protect traditional knowledge (Peru) and protect and manage forests and watersheds.

Incentives — some of which focused on livelihoods — sometimes covered the lag time before ecosystem service-related benefits from EbA measures emerged or to strengthen community support for an EbA initiative.

Knowledge generation and sharing facilitated EbA implementation at several sites. For example, participatory plant breeding was the foundation of EbA in China and Peru and farmer-to-farmer meetings and exchange visits were important in Uganda, Senegal, Burkina Faso and China. Combining local and scientific knowledge was often perceived as facilitating EbA implementation. For example, the project in China often undertook local research in collaboration with scientific institutes such as the Guangxi Maize Research Institute and the Yunnan Academy of Agricultural Science.

3.5 Barriers to EbA implementation

Interviews and project documentation identified various policy, governance and political challenges that inhibited the realisation of EbA benefits across the case study sites and in case study countries more broadly. These are the barriers to EbA implementation as seen by stakeholders in the study sites.

Insufficient political support: National and local governments alike often do not prioritise EbA, so agencies lack the mandate to work on it. When they identify conflicts, national governments often tend to prioritise economic growth and sectors such as mining or intensive agriculture that are less compatible with EbA. Climate change is often housed in relatively weak environment ministries, making it hard to secure the necessary cross-government support for EbA. Environmental legislation is often limited, which means EbA does not have the legal backing needed to realise benefits. Several case studies also showed that other issues important for EbA — such as devolution of governance and ensuring local or indigenous peoples' participation in decision making — also received limited government support.

Limited technical skills at local government level: Even where EbA is supported by various policies and plans (South Africa and Peru) the human resources needed for implementation were often insufficient. Skills relating to EbA monitoring and evaluation were a particular gap; government staff turnover was another common problem.

Weak governance and weak government institutions can lead to limited creation and enforcement of relevant legislation and management regimes at the local level. Capacity can also be lacking at higher government levels — for example, to incorporate EbA into national adaptation policy and planning processes. Corruption has reportedly contributed to government support for mining in Peru, poor enforcement of grazing regulations in Kenya and illegal natural resource extraction in Bangladesh, all of which undermined EbA implementation.

Weak community organisations and weak traditional leadership can lack the technical skills needed to implement EbA. Stakeholders thought this had made implementation challenging in some cases. At the project site in Burkina Faso, for example, there were no strong local organisations.

Limited funding for EbA at local, regional and national levels constrains EbA implementation even when plans and policies prioritising EbA are in place. While some external donors support EbA, this support may not be provided to government agencies or through government channels, such as National Research Foundation grants in South Africa. This can undermine nationally determined adaptation priorities.

Insufficient collaboration: EbA is typically a multi-sectoral effort and requires collaboration across a range of government levels. But governments tend to be structured according to sector and political rivalry or instability can hinder collaboration. Local government departments or technical services often work independently from each other and stakeholders often see citizen participation as insufficient in the spaces where decisions are made. Similarly, at provincial or regional government levels, governance is often fragmented and siloed. Nationally, collaboration between agencies responsible for climate change, disaster prevention and relief is often inadequate. Some sites identified transboundary collaboration as needing improvement — for example, in Bangladesh, hilsa fish travel through river systems and ocean waters under India and Myanmar's jurisdiction.

Knowledge gaps and inadequate knowledge sharing: Many stakeholders considered that government needed to improve its understanding of EbA and some noted that community understanding of the benefits of environmental protection and EbA was limited. Many reported the need for a stronger scientific evidence base on EbA, particularly in terms of quantitative socioeconomic assessments and economic cost-benefit analyses. Such knowledge gaps can make monitoring and evaluation — and securing robust evidence of impact — difficult. But comprehensively valuing the full range of social and economic benefits emerging from EbA is challenging and EbA benefits are often undervalued. Interpreting the science behind EbA and making it more accessible — particularly for policymakers — and placing more emphasis on EbA in national curriculums and higher education would help address this.

Weak policy and legal support for EbA: While many countries have policies and strategies addressing climate change and disaster risk reduction, EbA is often poorly integrated into these, so policy support for climate change and EbA is often insufficient. For example, Bangladesh has no policy or strategy for addressing climate change impacts in the fisheries sector and no national-level policy or strategy recognising and facilitating EbA. Policy and legal support in other areas can also be weak or undermine EbA. Such areas include water extraction and use and payments for ecosystem services schemes. Government subsidies in the farming and industrial sectors can support intensive agriculture, mining or deforestation, undermining EbA. Stakeholders at several sites saw government policies as undermining local agency — for example, by failing to support user rights on communal land or limiting devolution and decentralised governance. Policies can also be top-down and ill-suited to local conditions.

High levels of poverty and poor infrastructure: Stakeholders at various project sites thought these limited the potential benefits of EbA. For example, poor transport networks limited market access; high levels of unemployment and illiteracy, limited mobile phone coverage and poor water supplies all reportedly reduced adaptive capacity. In some cases, stakeholders thought that high levels of indebtedness affected compliance with natural resource use restrictions.

3.6 Opportunities for scaling up and sustaining EbA benefits

Various opportunities for scaling up EbA were apparent across the case studies. Many stakeholders perceived that mainstreaming EbA into national policies related to climate change, development, land, disaster risk reduction and the environment brought opportunities. In Peru, for example, the Mountain EbA project has mainstreamed EbA into local-level management plans, existing Nor Yauyos-Cochas Landscape Reserve structures and plans, the Junín Regional Climate Change Strategy and the National Policy Guidelines for Public Investment in Biodiversity and Ecosystem Services 2015–2021.

The case studies found that mainstreaming EbA into permanent government structures and planning processes would increase the likelihood that benefits would be sustained beyond the life of an externally initiated EbA project. Self-management and independence from external funding could also support sustainability, as demonstrated at the Potato Park.

Projects reported that financing EbA was a common challenge, but the case studies provided several possible models doing this independently from donors, at scale and for the longer term (Table 12).

Table 12. Models for financing EbA at scale and for the longer term

Model	Example from EbA case studies
Incorporation into public works/social protection programmes	South Africa has several expanded public works programmes — such as 'Working for Water' — into which EbA can be integrated. These address critical political priorities such as job creation, poverty reduction and water scarcity and are funded with tax allocations. These programmes have started to integrate EbA metrics so they can also measure success in terms of adaptive capacity gains.
County-level climate change planning and management	In Kenya, county climate change fund management legislation commits counties to committing a percentage of their development budget to climate change finance. The institutions for managing the Isiolo County Climate Change Fund are in place and integration into county-level planning and management systems means they can channel funding to local EbA investments. Project donor funding ended in 2016, but the county is seeking further funding from global climate funds or county-level climate change funds.
Conservation/trust fund	Several studies have proposed a national hilsa conservation fund in Bangladesh to cover the costs of incentives provided under the incentive-based hilsa conservation programme (Islam 2016; Dewhurst-Richman et al. 2016; Bladon et al. 2014; Bladon et al. 2016a).
Payments for ecosystem services	In Uganda, the EbA project bundled watershed and carbon services into credits that could be sold to buyers such as the National Water and Sewerage Corporation of Uganda.

Livestock farming in the Leliefontein communal area Namakwa District Municipality, South Africa (Conservation South Africa)

4 Discussion

Results from applying a framework to assess EbA effectiveness in 13 EbA projects around the world show that stakeholders perceived EbA as improving the resilience or adaptive capacity of local communities or reducing their vulnerability to climate change at all case study sites, although they did not view all project activities as contributing to this. This was even true for the project in Bangladesh, which did not explicitly set out to address climate change, but still built adaptive capacity (see Reid and Faulkner 2015 for another natural resource management initiative shown to increase adaptive capacity). Perceptions relating to the maintenance, restoration or enhancement of ecosystem services and improvements in ecosystem resilience after EbA project implementation were also positive across all sites, though not as a result of all project activities.

Stakeholders perceived most projects as providing (or able to provide, should enabling conditions continue) long-term adaptation-related benefit accrual and improvements in ecosystem services delivery.

Stakeholders thought that some activities initiated under the EbA projects studied did not directly improve the resilience, adaptive capacity or vulnerability of local communities facing specific local climate change-related threats, though some of these activities probably had indirect positive impacts. Similarly, they thought certain EbA project activities had not improved ecosystem service provision or ecosystem resilience at the time of our research. Reasons for this included poor implementation, the challenges of securing an appropriate policy and institutional framework for implementation, the time taken for results to emerge, the challenges of measuring ecosystem-related parameters, and in the case of South Africa, the ecological complexities of rangeland restoration. This last point mirrors global experiences elsewhere showing that rangeland restoration has low success rates (James et al. 2013).

4.1 Social co-benefits

Many authors have emphasised the social co-benefits of EbA (GIZ 2013; Rao et al. 2013; UNFCCC 2017; Lo 2016; Bubeck et al. 2019). This research supports their findings; all our case studies provided examples of a multitude of perceived co-benefits, defined as benefits that did not have (or were not perceived as having) any clear direct link to known local climate change threats and that did not directly contribute to adaptive capacity, resilience or reducing vulnerability at each site (Mach et al. 2014). Based on the understanding that adaptive capacity is a function of the amount, diversity and distribution of human, social, physical, natural and financial capital (Ensor and Berger 2009; Ayers et al. 2012) many of these co-benefits do, however, contribute indirectly to adaptation. The similarities between adaptation-related benefits (Table 3) and social co-benefits (Table 5) listed by interviewees is striking. These social co-benefits can also help deliver on a number of national and international development-related priorities, such as the Sustainable Development Goals (Lo 2016), and targets articulated in the Sendai Framework for Disaster Risk Reduction 2015-2030. Both Table 3 and Table 5 highlight disaster risk reduction as a perceived adaptation-related benefit and social co-benefit emerging from EbA projects.

4.2 Reaching the most vulnerable

Many authors claim that EbA initiatives can help the world's poorest, who are most vulnerable to climate change impacts and most reliant on natural resources (Doswald et al. 2014; Reid 2011; Bubeck et al. 2019). Many see this not only as a development issue, but also as a matter of fairness because these people have usually contributed least to the problem of climate change (Reid et al. 2009).

Results from this study reinforce the view that EbA can be a pro-poor approach to adaptation. Perceived improvements in resilience, adaptive capacity and vulnerability as a result of the EbA project activities analysed tended to accrue among particularly vulnerable groups of people. In some instances, this was because the EbA projects specifically targeted vulnerable groups or were in areas with populations of particularly vulnerable groups.

Women accrued adaptation-related benefits in many projects, but other vulnerable groups — including the elderly, children, the poorest and indigenous groups — also experienced improvements in resilience, adaptive capacity and vulnerability as a result of EbA project activities. Some less vulnerable groups also accrued adaptation-related benefits as a result of EbA project activities. At many project sites, social co-benefits also reached particularly vulnerable groups, including women. While our findings do not indicate that EbA automatically provides high levels of social benefits to vulnerable groups, they demonstrate that the EbA approach allows interventions to be designed in a way that ensures they do.

Several of the EbA projects we studied provided adaptation-related benefits and social co-benefits to a broad spectrum of beneficiaries, including people outside the project area.

4.3 Trade-offs and synergies

Several authors have argued that EbA measures should be designed as no-regrets or win-win approaches to adaptation, that do not worsen vulnerabilities to climate change and have a positive impact on livelihoods and ecosystems (Rizvi et al. 2014; Colls et al. 2009; UNFCCC 2017). This could prove challenging, however, as several case studies under this project showed that stakeholders perceived that some groups accrued more adaptation-related benefits than others. While some case studies identified no trade-offs in terms of who accrued adaptation-related benefits, in several projects, people believed that one group was receiving adaptation-related benefits at the expense of others. Many case studies also suggested that some groups accrued more social co-benefits than others. Sometimes, this was at the expense of others. In some instances, less vulnerable groups reportedly accrued more social co-benefits than other groups, while in others, certain stakeholder groups experienced negative social impacts from the project.

A few case studies noted trade-offs in ecosystem service delivery between timescales and several reported trade-offs or potential trade-offs between ecosystem service provision at different geographical scales or sites.

Acknowledging and understanding these differential benefits and trade-offs is the first step towards tackling them. Lo (2016) and UNFCCC (2017) recommend the use of tools and methodologies such as Integrated Valuation of Environmental Services and Trade-offs (InVEST) to support this process.

Despite the trade-offs and differential levels of benefit accrual observed, synergies between ecosystem service provision at different geographical scales or sites were more apparent than trade-offs. Some challenges experienced by the EbA projects are also not unique to EbA. For example, development practitioners have struggled for many years to ensure projects reach the most vulnerable (Robertson et al. 2012; Lipton 1988).

Projects reported improvements to ecosystem service provision over a range of timeframes, which varied by study site and service. Some perceived or expected improvements will take time to materialise; in some cases, this may be after the project's lifetime. Many case studies demonstrated that adaptation-related benefits could take several years to materialise and that short-term costs could accrue while waiting for longer-term benefits to emerge. Some projects tackled this challenge by providing incentives to offset the short-term losses. For example, a gravity flow scheme in Sanzara, Uganda, provided an immediate secure source of water for 1,000 people in the parish, and farmers who used to suffer from drought-induced crop failure can now access water all year round. Such short-term incentives have proved useful (in terms of adaptation and disaster risk reduction) in EbA projects elsewhere (Bubeck et al. 2019) and are something that future EbA project planners and implementers should consider.

4.4 The value of participatory practices and local knowledge

Results from all our projects clearly showed that adopting participatory processes and valuing indigenous or local knowledge is essential for building adaptive capacity (a point also stressed by UNFCCC 2017 and Lo 2016). In some instances, interviewees noted that greater levels of participation could have improved the project. This is an important point for those implementing EbA projects, especially conservation or environment-focused agencies with less expertise in development project planning/implementation and applying participatory processes. Much of the early EbA literature and guidance places inadequate emphasis on valuing indigenous or local knowledge and adopting genuine participatory processes; or it gives little detail on how to do this effectively (see Travers et al. 2012).

Rhetoric on these issues also needs genuine translation into meaningful and equitable implementation. This can be challenging when different community members hold and value different elements of traditional/local knowledge, when working with local organisations entrenches existing power imbalances or when participation becomes a burden rather than a benefit to those involved (Cooke and Kothari 2001). We must also remember that traditional knowledge alone may not be enough to address new climate change-related risks: some of the EbA projects we studied saw the combination of scientific and local or indigenous knowledge as important (UNFCCC 2017 and Mercer et al. 2012 also stress this point).

4.5 Increasing biodiversity for greater resilience

Pressures (from climate change and other stressors) on ecosystems affect ecosystem resilience and service delivery, which in turn contribute to diminished human wellbeing (MEA 2005). Perceptions gathered for this study suggest there were improvements in ecosystem service provision and resilience at all sites and in all ecosystem types, implying that EbA can be effective in the context of ecosystem-related criteria for effectiveness. It is important to note, however, that measuring ecosystem resilience is technically very difficult and gathering perceptions related to this is unlikely to provide a robust measure of effectiveness. This study included projects that promoted agricultural diversity (China, the Potato Park and Costa Rica/Panama – see Appendix 3) which were also perceived as supporting ecosystem resilience and service delivery. This is in line with the widely held view that more biodiverse systems are more productive and resilient to climate change and other stressors (Cardinale et al. 2012; Seddon et al. 2016b). This observation is important in the context of choosing adaptation options for agricultural ecosystems, where non-EbA adaptation approaches often promote monocultures. Interviewees at all sites identified threats to ecosystems and local ecosystem service provision — such as natural disasters, overexploitation, land conversion, poorly planned infrastructure, mining, poor management practices, invasive species, pollution or bushfires — in addition to climate change impacts. Greater biodiversity can improve resilience against a variety of threats as well as climate change; so EbA approaches that increase diversity may be less exposed to risk from external factors.

4.6 A wider landscape

The perceived maintenance, restoration or enhancement of ecosystem services at project sites occurred at various geographic scales, but the watershed or catchment area was considered the most appropriate level for implementing EbA activities at several sites. Several projects considered implementing activities at a wider landscape level important. This is in line with the broader EbA literature, which also notes the benefits of working at watershed or landscape scale (see Colls et al. 2009; Van de Sand et al. 2014; Chandra and Gaganis 2016; Vignola et al. 2015). Watershed or landscape boundaries at the case study sites, however, do not always match with administrative or political boundaries. Useful tools for addressing this challenge include policy-network analysis (Vignola et al. 2013) and the Catchment Adaptation Framework (Lukasiewicz et al. 2016).

4.7 Thresholds or tipping points

Interviewees posited various factors that might push ecosystems towards thresholds beyond which they could no longer provide key services, or their structure and functioning would be irreversibly altered, but evidence for the existence of such thresholds was weak. This could be because there is generally an insufficient body of knowledge about thresholds in connection with climate change impacts on ecosystems (a challenge noted by Doswald et al. 2014 and Maron et al. 2017). This could be a result of insufficient understanding of the ecosystems at the case study sites or because the threshold or tipping point concept was less relevant at these sites. According to the wider literature, thresholds are important for some ecosystems, for example:

- Thresholds in land degradation may have already been exceeded in South Africa's Succulent Karoo (Bourne et al. 2017; Van der Merwe and van Rooyen 2011)
- Glacial melt as a result of temperature increases in the Andes could dramatically affect downstream water supplies (Vuille et al. 2008; Urrutia and Vuille 2009), and
- Mangrove die-off has been observed as a result of sea level rise in Australia (Lovelock et al. 2017).

But the threshold concept may not have wide applicability and some studies suggest that "variation along a continuum" might better characterise most changes observed in natural systems (Cardinale et al. 2012; Capon et al. 2015; Montoya et al. 2018).

4.8 Cost-effectiveness and economic benefits

Stakeholders perceived many EbA projects as cost-effective or more cost-effective than alternatives and quantitative assessments sometimes supported these perceptions. This is in line with other studies showing that EbA can be a more cost-effective approach to adaptation than alternative approaches such as infrastructure (Baig et al. 2015; Rao et al. 2013; Bubeck et al. 2019). In a few instances, perceptions did not match the outcomes of quantitative assessments, which could be a result of overconfidence in EbA or of broader knowledge on its benefits not being captured by a quantitative monetary assessment. EbA measures with high initial intervention costs tended to fare worse against alternative options when assessed using monetary cost-benefit analysis, especially when applying high discount rates. In situations like that in South Africa, where rangelands are highly degraded and restoration is prohibitively expensive, it may make economic sense to consider pre-emptive interventions – for example, using national restoration programmes such as conditional transfers and public works programmes – to prevent such situations from happening. Decision makers should balance the benefits of investing in EbA (including potential subsidies or compensations during early adoption) against the future costs of no-action or alternative actions.

Stakeholders felt a wide range of broader economic benefits had emerged from most EbA projects. Several of these benefits demonstrated synergies or multiplier effects in the context of economic benefits as a result of the project. As with adaptation-related benefits and social co-benefits, they perceived economic benefits as potentially long-lasting, if enabling conditions continued.

4.9 Economic trade-offs

At times, the financial costs and benefits accrued were different for different people. For example, the incentive-based hilsa conservation programme may have been a good investment for the government of Bangladesh, but costly for fishers affected by the ban, who may not even benefit from better prices for bigger fish because they lack market power. Trade-offs also took place, with groups benefiting economically at the expense of others. Some projects also demonstrated broader economic costs, including opportunity costs and other unintended negative socioeconomic consequences as a result of shifting market forces – for example in fish, loan, wage labour and rice supply chains in Bangladesh. While stakeholders perceived some financial or economic benefits as immediate after EbA project implementation, several case studies provided examples of how it could take up to 20 years for financial benefits to emerge. In some cases, economic incentives helped compensate for this delay or reduce the impact of short-term losses. Some authors have, however, highlighted distributional issues relating to equity and fairness as a result of incentives provision (Pascual et al. 2014; McDermott 2013). Incentives provided under the project in Bangladesh, for example, did not reach all those experiencing costs as a result of fishing restrictions or consider resulting negative socioeconomic consequences. Adopting a framework to assess equity can help address this challenge (Schroeder and McDermott 2014).

4.10 Measuring economic benefits

The challenges of fully measuring direct and indirect financial and economic costs and benefits with comparable methods were widely apparent across case studies (see also Rossing et al. 2015). This undermines confidence in the assessment results and means that the playing field is unlikely to be level when comparing EbA with alternative adaptation approaches. That said, it is notable that EbA performed well in most cost-benefit analyses and comparisons with alternatives across our project sites, in spite of the many economic benefits that were excluded from the monetary analyses. So, while cost-benefit analysis can be a useful tool to help decision makers decide whether it makes economic sense to invest in EbA, such studies should not be the sole basis for investment choices (Black and Turpie 2013). There needs to be continued progress on developing robust methods for assessing the direct primary financial costs and benefits and broader economic costs and benefits of EbA (Hills 2015; Seddon et al. 2016b). It may also be appropriate to use lower discount rates than the 8% used in the South African monetary cost benefit analysis. Nordhaus (2017) for example recommends using a discount rate of 3% when considering climate change, and Stern used a discount rate of 0.1% in his seminal 2006 review (Stern 2006). Redesigning standard cost-benefit analysis methods to cover a wider set of components of success and effectiveness — including those that are non-monetary and difficult to measure — would also help. For example, food security is an important co-benefit of EbA and should be an integral part of any cost-benefit analysis. There must be more research to develop shared, coherent frameworks that gather monetary and non-monetary values to support better comparison with other adaptation options, thus better informing investment decisions at large scales.

4.11 Success factors and challenges to overcome

Analysis of the case studies revealed a number of common important political, policy and governance-related factors that stakeholders felt helped realise potential EbA benefits at the sites and more broadly in the country. These included government prioritisation of and capacity to support EbA, EbA champions, working with or strengthening local organisations, strong policies relating to climate change and other issues, the provision of incentives and strong knowledge generation and sharing. Various challenges — including insufficient or weak political and legal support for EbA and insufficient collaboration across a range of government levels — also inhibited the realisation of EbA benefits across case study sites and countries. It is important to address such barriers to EbA implementation to maximise the full potential of EbA. Many of these challenges are not unique to EbA and are also found in programmes addressing poverty reduction or environmental management improvements. Based on the outcomes of this study, to overcome these barriers, governments need to prioritise EbA in climate change and development policymaking and facilitate collaboration across a range of departments and sectors from local to national levels. UNEP-WCMC has developed a navigator for EbA tools,[4] many of which provide guidance on EbA mainstreaming, that can support this. Governments must also build local technical capacity to implement EbA and support research and knowledge sharing on EbA to boost uptake (see also UNFCCC 2017). Working with or strengthening local organisations and planning processes — and adopting genuine participatory processes — is also key for EbA success.

[4] www.iied.org/help-pilot-navigator-tools-for-ecosystem-based-adaptation

Scaling up EbA is important if benefits are to extend beyond the project level and reach the large number of poor and vulnerable people who have done little to cause climate change but are particularly vulnerable to its impacts. Models for funding EbA at scale — for example, through existing or new social protection programmes — need exploring. Several studies describe funding models that complement those described in our case studies (GIZ 2017, Wertz-Kanounnikoff et al. 2011 and Van de Sand et al. 2014).

4.12 Methodological limitations

Most EbA projects lack experimental counterfactuals to compare them with, and many lack robust scientific data that measures — for example — ecosystem service provision (Doswald et al. 2014; Seddon et al. 2016c; Ojea 2015). In the absence of such quantitative data, capturing perceptions is a useful way to assess EbA effectiveness. We have also shown how perceptions can provide important information that quantitative methods do not capture. For example, current quantitative methodologies for monetary cost benefit analysis can inadequately capture indirect financial and economic costs and benefits and should not be the only factor influencing investment choices. But perceptions analysis cannot be used to comprehensively assess technical concepts such as ecosystem resilience or cost-effectiveness (as demonstrated by the EbA projects in South Africa and Bangladesh where perceptions did not always match the outcomes of the monetary analysis). Whilst stakeholders may accurately note changes in components of EbA effectiveness, this doesn't confirm attribution. And perceptions may also perpetuate accepted 'truths' without independent assessment and verification. It was notable how perceptions tended to correlate with information from project documentation — formally published or otherwise. Such correlation could indicate verification and the robustness of results, but it could also occur if stakeholders had merely repeated what they had read in project documentation or vice versa. Collecting perceptions was also challenging at times. Whilst we tried to ensure that we collected perceptions from different stakeholder groups (as detailed in Table 1), and also perceptions from different sub-groups of community beneficiaries, it was not possible to guarantee that the stakeholders interviewed truly represented all community beneficiaries. Efforts to interview certain stakeholders were not successful in some instances. For example, although women were invited to the focus group discussion in Canchayllo, Peru, only men attended. Lastly, whilst efforts were made to ensure a common understanding of technical terms, this did not always succeed. Interviewees sometimes, for example, interpreted trade-offs as costs rather than costs for some as a result of benefits for others.

5
Conclusions

The UNFCCC has argued that "EbA has demonstrated potential to increase social and ecological resilience to climate change and adaptive capacity in the long term" (UNFCCC 2017). This research strongly supports this view, showing that EbA can provide a variety of strong, long-lasting and wide-reaching adaptation-related benefits, social co-benefits and ecosystem-related benefits. The evidence we present here on the economic effectiveness of EbA also supports the UNFCCC perspective that "the evidence of the effectiveness and economic viability of EbA, although largely anecdotal and project-derived, is promising" (UNFCCC 2017) and bolsters the view that EbA can in some situations be a more cost-effective approach to adaptation than the alternatives.

This research should help policymakers recognise when and how EbA can be effective and enable them to integrate, where appropriate, EbA principles and approaches into national and international climate adaptation policy and planning processes, such as national adaptation plans. The UNFCCC has suggested that "countries should consider EbA in their approach to adaptation, including in national adaptation plans" (UNFCCC 2017). Given the perceived ability of EbA to meet the three criteria developed to assess EbA effectiveness demonstrated by this research, we strongly support this view.

Appendices

Appendix 1: Glossary of key technical terms

Adaptive capacity: The ability to shape, create or respond to longer term change in addition to bouncing back from shocks. Strengthens resilience and reduces vulnerability to a wide range of hazards. Requires information plus the capacity and opportunity to learn, experiment, innovate and make decisions. The number, diversity and distribution of assets and resources of the five livelihood capitals facilitates alternative strategies:

1. Human capital represents the skills, knowledge, ability to work and good health that together enable people to pursue different livelihood strategies and achieve their livelihood objectives
2. Social capital means the social resources that support people in pursuit of their livelihood objectives
3. Physical capital comprises the basic infrastructure and goods needed to support livelihoods
4. Natural capital means the stocks from which ecosystem services flow, and
5. Financial capital denotes the financial resources that people use to achieve their livelihood objectives.

Source: Adapted from Ayers et al. (2012) and Ensor and Berger (2009)

Biodiversity: The variability among living organisms from all sources including terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are part. It also includes diversity within and among species and diversity within and among ecosystems.

Source: MEA (2005)

Community-based adaptation: A community-led process, based on communities' priorities, needs, knowledge and capacities, which should empower people to plan for and cope with the impacts of climate change.

Source: Reid et al. (2009)

Ecosystem services: The benefits people obtain from ecosystems. These include provisioning services such as food and water; regulating services such as flood and disease control; cultural services such as spiritual, recreational, and cultural benefits; and supporting services such as nutrient cycling that maintain the conditions for life on Earth. Some ecosystem services can enhance people's capacity to adapt to climate change.

Source: MEA (2005)

Indigenous or local knowledge: Knowledge that is unique to a given culture or society. It is the basis for local-level decision making in agriculture, healthcare, food preparation, education, natural resource management and a host of other activities in rural communities. It contrasts with the international knowledge system generated by universities, research institutions and private firms.

Participatory approaches: A range of approaches involving communities in project planning and implementation that can include:

- Passive approaches, where people are told what is going to happen or has already happened
- Information giving, where people answer questions posed by extractive researchers (they cannot influence proceedings and research findings may not be shared with them)
- Consultation by external professionals, who define both problems and solutions; in these cases, decision making is not shared and professionals are under no obligation to take on board people's views
- Providing resources such as labour in return for food, cash or other material incentives
- Functional approaches, where people form groups to meet predetermined objectives related to the project, usually during later project cycle stages after major decisions have been made
- Interactive approaches, where people participate in joint analysis, which leads to action plans and the formation of new local institutions or the strengthening of existing ones as groups take control over local decisions, giving people a stake in maintaining emerging structures or practices, and
- Self-mobilisation, where people take initiatives independently of external institutions, developing contacts with external institutions for the resources and technical advice they need, but retaining control over how they use resources.

Source: Adapted from Adnan et al. (1992) and Dazé et al. (2009)

Resilience (ecosystem): A system's capacity to tolerate impacts of drivers without irreversible change in its outputs or structure.

Source: MEA (2005)

Resilience (human): The ability to absorb shocks or ride out changes while also moving beyond short-term coping strategies and a return to the status quo to longer-term development in spite of (or in light of) climate change. Important components of resilience include having diverse assets or livelihood strategies to reduce vulnerability to a wide range of hazards, good connectivity between institutions and the degree of social inclusion and social capital.

Source: Ayers et al. (2012) and Ensor and Berger (2009)

Vulnerability: Vulnerability to climate change is assessed in reference to a hazard – such as flooding – and considers underlying human and environmental factors. It is affected by exposure to a hazard, which is often related to geographic location, such as living in a flood-prone area, and the sensitivity of the community affected – for example, a community dependent on rain-fed agriculture will be more sensitive to changes in rainfall.

Source: Ayers et al. (2012) and Ensor and Berger (2009)

Wellbeing: A context- and situation-dependent state, comprising basic material for a good life, freedom and choice, health, good social relations and security.

Appendix 2: Questionnaire for assessing EbA effectiveness

1. Effectiveness for human societies: Did the initiative allow human communities to maintain or improve their adaptive capacity or resilience, and reduce their vulnerability in the face of climate change, while enhancing co-benefits that promote long-term wellbeing?	
1.1 Does/did the EbA initiative maintain or improve the resilience and adaptive capacity of local communities, and help the most vulnerable (eg women, children and indigenous groups)? If so, over what timeframes are/were these benefits felt, and are/were they equitably distributed among different social groups?	
a. How did/does the EbA initiative affect the resilience of local communities? (Circle which one applies and provide details if possible)	*Resilience improved; resilience unaffected; resilience declined*
b. How did/does the EbA initiative affect the adaptive capacity of local communities? (Circle which one applies and provide details if possible)	*Adaptive capacity improved; adaptive capacity unaffected; adaptive capacity reduced*
c. How did/does the EbA initiative affect the vulnerability of local communities? (Circle which one applies and provide details if possible)	*Vulnerability reduced; vulnerability unaffected; vulnerability increased*
d. Which particular social groups experienced changes in resilience, adaptive capacity or vulnerability as a result of the initiative? (Circle all that apply and provide details if possible)	*Poorest and most vulnerable people; women; children; elderly; indigenous groups; other (please specify)*
e. Were/are there trade-offs (or synergies) in terms of who experiences changes in resilience, adaptive capacity or vulnerability, particularly with regards to the poorest and most vulnerable? (For example, are adaptation benefits accrued by one social group whilst others are excluded?)	*No/yes*
f. If yes, please provide details	
g. Were/are there trade-offs (or synergies) in terms of where changes in resilience, adaptive capacity or vulnerability occur? (For example, are adaptation costs/benefits accrued by communities in one area at the cost of those in another?)	*No/yes*
h. If yes, please provide details	
i. Were/are there trade-offs (or synergies) in terms of when changes in resilience, adaptive capacity or vulnerability occur? (For example, are changes short term and/or long term?)	*No/yes*
j. If yes, please provide details	

1.2 Did any social co-benefits arise from the EbA initiative, and if so, are/were they equitably distributed among different social groups?	
a. What, if any, social co-benefits arise/arose from the EbA initiative? (Circle all that apply and provide details of each if possible)	*Disaster risk reduction; livelihood provision/diversification; market access; food security; health benefits; sustainable water provision; security; reduced conflict over resources; improved social cohesiveness; improved policies; improved governance; knowledge enhanced; climate change mitigation; other (please specify)*
b. Do some social groups benefit more from these co-benefits than others?	*No/yes*
c. If yes, please provide details	
1.3 What role in the EbA initiative did stakeholder engagement through participatory processes and local/indigenous knowledge play? Did/does the use of participatory processes support the implementation of EbA and build adaptive capacity?	
a. Does/did the initiative incorporate local/indigenous knowledge or practices?	*Yes/no*
b. If yes, please provide details	
c. What type of participatory processes engaged the local community in the initiative? (Circle one. See glossary for typology of participatory approaches)	*None; passive; information giving; consultation by external professionals; for material incentives; functional (ie in implementation); interactive; self-mobilisation; other (please specify)*
d. If participatory processes were used, did they support the implementation of EbA and build adaptive capacity?	*Yes/no*
e. If yes, please provide details	
2. Effectiveness for the ecosystem: Did the initiative restore, maintain or enhance the capacity of ecosystems to continue to produce ecosystem services for local communities, and allow ecosystems to withstand climate change impacts and other pressures?	
2.1 What were/are the factors having an impact on local ecosystem(s)? How did/do these pressures affect the resilience of the ecosystem(s) to climate change and other pressures and their capacity to deliver ecosystem services over the long term?	
a. What were/are the factors having an impact on the local ecosystem(s)? (Circle all that apply)	*Climate change; nutrient pollution; land conversion leading to habitat change; overexploitation; invasive species; disease; weak governance, institutions or legal framework; other factors (please specify)*
b. How did/do these pressures affect ecosystem(s) and landscapes and their ability (or not) to adapt to climate change and other stresses?	
c. How did/do these pressures affect the capacity of the ecosystem(s) to deliver ecosystem services?	

d. Are there any boundaries that influence ecosystem resilience? (For example, is there a minimum ecosystem size or water catchment area that needs to be protected to ensure ecosystem resilience and continued service delivery? Are there processes occurring outside the project area that affect project ecosystem resilience and service delivery?)	*Yes/no*
e. If yes, please detail	
f. Are there thresholds beyond which the ecosystems can no longer provide key ecosystem services? (For example, are there degrees of temperature change, degradation/exploitation, sea level rise or salinity that irreversibly alter ecosystem structure and functioning?)	*Yes/no*
g. If yes, please detail	
2.2 After the EbA initiative, which ecosystem services were maintained, restored or enhanced, and did the resilience of the ecosystem change? Over what geographic scale(s) and time frame(s) were these effects felt, and were there trade-offs (or synergies) between the delivery of different ecosystem services at these different scales?	
a. After the initiative how did ecosystem resilience change? (Circle one)	*Resilience improved; resilience unaffected; resilience declined*
b. After the initiative were ecosystem services maintained, restored or enhanced?	*Yes/no*
c. If yes, which ecosystem services were maintained, restored or enhanced? (Circle all that apply and provide detail on each if possible)	*Provisioning (eg food, water, wood, fibre, fuel); regulating (eg climate regulation, flood regulation, water purification, disease regulation); cultural (eg spiritual, aesthetic, recreation, education); supporting (eg primary production, soil formation, nutrient cycling); other (please specify)*
d. At what geographic scale(s) were ecosystem services maintained, restored or enhanced?	*Local village/area; watershed; forest; mountainous region; other (please specify)*
e. Were/are there trade-offs (or synergies) between the delivery of different ecosystem services at different geographical scales? (For example, are there trade-offs/synergies between water security at the project site and 'downstream' or in neighbouring ecosystems/watersheds, or trade-offs/synergies between an ecosystem service such as water security in one area with agricultural productivity in another?)	*Yes/no*
f. If yes, please detail	
g. Over what time frame(s) were/will ecosystem services be maintained, restored or enhanced? (Please specify for each service)	*0-1 year; 1-2 years; 2-5 years; 5-10 years; 10+years*

h. Were/are there trade-offs (or synergies) between the delivery of different ecosystem services at these different timescales? (For example, does the initiative meet current needs, whilst compromising the ability to address future needs, or vice versa?)	*Yes/no*
i. If yes, please detail	
3. Financial effectiveness: Is EbA cost-effective and economically viable over the long term?	
3.1 What are the general economic costs and benefits of the EbA initiative? How cost-effective is it, ideally in comparison to other types of interventions, and are any financial or economic benefits sustainable over the long term?	
a. Is there evidence about how cost-effective (in terms of initiative financial costs and benefits) the EbA initiative was/is?	*No/yes*
b. If yes, please provide details of any formal cost-benefit analysis conducted, or any less formal estimates of project costs and benefits.	
c. Was the EbA approach compared to any other types of interventions or approaches (eg infrastructure, community services, inaction etc)?	*No/yes*
d. If yes, how cost-effective was/is the EbA initiative compared to other interventions/approaches? (Circle one and provide details if possible)	*More cost-effective; costs and benefits roughly equivalent; less cost-effective*
e. Are there any broader economic costs and benefits from the EbA initiative (these go beyond project operational costs and profits?)	*No/yes*
f. If yes, please specify. (Circle all that apply and provide details if possible).	*Avoided/increased losses from disaster risks; avoided/increased costs of using man-made systems instead of ecosystem services; land or service value increases/decreases; local income enhancement/ reduction; opportunity costs when other land uses are not taken up; other (please specify)*
g. Please quantify and provide evidence regarding the above economic costs and benefits where possible.	
h. Were/are there financial/economic trade-offs (or synergies) between management at different geographical scales? (For example, are financial/ economic gains/losses accrued outside the project site?)	*No/yes*
i. If yes, please detail.	
j. Have/do financial/economic benefits and costs change(d) over time? (For example, are financial/ economic benefits short lived or long term?)	*No/yes*
k. If yes, please detail.	

4. Policy and institutional issues: What social, institutional and political issues influence the implementation of effective EbA initiatives and how might challenges best be overcome?	
4.1 What are the key policy, institutional and capacity barriers to, or opportunities for, implementing EbA at the local, regional and national levels over the long term?	
a. What were/are the key policy, institutional and capacity barriers to implementing EbA at the local level? (Circle all that apply, order in terms of importance and provide details if possible)	*Knowledge unavailable; financial resources unavailable; technical skills unavailable; key stakeholders lack the authority to take the actions needed/planned; mandates unclear; insufficient implementation capacity; weak institutions; insufficient cross-sectoral institutional or inter-ministerial collaboration; weak or no collaborative cross-sectoral legal frameworks; unsupportive donor/government policy; low donor/government priority; other (please specify)*
b. What were/are the key policy, institutional and capacity barriers to implementing EbA at the provincial/state/sub-national/regional level? (Circle all that apply, order in terms of importance and provide details if possible)	*Knowledge unavailable; financial resources unavailable; technical skills unavailable; key stakeholders lack the authority to take the actions needed/planned; mandates unclear; insufficient implementation capacity; weak institutions; insufficient cross-sectoral institutional or inter-ministerial collaboration; weak or no collaborative cross-sectoral legal frameworks; unsupportive donor/government policy; low donor/government priority; other (please specify)*
c. What were/are the key policy, institutional and capacity barriers to implementing EbA at the national level? (Circle all that apply, order in terms of importance and provide details if possible)	*Knowledge unavailable; financial resources unavailable; technical skills unavailable; key stakeholders lack the authority to take the actions needed/planned; mandates unclear; insufficient implementation capacity; weak institutions; insufficient cross-sectoral institutional or inter-ministerial collaboration; weak or no collaborative cross-sectoral legal frameworks; unsupportive donor/government policy; low donor/government priority; other (please specify)*
d. What were/are the key policy, institutional and capacity opportunities for implementing EbA at the local level? (Circle all that apply, order in terms of importance and provide details if possible)	*EbA 'champions'; government prioritisation; appropriate incentives in place to motivate action; strong local institutions; strong local governance/bylaws; other (please specify)*
e. What were/are the key policy, institutional and capacity opportunities for implementing EbA at the provincial/state/sub-national/regional level? (Circle all that apply, order in terms of importance and provide details if possible)	*EbA 'champions'; government prioritisation; appropriate incentives in place to motivate action; strong regional institutions; strong regional policy/legislation; other (please specify)*
f. What were/are the key policy, institutional and capacity opportunities for implementing EbA at the national level? (Circle all that apply, order in terms of importance and provide details if possible)	*EbA 'champions'; government prioritisation; appropriate incentives in place to motivate action; strong national institutions; strong national policy/legislation; other (please specify)*

g. Is/was the local level policy, institutional and capacity support available enough to ensure the initiative can be sustainable over the long term?	*Yes/no*
h. Please provide details.	
i. Is/was the provincial/state/sub-national/regional level policy, institutional and capacity support available enough to ensure the initiative can be sustainable over the long term?	*Yes/no*
j. Please provide details.	
k. Is/was the national policy, institutional and capacity support available enough to ensure the initiative can be sustainable over the long term?	*Yes/no*
l. Please provide details.	
4.2. What (if any) opportunities emerged for replication, scaling up or mainstreaming the EbA initiative or for influence over policy, and how?	
a. Did any opportunities emerge for replication, scaling up or mainstreaming the EbA initiative or for influencing government/donor policy?	*Yes/no*
b. If yes, please detail. (Circle all that apply, order in terms of importance and provide details if possible).	*National policy change leading to widespread national roll out; inclusion in NAP/INDC; change in attitude to EbA from policy makers/planners; stronger links forged between relevant government bodies supports cross-sectoral planning; change in donor policy and hence in-country funding; new tools developed to support replication; other (please specify)*
4.3 What changes in local, regional and/or national government or in donor policies are required to implement more effective EbA initiatives?	
a. What changes in local, regional and/or national government or in donor policies are required to implement more effective EbA initiatives?	*Local:* *Regional:* *National government:* *Donor:*

Source: Reid et al. (2017)

Appendix 3: EbA case studies selected for research

Country and case study reference	In-country partner	EbA project	Project timeline	Project aims and activities
China Reid and Zhang (2018)	Centre for Chinese Agricultural Policy, Chinese Academy of Science	Participatory plant breeding and community supported agriculture in Southwest China	2000–2016	The project aimed to improve and conserve crop varieties (especially maize, wheat, rice and soybean) that were tailored to local conditions (especially drought) using local landraces. It also aimed to conserve crop diversity and resilient landraces for food security and climate adaptation. It worked to link local and formal seed systems through direct collaboration on participatory plant breeding, raising awareness on the need to conserve landraces for adaptation within formal agricultural research systems, improving policy support for genetically diverse local seed systems and securing farmers' rights to benefit from these. The project also promoted climate-resilient and nutrition-sensitive agroecological farming practices by improving links to urban markets.
Nepal Reid and Adhikari (2018)	IUCN	Ecosystem-based adaptation in mountain ecosystems programme	2011–2016	The project aimed to enhance the ability of decision makers to plan and implement EbA strategies and measures at national and ecosystem levels. Stakeholders targeted by the project included vulnerable, marginalised and poor communities from the Panchase Protected Forest area and local-and national-level policymakers and decision makers. EbA measures implemented under the project included: • Maintaining and restoring ecosystems through agroforestry, forest resource conservation and fodder species and broom grass plantations, particularly along roadsides to reduce landslides. • Restoring wetlands, springs and ponds to ensure year-long water supplies. • Soil nutrient management by promoting organic soil nutrient use (compost dung and animal urine) to maintain and enhance soil health, increase crop productivity and increase soil moisture during dry periods. • Strengthening homestay businesses to diversify livelihoods and build local people's resilience to climate change.

Country and case study reference	In-country partner	EbA project	Project timeline	Project aims and activities
Bangladesh Reid and Ali (2018)	Bangladesh Centre for Advanced Studies	The incentive-based hilsa conservation programme	2003 and ongoing	Concerns about collapse of the hilsa fishery prompted the Bangladesh government Department of Fisheries to establish the Hilsa Fisheries Management Action Plan in 2003, which involved: • Declaring five sanctuary sites in the coastal areas of Bangladesh to reduce pressure on the *jatka* (juvenile hilsa). All forms of fishing are banned in the sanctuaries at certain times of the year to coincide with peak *jatka* abundance. • Establishing four nationally important spawning grounds covering an area of 6,900 square kilometres in the Meghna River estuary. • Implementing a fishing ban for 11 days (later extended to 15) in October in these spawning grounds to conserve brood fish and allow for uninterrupted spawning. • Enforcing the Protection and Conservation of Fish Act (1950) — for example, banning nets with small mesh sizes that catch juvenile fish. • Compensating fishers affected by the ban. The government gave affected fisher communities (186,000 households, increasing to 224,000 households by 2016) 30kg (later increased to 40kg) of rice per household per month through its Vulnerable Group Feeding Programme, support for alternative income-generating activities such as sewing and better access to microcredit. • Efforts to generate awareness and support for the fishing bans included using boat rallies, mass media, leaflet distribution, posters and involving public representatives in management interventions. The Department of Fisheries also introduced special measures for protecting the *jatka*, formulating a specific act for these measures in 2003.

Country and case study reference	In-country partner	EbA project	Project timeline	Project aims and activities
Kenya Reid and Orindi (2018)	Adaptation Consortium; Kenya Drought Management Authority	Supporting counties in Kenya to mainstream climate change in development and access climate finance project	2013–2016	The Adaptation Consortium aims to prepare county governments to access global climate finance to support adaptation and climate-resilient development and mainstream mechanisms that allow communities to prioritise investments in public goods that build their resilience to climate change. EbA-related activities funded under the first round of the Isiolo County Climate Change Fund disbursements include: • Rehabilitating, fencing and/or building 11 sand dams, 4 water pans, 2 shallow wells and 1 water tank, with accompanying water governance activities • Drilling a borehole in a strategic drought reserve, allowing access to pastures during difficult times, thereby reducing livestock mortality and asset loss • Sealing off an existing water pan in a dry season grazing reserve, which will leave an existing borehole as the reserve's only water source • Funding for planning meetings and the operational costs of four customary range management institutions (*dedha*) • Workshop to integrate climate change into the Isiolo County Integrated Development Plan 2013–2017, and • Developing, together with the Kenya Meteorological Department, the County Climate Information Services Plan and establishing a community radio station in Garbatulla to enhance access to climate and other development and governance-related information.
South Africa Reid, Scorgie, Muller and Bourne (2018)	Conservation South Africa	Climate resilient livestock production on communal lands: rehabilitation and improved management of dryland rangelands in the Succulent Karoo	2011–2015 (with ongoing work funded in 2016)	The project aimed to rehabilitate 25,000 hectares of communal rangeland to improve livelihood security for the 100 farmers who rely on it. As a result of the arid nature of the Succulent Karoo biome, pastoralists have adopted opportunistic strategies in their use of available natural resources and they rely on the wetlands of the Kamiesberg uplands as part of their seasonal grazing system. Small, ephemeral wetlands are a source of both livestock drinking water and fodder during the dry summer months, and as such are critical for maintaining livestock stocking rates throughout the year. These wetlands are extensively degraded. The project also aimed to rehabilitate wetlands in the Kamiesberg uplands with a view to supporting adaptation to the predicted impacts of climate change on livestock-carrying capacities in the Leliefontein communal area.

Country and case study reference	In-country partner	EbA project	Project timeline	Project aims and activities
Uganda Reid, Kutegeka and Busingye (2018)	IUCN	Ecosystem-based adaptation in mountain ecosystems programme	2011–2016	The project aimed to help rural vulnerable mountain communities in the Mount Elgon region adapt to the adverse impacts of climate change by conserving, managing, restoring and maintaining ecosystem services and biodiversity, and enhancing adaptive capacities, as part of overall local and national adaptation strategies. EbA measures implemented under the project include: improved water retention through roadside drainage bunds and run-off retention drains; a gravity flow engineered irrigation scheme, combined with reforestation, soil and water conservation and riverbank restoration to create a hybrid grey-green solution to catchment-scale water management; and tree-planting using an agroforestry approach to stabilise soil and reduce landslides.
Burkina Faso Reid, Savadogo and Somda (2018)	IUCN	Ecosystems protecting infrastructure and communities (EPIC): strengthening local climate change adaptation strategies in West Africa	2013–2017	The project aimed to diversify and strengthen the actors (and their strategies) involved in the prevention of, and adaptation to, climate change impacts on livelihoods and natural resources. EPIC project activities were implemented in Yatenga and Lorum provinces. Combined climate-smart agriculture and EbA techniques adopted under EPIC to address droughts and floods included: • Soil protection and restoration and water conservation techniques, such as using stone bunds, *zaï* and half-moons (farming techniques that concentrate compost and prevent water run-off during rains) • Reforestation and farmer-managed natural cropland regeneration • Riverbank and dam bank protection • Biodigestors • Organic gardening, including establishing 56 manure pits, and • Artificial pools (*boulis*) constructed to collect run-off water.

Country and case study reference	In-country partner	EbA project	Project timeline	Project aims and activities
Senegal Reid and Ballé Seye (2018)	IUCN	Ecosystems protecting infrastructure and communities (EPIC)	2012–2017	The project aimed to build community resilience by implementing nature-based solutions to disaster risk reduction and climate change adaptation. Activities implemented in Djilor District, in Senegal's Fatick region, included: • Building 76 traditional anti-salt bunds (called *diguettes* or *fascines*) to reduce salt intrusion and soil erosion and increase water infiltration • Establishing two nurseries — these have produced some 1,766 plants, which have been planted on degraded lands, increasing the community's nursery production capacity and improving plant cover in agroforestry areas • Applying assisted natural regeneration techniques to conserve forest resources and restoring vegetation cover using local species to combat water and wind erosion • Reforestation activities in two villages • Introducing 120 roosters of the stronger and better Blue Holland variety as an income-generating livelihood strategy for women • Vegetable gardening to diversify and improve livelihoods, and • Establishing mechanisms for regulating the exploitation of natural resources. This included developing action plans for activities such as stone bund construction and strategies for training and exchange visits.
Peru Reid, Podvin and Segura (2018)	IUCN	Ecosystem-based adaptation in mountain ecosystems Programme	2011–2016	EbA measures implemented in the Nor Yauyos-Cochas Landscape Reserve included: • Restoring water channels and reservoirs to support micro-watersheds and wetlands to secure water provision for the reserve's communities and downstream users (Canchayllo and Miraflores) • Grassland management to enhance pastoral livelihoods and increase resilience to drought and frost (Canchayllo, Miraflores and Tanta), and • Vicuña management to produce animal fibre for livelihoods and communal livestock management in natural grasslands (Tanta).

Country and case study reference	In-country partner	EbA project	Project timeline	Project aims and activities
Peru Reid, Argumedo and Swiderska 2018)	ANDES	Potato Park	2000 and ongoing	Located in Peru's Cusco region. At altitudes ranging between 3,400 and 4,600 metres above sea level, the park spans a territory of more than 9,000 hectares. Managed by indigenous communities rather than governments, it is governed collectively by a legally registered Association of Communities of the Potato Park, which has a communal land title. The park focuses on protecting and preserving the critical role and interdependency of indigenous biocultural heritage for local rights, livelihoods, conservation and sustainable agrobiodiversity use. By sustaining diverse locally adapted crop varieties and ancestral knowledge about adaptation to climate change and resilient agroecological farming practices, the Potato Park supports adaptation by highland communities, which have already been significantly impacted by changes in climate. By sustaining evolving crop wild relatives and co-evolutionary processes whereby farmers select and improve local germplasm in extreme conditions, the park also provides a reservoir of resilient genetic resources for national and global adaptation and for maintaining future options.
Chile Reid and Podvin (2018)	IUCN	Ecosystems protecting infrastructure and communities (EPIC), South America geographical component	2012–2017	EPIC aimed to build community resilience by implementing nature-based solutions to disaster risk reduction and climate change adaptation. The overall goal was to promote the conservation of forest ecosystem services as an integral part of policies, strategies and programmes for disaster risk reduction and climate change adaptation. Specific project goals in Chile's Corredor Biológico Nevados del Chillán – Laguna del Laja Biosphere Reserve in the Biobío Region were to: 1. Demonstrate the importance of sustainable ecosystem management as an alternative to disaster risk reduction and climate change adaptation 2. Strengthen capacities and sensitise and communicate about the potential of sustainable ecosystem management for disaster risk reduction and climate change adaptation, and 3. Disseminate through multi-stakeholder platforms, lessons learned and practical solutions that can be replicated or used as inputs for programmes and public policies.

Country and case study reference	In-country partner	EbA project	Project timeline	Project aims and activities
Costa Rica/ Panama Reid, Pérez de Madrid and Ramírez (2018a)	IUCN	Adaptation, Vulnerability and Ecosystems (AVE) project site: the Sixaola River Basin (Costa Rica and Panama)	2015–2018	This project is in the middle basin area of the binational Sixaola River basin. Local-level project activities involve: • Design and implementation of integrated farming involving: crop diversification; using local biodiversity and germplasm with local seeds, basic grains, roots, tubers, forage species and so on; restoring the water basin ecosystem (riparian forest) with timber and local fruit trees; improving cocoa production; agroforestry; and improving local capacities for water governance. • Training for farmers, municipalities, youth groups and binational institutions and • Establishing local timber and fruit tree nurseries.
El Salvador Reid, Pérez de Madrid and Ramírez (2018b)	IUCN	The Governance for Ecosystem-based Adaptation: Transforming Evidence into Change project	2015–2018	The project learning site in the lower basin and coastal area of the Paz River. The objective of local EbA interventions targeting the coastal local communities of Garita Palmera, El Tamarindo and Bola de Monte was to improve mangrove management and restore water flows, with a view to building adaptive capacity through action learning. Local-level EbA measures implemented under the project include: 1. Unblocking channels and removing silt in mangrove canals to recover the hydrodynamics of the ecosystem, so freshwater can enter the mangroves and restore the optimum level of salinity in the system 2. Reforesting degraded mangrove areas 3. Community surveillance to prevent the indiscriminate felling of mangroves and the excessive extraction of crabs, fish and other natural resources and to protect newly planted seedlings in reforested areas, and 4. Design and implementation of a local plan for sustainable extraction to regulate the extraction of fish, crustaceans, mammals and so on from the mangrove ecosystem.

Appendix 4: Questions for assessing EbA effectiveness using non-technical language

Questions	Link to Appendix 2 questionnaire
The local ecosystem	
What pressures are there on local ecosystems (communities of plants and animals in an area) and landscapes?	2.1 a
How do these pressures affect you and your wellbeing?	2.1 b, c
What sorts of ecosystem benefits and functions returned after the project (eg food, water, wood provision; flood/disease control; spiritual, recreational and cultural benefits; and healthy soils/air/water)?	2.2 b, c
What sort of geographical area did these benefits cover?	2.2 d
How long do you think these benefits will last?	2.2 g
Benefits to people	
How does the project affect whether people can cope with the impacts of climate change?	1.1 a, b, c
How does the project help poor people, women, children, the elderly and indigenous groups cope with the impacts of climate change?	1.1 d
Do some people benefit more than others?	1.1 e
Do people in some places benefit more than people in other places?	1.1 g
Do people benefit now or later?	1.1 i
How else does the project benefit communities? (Eg are disasters less frequent? Are livelihoods, food security or market access better? Are there health benefits? Are water sources better? Are local/national institutions better? Is conflict reduced? Is social cohesion better? Is security improved? Are people more knowledgeable?)	1.2 a
Do some people get more of these other project benefits than other people?	1.2 b
How were communities involved in project planning and implementation? (Were communities told what was going to happen without opportunities to shape the project? Did they give information to researchers without opportunities to shape the project? Did they get money or food for working on the project? Did they help the project meet its predetermined objectives? Did they help analyse challenges, participate in project decision making and help create project plans?)	1.3 c
How does involving the community affect whether people can cope with the impacts of climate change?	1.3 d

Source: Reid et al. (2017)

Appendix 5: Stakeholders interviewed for each case study

Case study	Stakeholders interviewed at different levels for each case study			
	National	**Local government**	**Implementing partners**	**Community**
China	Representatives from the Chinese Academy of Agricultural Sciences; the Chinese Academy of Science	Representatives from the Research Institute of Guangxi Academy of Agricultural Science	Representatives from the Agricultural Policy Research Center of the Chinese Academy of Science, the Centre for Chinese Agricultural Policy at the Chinese Academy of Science, the Beijing Liangshuming Rural Reconstruction Center, and Third World Network	Representatives from Guzhai Village, Mashan County, Guangxi Province, and also the leaders of the Nonglvtun women-led Cooperative, Hongdu Village, Duan County, Guangxi Province. Interviews were also conducted in the Youmi, Wumu and Stone Villages, Yunnan Province
Nepal	Stakeholders from the Ministry of Population and Environment, the Ministry of Forest and Soil Conservation, the Department of Forests, the national NGOs Green Governance Nepal (GGN) and the Institute for Social and Environmental Transition (ISET Nepal), and the deputy chair of the IUCN Commission on Ecosystem Management	Stakeholders from the District Forest Office, the District Soil Conservation Office, the District Agriculture Office and the Institute of Forests	Stakeholders from the Panchase Protected Forest Council, the Machapuchhre Development Organisation and Aapasi Sahayog Kendra	Chairperson of the mothers' group; the Village Development Committee secretary; members of the Panchase Protected Forest Council. Focus group discussions with a mother's group, a youth club, local leaders, a disadvantaged community (the Dalit community), teachers, a group of elders and a homestay group

Case study	Stakeholders interviewed at different levels for each case study			
	National	**Local government**	**Implementing partners**	**Community**
Bangladesh	Additional Secretary, Ministry of Fisheries and Livestock; Director General, Department of Fisheries; Director, Hilsa Fisheries Management, Department of Fisheries; Chief (Fisheries Sector), Planning Commission; Director (Planning), Department of Environment; Director General, Bangladesh Fisheries Research Institute; Principal Scientific Officer, Bangladesh Fisheries Research Institute; Project Director, Jatka Conservation Project (Department of Fisheries)	District Fisheries Officer (Chandpur, Laxmipur, Barisal, Bhola, Patuakhali Districts), Deputy Commissioner (Administration – Chandpur, Laxmipur, Barisal, Bhola, Patuakhali Districts), Deputy Director of Fisheries (Barisal Division and Chittagong Division), Chief Scientific Officer (Bangladesh Fisheries Research Institute), and Principal Scientific Officer (Bangladesh Fisheries Research Institute)	The Upazila Nirhabi Officer, who heads the upazila (in each of the five districts), the Upazila Fisheries Officer (one from each of the five districts) and the upazila chairman and/or upazila members. Stakeholders from NGOs (such as the Bangladesh Centre for Advanced Studies, Centre for Natural Resource Studies, Community Development Centre, or CODEC) and local leaders	Fishers association chairman/secretary, fishers community leader, fish traders, aratdar (who receive fish from fishers to sell by auction to wholesalers and sometimes large retailers; they also act as informal money lenders), ice factory owners, hilsa fishers, fisher groups (focus group discussion), fish trader groups (focus group discussion), and women fishers community groups at Barisal and Chandpur
Kenya	Representatives of key organisations in Kenya with knowledge on EbA, including environmental consultants, the Kenya Wildlife Service, the Kenya Forest Service, WWF, National Museums of Kenya, and the Finance Innovation for Climate Change Fund. A national stakeholder workshop held in November 2016 also discussed and validated emerging results	Stakeholders who had participated in fund management	ADA Consortium members working on fund governance	Community members in Kinna and Garba Tula Wards in Garba Tula sub-county with direct knowledge of four Isiolo County Climate Change Fund-funded projects: the Bibi Water pan, the Boji livestock facility, the Kinna customary rangeland management institution and the Garbatulla customary rangeland management institution

Case study	Stakeholders interviewed at different levels for each case study			
	National	Local government	Implementing partners	Community
South Africa	Representatives from the South African National Biodiversity Institute, the adaptation and biodiversity branches of the Department of Environmental Affairs (DEA), Stellenbosch University and independent consultants working with the DEA	Representatives from the provincial and local governments in areas where project activities were implemented: the Namakwa District Municipality, Kamiesberg Municipality and the Northern Cape Department of Environment and Nature Conservation	Conservation South Africa staff and representatives from SaveAct and the Environmental Monitoring Group	Representatives from community groups, including the Manager of the Heiveld Cooperative, Chairperson of the Biodiversity and Red Meat Cooperative, manager/founder of Eco Tourism, and manager/founder of NAM Petroleum
Uganda	Former project technical steering committee members from: the Ministry of Water and Environment, UNDP, the Environmental Conservation Trust of Uganda, the Ministry of Agricultural Animal Industry and Fisheries, the National Forestry Authority, the Office of the Prime Minister, and IUCN	Project focal persons from the local governments in the four districts that participated in project implementation	Leadership of the community-based organisations, community groups and private companies that directly participated in project implementation: Kapchorwa Trinity Radio, Eco Development Foundation, Mount Elgon Beekeeping Community – Sironko, Masaba Foundation for Development, Nature Harness Initiatives and Tree Talk Foundation	Representatives from: the Kapchorwa Community Development Association, Sironko Valley Integrated Project, Kwoti community group, Sangasana Women's Group, Sanzara community group
Burkina Faso	Permanent Secretariat, National Council for Sustainable Development (CNDD); Permanent Secretariat of the National Council for Emergency Relief and Rehabilitation (CONASUR); the Friends of Nature Foundation (NATURAMA – an IUCN member NGO); SOS SAHEL (an NGO)	High commissariat of Titao (Haut-commissariat de Titao); Provincial Directorate of Agriculture of Ouahigouya; Regional Directorate of Animal Resources of Ouahigouya; Association pour la Promotion des OEuvres Sociales (APROS – an NGO in Ouahigouya); Titao Town Hall officials	IUCN staff member	Focus group discussions with the beneficiary communities of Tougou (Yatenga Province) and Sillia (Lorum Province)

Case study	Stakeholders interviewed at different levels for each case study			
	National	**Local government**	**Implementing partners**	**Community**
Senegal	Two officials from the National Committee on Climate Change (Comité National sur les Changements Climatiques – COMNACC), two from the Directorate of Environment and Classified Establishments (Direction de l'Environnement et des Etablissements Classés – DEEC), one from the National Parks Directorate (Direction des Parcs Nationaux – DPN), and one from the Centre of Ecological Monitoring (Centre de Suivi Écologique – CSE)	Officials from the Regional Committee on Climate Change (Comité Régionale du Changement Climatique – COMRECC), the Support Centre for Local Development in Djilor (Centre d'Appui au Développement Local – CADL), Regional Development Agency (Agence Régionale de Développement – ARD), Djilor District officials and departmental authorities	Representatives from the Senegalese Institute of Agricultural Research (Institut Sénégalais de Recherches Agricoles – ISRA), the National Research Institute of Forestry (Centre National de Recherches Forestières – CNRF), the Centre of Ecological Monitoring (Centre de Suivi Écologique – CSE), the Institute of Environmental Sciences (L'Institut des Sciences de l'Environnement – ISE), the National Agency of Agricultural and Rural Council (Agence Nationale de Conseil Agricole et Rural – ANCAR) and World Vision	Head community members were interviewed and focus group discussions were held with groups representing women, men, the elderly and the young in the five project villages (Sadioga, Péthie, Kamatane Bambara, Djilor and Goudème Sidy)
Peru (EbA in mountain ecosystems Programme)	Stakeholders from the Ministry of Environment (MINAM) and The National Service of Natural Protected Areas (SERNANP)	The head and staff of the Nor Yauyos-Cochas Landscape Reserve (NYCLR), as well as local authorities from both communities	Staff members from The Mountain Institute (TMI), UNDP and IUCN	Local researchers from Canchayllo and Miraflores, and also members of both communities. Some 16 people from Canchayllo and 16 from Miraflores attended focus group discussions
Peru (Potato Park)	An IIED researcher		A member of Asociación para la Naturaleza y el Desarrollo Sostenible (ANDES)	

Case study	Stakeholders interviewed at different levels for each case study			
	National	**Local government**	**Implementing partners**	**Community**
Chile	Representative from the Ministry of Environment, the project political partner at the national level	Stakeholder from the Regional Environmental Secretariat of the Ministry of Environment (Region Biobío)	Swiss Institute for Snow and Avalanche Research and IUCN staff from headquarters, the regional office in South America and in-country support (a consultant)	
Costa Rica / Panama	Officials from the Regional Área de Conservación Amistad Caribe Sistema Nacional de Áreas de Conservación, the Comisión Binacional Río Sixaola, Minsterio de Agricultura y Ganadería and the Talamanca Instituto Nacional de Desarrollo Rural	Officials from the Asociación de Desarrollo Integral del Territorio Indígena Bribri, Alcaldia Municipal de Talamanca and the Asociación de Desarrollo Integrar del Territorio Indigena Cabécar	IUCN officials involved with the project, and Asociación de Organizaciones del Corredor Biológico Talamanca Caribe (ACBTC) officials	Local community members from El Guabo, Yorkín, Paraíso and the Bribri community
El Salvador	Government officials from the Ministry of Environment and Natural Resources (MARN) and the Ministry of Agriculture and Livestock; staff member from the Centro de Tecnología Agropecuaria y Forestal (CENTA) – a research organisation operating in the River Paz area	Official from the Alcaldía Municipal de San Francisco Ménendez	Unidad Ecológica Salvadoreña (UNES) staff members	Members of the Istatén Association (Asociación Comunitaria para la Protección Ambiental Marino Costera de Ahuachapán Sur) and the River Aguacate Micro-Watershed Committee

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Knowledge Products

Research Report

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The global climate is changing rapidly and countries need clear direction on how best to adapt to these changes. Ecosystem-based adaptation (EbA) is becoming an increasingly popular strategy, especially in poor countries where dependence on natural resources for lives and livelihoods is high. But EbA implementation is neither widespread nor consistent, partly due to a shortage of documented evidence relating to its effectiveness. This report shares results from research assessing EbA effectiveness at 13 case study sites in 12 countries to help address this gap. It also describes political, institutional and governance-related conditions that facilitate or inhibit effective EbA at each site.

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