Ecosystem-based adaptation: a handbook for EbA in mountain, dryland and coastal ecosystems

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ACRONYMS

AI	Aridity index
ALivE	Adaptation, Livelihoods and Ecosystems Planning Tool
BRACED	Building Resilience and Adaptation to Climate Extremes and Disasters project
CbA	Community-based adaptation
CBD	Convention on Biological Diversity
CBO	Community-based organisation
CBNRM	Community-based natural resource management
CCAP	Center for Chinese Agricultural Policy, Chinese Academy of Sciences
CVCA	Climate vulnerability and capacity analysis framework
DCF	Decentralised climate funds
DFID	UK Department for International Development
DRR	Disaster risk reduction
EbA	Ecosystem-based adaptation
EPIC	Ecosystems Protecting Infrastructure and Communities project
FGD	Focus group discussion
FPIC	Free prior and informed consent
GDP	Gross domestic product
GFS	Gravity flow scheme
GIZ	German Agency for International Cooperation
GPS	Global Positioning System
IIED	International Institute for Environment and Development
IISD	International Institute for Sustainable Development
IPCC	Intergovernmental Panel on Climate Change
IPCCA	Indigenous Peoples' Biocultural Climate Change Assessment Initiative
IUCN	International Union for Conservation of Nature
M&E	Monitoring and evaluation
mcm	Million cubic metres
NGO	Non-governmental organisation
PAR	Participatory action research
PES	Payments for ecosystem services
PPB	Participatory plant breeding
PRA	Participatory rural appraisal
PVS	Participatory varietal selection
RRA	Rapid rural appraisal
RSCN	Royal Society for the Conservation of Nature
SDGs	Sustainable Development Goals
SMART	Specific, measurable, attainable, relevant and time-bound
SUMAMAD	Sustainable Management of Marginal Drylands
ToC	Theory of change
UNCCD	UN Convention to Combat Desertification
UNEP	United Nations Environment Programme
UNEP-IEMP	United Nations Environment Programme-International Ecosystem Management Partnership
UNFCCC	United Nations Framework Convention on Climate Change
VIA	Vulnerability and impact assessment
WAPC	Ward adaptation planning committee
WCMC	UN Environment World Conservation Monitoring Centre

GLOSSARY OF KEY TERMS

Biodiversity (biological diversity): The variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems (Convention on Biological Diversity).

Adaptive capacity: The ability of those affected by climate change to continue to realise sustainable development and to reduce and spread risks in the face of continuous change and uncertainty. It enables people to 'bounce back' from shocks and successfully adapt to longer-term trends or changing conditions in the future (Berger *et al.* 2014).

Community-based adaptation (CbA): 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 (Reid *et al.* 2009).

Free prior and informed consent (FPIC): Processes by which communities decide whether or not to allow projects affecting their land or resources to go ahead, and on what terms. The requirement for prior informed consent (PIC) to be 'free' responds to experiences where indigenous peoples have been coerced into giving their consent, rather than being allowed to give it freely or deny consent (Swiderska *et al.* 2012).

Participatory approaches: A range of approaches involving communities in project planning and implementation, from passive participation (where people are informed or provide information) to consultation (where the information provided is used for decision making by others), to collaborative or active participation (where decisions are made with or by local people).

Resilience (ecosystem): The capacity of a system to tolerate impacts of drivers without irreversible change in its outputs or structure (MEA 2005a).

Resilience (human): The ability to not only absorb shocks or ride-out changes, but also to move beyond short-term coping strategies and return to the status quo, in spite of climate change. Important components of resilience include: a diversity of 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 (Ayers *et al.* 2012, Ensor and Berger 2009).

Socioecological systems describes the interplay between social and ecological systems – in other words, between people and nature. The term seeks to demonstrate that delineations between social and ecological systems are artificial and arbitrary: each should be given equal weight (Stockholm University).

Traditional or indigenous knowledge: Knowledge that is produced and transmitted in a traditional context, including ancestral knowledge and new knowledge. It is the basis for local-level decision making in agriculture, healthcare, food, education, natural resource management, and a host of other activities in rural communities.

Vulnerability to climate change is assessed in reference to a particular hazard, such as flooding, and considers underlying human and environmental factors. Vulnerability is affected by exposure to a hazard (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 rainfed agriculture will be more sensitive to changes in rainfall) (Ayers *et al.* 2012, Ensor and Berger 2009).

Preface

Bangladesh. Credit: Md Monirul Islam

Purpose and objectives of the handbook

The purpose of this handbook is to provide a tool to guide the planning and implementation of ecosystem-based adaptation (EbA) in developing countries to help address the growing impacts of climate change.

The handbook provides practical guidance for EbA in drylands, mountains and coastal zones, since these ecosystems and the people living in them are particularly vulnerable to climate change. For each type of ecosystem, it sets out the steps to take when planning and implementing EbA interventions, in order to increase the resilience of vulnerable people through ecosystem management and biodiversity conservation.

Healthy ecosystems are more resilient and can better resist the negative impacts of climate change, thus supporting the people who depend on them. The handbook promotes a bottom-up, community-centred approach to ensure the needs of vulnerable people are addressed and to foster local ownership and sustainability of the EbA process.

The first part of the handbook (Part I) introduces the concept of EbA and is intended for a broad audience, including policymakers. Part II introduces the ecosystems and Part III provides general protocols for EbA planning and implementation in drylands, mountains and coastal zones. These sections are intended for project managers, practitioners and technical specialists in different organisations and sectors – including government, civil society and private-sector organisations, in climate change, natural resources, agriculture, land use, poverty reduction and disaster risk reduction (DRR) sectors.

The handbook complements existing EbA guidance in several ways:

- By fully integrating both the ecosystem and community development aspects of EbA, it complements much technical guidance which already exists.[1]
- By providing ecosystem-specific guidance, it complements generic guidance such as the IIED/IUCN/UNEP-WCMC guidance for assessing EbA effectiveness (Reid *et al.* 2017). See: http://pubs.iied.org/17606IIED
- By focusing on implementation as well as planning, it complements existing tools that focus only on planning, such as the UN Environment/IISD/IUCN software-based tool ALivE – Adaptation, Livelihoods and Ecosystems (Terton and Dazé 2018). See: www.iisd.org/blog/alive-ecosystem-based-adaptation
- By focusing mainly at the landscape/ecosystem level, it complements tools for mainstreaming EbA at higher levels (eg districts or watersheds), such as the GIZ EbA mainstreaming guidance (GIZ 2017).[2] See: http://bit.ly/2GKNEps

The handbook provides links to useful resources and tools (both generic and ecosystem-specific) for each step in the project cycle, drawing on EbA, Community-based Adaptation (CbA) and participatory practice.

1 UNEP-WCMC has collated more than 200 EbA-relevant tools that are categorised according to stages in the project cycle (see UNEP-WCMC *et al.* 2015).

2 The GIZ (2017) EbA mainstreaming guidance is currently being integrated into the CBD (forthcoming 2018) *Guidelines for ecosystem-based approaches to climate change adaptation and disaster risk reduction.* A draft is available here: www.cbd.int/sbstta/sbstta-22-sbi-2/EbA-Eco-DRR-Guidelines-en.pdf. There is also the GIZ (2018a) NDC adaptation toolbox. See: www.adaptationcommunity.net/nap-ndc/ndc-adaptation-toolbox.

Structure of the handbook

- **Part I introduces the concept of EbA and its importance.** It sets out five key principles for effective EbA, based on broad practical experience to date. It introduces the key stakeholders in EbA, the principles of participatory action research (PAR) that underpin a community-led approach, and the importance of also engaging government actors. It highlights the similarities and differences between EbA in drylands, mountain and coastal ecosystems. It also provides an overview of each key step in the EbA planning and implementation process.
- **Part II introduces mountain, coastal and dryland socioecological systems,** their vulnerability to climate change, and the types of EbA activities that have proved effective.
- **Part III provides step-by-step guidance** for planning and implementing EbA interventions on the ground, structured around eight key steps in the project cycle. Each step provides general guidance which is applicable to all three ecosystems, including objectives, a brief overview and key sub-steps, followed by specific guidance and examples for each ecosystem type. The expected outputs and useful tools and resources are also highlighted for each step. Step 6 'Implementing EbA actions on the ground' provides general implementation protocols for 2–3 types of EbA intervention that have proven effective in mountain, coastal and dryland socioecological systems.

How to use this handbook

This handbook provides a practical guide for the design, planning and implementation of EbA projects in specific ecosystems. In Part III, for each ecosystem type it provides guidance structured around eight key steps in the project cycle:

Step 1. Exploring viability and mobilising stakeholders

Step 2. Understanding the ecosystem and livelihoods context

Step 3. Analysing climate risks and vulnerability

Step 4. Understanding the role of ecosystem services in adaptation

Step 5. Identifying and designing priority EbA actions

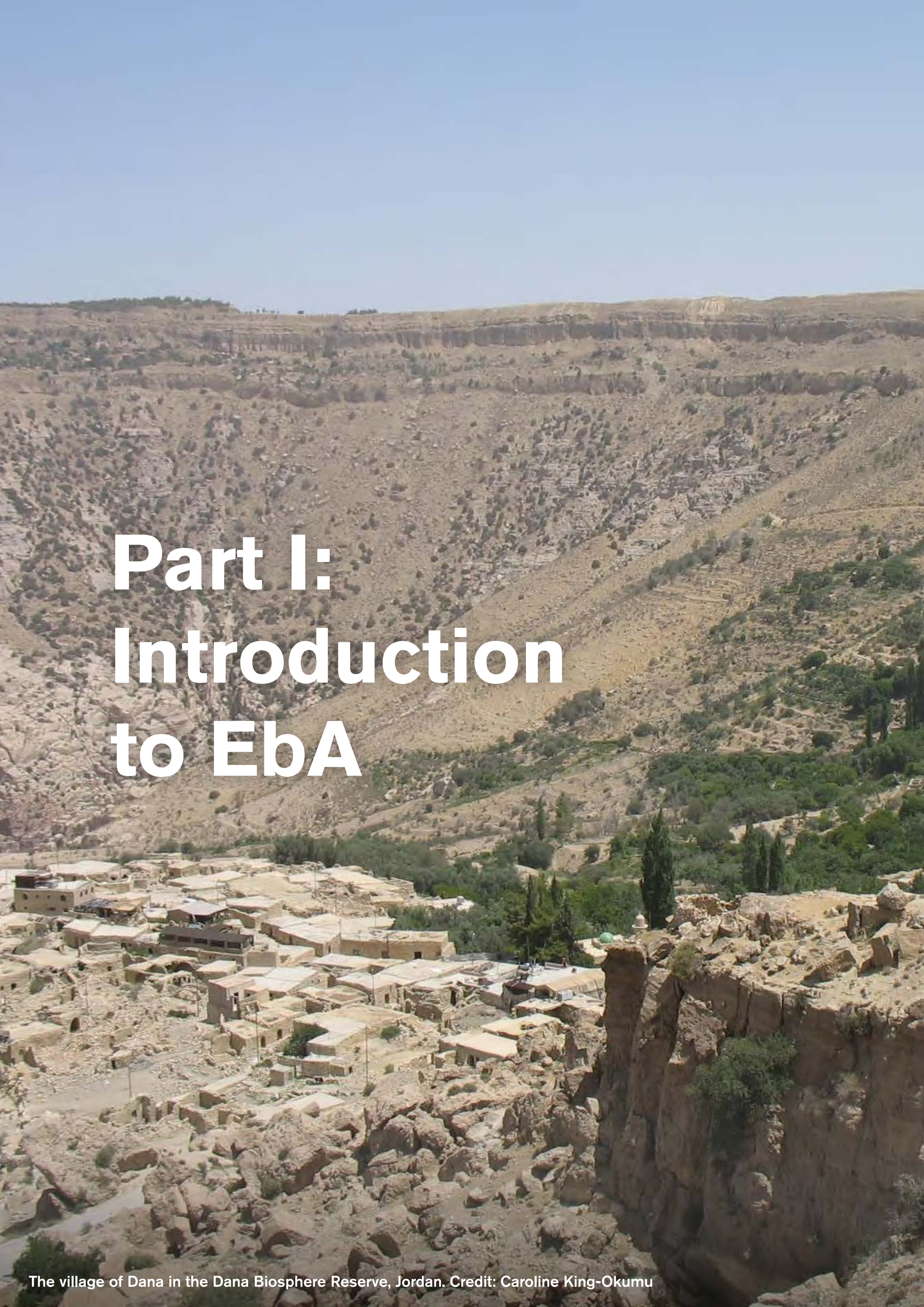
Step 6. Implementing EbA actions on the ground

Step 7. Monitoring and Evaluation for learning

Step 8. Mainstreaming EbA and promoting synergies

Each step comprises key sub-steps, participatory methods and technical aspects to consider. Handy checklists are also provided, while Step 6 includes key implementation protocols for EbA in mountains, coasts and drylands. The handbook includes general and ecosystem-specific guidance for each step, and provides links to useful resources and tools, since much EbA guidance already exists.

Part I: Introduction to EbA



The village of Dana in the Dana Biosphere Reserve, Jordan. Credit: Caroline King-Okumu

1.1 What is EbA and why is it important?

With global temperatures likely to increase by more than 1.5 degrees Celsius above pre-industrial levels by 2100 (IPCC 2014a), adaptation to climate change is arguably one of the biggest challenges facing humanity. Climate change is already impacting vulnerable ecosystems such as drylands, mountains and coastal areas:

- **Drylands** are suffering severe water constraints and challenges associated with increasingly variable rainfall.
- **Mountains** are facing rapid temperature rises, particularly in high tropical regions, causing glaciers to melt, water shortages and significant shifts in flora and fauna.
- **Coastal zones** are experiencing increasingly frequent and severe storms and sea level rise, resulting in coastal erosion and saltwater intrusion.

The United Nations Framework Convention on Climate Change (UNFCCC) Paris Agreement, signed by 177 parties, addresses adaptation as a key objective, with the aim of 'enhancing adaptive capacity, strengthening resilience and reducing vulnerability to climate change, with a view to contributing to sustainable development' (UNFCCC 2015). Ecosystems are both affected by climate change and have an important role to play in helping vulnerable people adapt, particularly in developing countries where livelihoods are dependent on natural resources. The Paris Agreement calls on parties to pursue adaptation actions 'on the basis of equity and in the context of sustainable development and efforts to eradicate poverty' and to take into consideration 'vulnerable groups, communities and ecosystems' (ibid).

The term 'ecosystem-based adaptation' as defined by the Convention on Biological Diversity (CBD 2009) is now widely accepted:

> **Ecosystem-based adaptation is the use of biodiversity and ecosystem services as part of an overall adaptation strategy to help people to adapt to the adverse effects of climate change.**

EbA includes the sustainable management, conservation and restoration of biodiversity and ecosystems to provide services that help people adapt to the adverse effects of climate change. Healthy ecosystems such as forests provide vital ecosystem services for people, such as clean water for drinking, preventing soil erosion and spiritual well-being (see Box 1). They also provide 'green infrastructure' to reduce the impacts of extreme weather events. For example, mangrove forests can protect coastal areas from erosion and storm damage.

Box 1. What are ecosystem services?

Human health and well-being depends on the services provided by ecosystems and their components (water, soil, nutrients and organisms). Ecosystem services are the benefits that people derive from ecosystems such as clean air, water, food and materials. The Millennium Ecosystem Assessment classifies ecosystem services as follows:

- **Provisioning services:** The products obtained from ecosystems, including food, fibre, fuel, genetic resources, biochemicals, natural medicines, pharmaceuticals, ornamental resources and fresh water.
- **Regulating services:** The benefits obtained from the regulation of ecosystem processes, including air quality regulation, climate regulation, water regulation, erosion regulation, water purification, disease regulation, pest regulation, pollination and natural hazard regulation.
- **Cultural services:** The non-material benefits people obtain from ecosystems and landscapes such as spiritual well-being, recreation and educational and aesthetic value.
- **Supporting services:** The services that are necessary for the production of all other ecosystem services including soil formation, photosynthesis, primary production, nutrient cycling and water cycling.

Source: MEA (2005a)

EbA is particularly important for people whose livelihoods depend on climate-vulnerable ecosystems. It can complement or substitute for hard infrastructure measures (such as dykes, dams, river stabilisation structures or manmade water reservoirs), providing cost-effective alternatives. For example, economic analysis of adaptation options for the town of Lami in Fiji found that protecting and maintaining intact mangroves, forests, seagrass, mud flats and coral reefs, represented the cheapest adaptation options with greatest benefit-to-cost ratios (Rao *et al.* 2013). EbA options were estimated to have a cost-benefit ratio of 19.50 Fiji dollars, compared to 9.0 Fiji dollars for engineered options.

EbA also often provides multiple additional benefits for livelihoods and climate change mitigation – or 'co-benefits'. For example, a restored mangrove forest supports carbon sequestration and provides a spawning ground for fish and crustaceans for food and livelihoods, and limits risks from natural hazards by reducing the impacts of storm surges.

EbA includes the sustainable management and restoration of ecosystems to secure ecosystem functions and services, and the use of ecosystems for DRR (see Box 2). It builds on a wide range of existing practices employed by the conservation and development sectors, such as:

- Sustainable natural resource management
- Community-based natural resource management (CBNRM) and
- Community-based adaptation (CbA).

However, ecosystem health alone does not guarantee human resilience. The difference between EbA and 'business-as-usual' ecosystem management practices is that EbA links conventional biodiversity and ecosystem conservation approaches with sustainable socioeconomic development, as part of an overall strategy for helping people adapt to shocks and risks associated with climate change (Bertram *et al.* 2017). Thus, EbA contributes to biodiversity and ecosystem conservation, and climate change adaptation, and also provides socio-economic benefits.

EbA interventions should be developed as part of national climate change adaptation strategies (eg National Adaptation Plans[3] and Nationally Determined Contributions[4]), and regional and local adaptation plans. EbA can be embedded into these overall adaptation strategies by:

- Identifying synergies and entry points (see Part III, Step 8 on mainstreaming EbA),
- Engaging EbA experts and vulnerable communities in adaptation planning, and
- Supporting decentralised planning processes by communities (see Part III, Step 5 and Box 25).

Box 2. Examples of ecosystem-based adaptation

- **Restoring coastal ecosystems** such as coral reefs, mangrove forests, dune systems and salt marshes, in order to dissipate the energy of powerful tropical storms and reduce risk for coastal communities.
- **Wetland and floodplain management** to prevent floods in inhabited areas and maintain water flow and quality for communities in the face of changing rainfall regimes.
- **Conservation and restoration of forests** and other natural vegetation to stabilise slopes (including sand dunes), prevent landslides, protect and restore watersheds, and regulate water flows to prevent flash flooding.
- **Agroecological farming and agroforestry** systems to cope with increasingly variable and extreme climates (eg use of shade trees in coffee plantations in drier climates, crop diversification to reduce the risk of crop failure).
- **Traditional water and land management practices** in drylands to manage the increasingly uneven spatial and temporal distribution of water by moulding the earth to channel water to where it can be conserved.

3 'The national adaptation plan (NAP) process […] enables Parties to formulate and implement national adaptation plans (NAPs) as a means of identifying medium- and long-term adaptation needs and developing and implementing strategies and programmes to address those needs. It is a continuous, progressive and iterative process which follows a country-driven, gender-sensitive, participatory and fully transparent approach' (UNFCCC 2014a).

4 The 2015 Paris Agreement requests that Parties to the agreement outline and communicate their post-2020 climate actions, known as their Nationally Determined Contributions (NDCs). NDCs embody efforts by each country to reduce national emissions and adapt to the impacts of climate change (UNFCCC 2014b).

Ecosystem-based adaptation contributes to meeting objectives under all three Rio Conventions: the Convention on Biological Diversity (CBD), the United Nations Convention to Combat Desertification (UNCCD), and the United Nations Framework Convention on Climate Change (UNFCCC). Many countries have included EbA or ecosystem-oriented visions in their Nationally Determined Contributions under the Paris Agreement (Seddon *et al.* 2016). By providing co-benefits such as carbon sequestration, EbA helps countries to meet mitigation targets under the UNFCCC. Its emphasis on restoring and maintaining biodiversity and ecosystem services, and increasing habitat connectivity, helps countries meet their obligations under the CBD. EbA often involves maintaining or restoring the capacity of ecosystems to regulate water cycles, thus aligning with the goals of the UNCCD (Seddon *et al.* 2016). By building on traditional knowledge as well as science, EbA supports obligations under the CBD, the Paris Agreement and the UNCCD.

EbA promotes sustainability in multiple sectors such as agriculture, forestry, energy, water, health, education and livelihood diversification, thus helping to achieve the UN 2030 Sustainable Development Goals (SDGs). It contributes to economic development by sustaining vital ecosystem services like water, and by enhancing natural resources and increasing agricultural productivity. It can also enhance social cohesion and reduce conflicts among communities. By increasing the resilience of vulnerable communities to extreme events such as coastal flooding and landslides, EbA also helps countries to meet commitments under the Sendai Framework for Disaster Risk Reduction (Seddon *et al.* 2016).[5]

1.2 Principles of effective EbA

For an activity, initiative, project or strategy to qualify as ecosystem-based adaptation, it should address all three elements of the CBD (2009) definition of EbA. It should:

- Help people adapt to climate change
- By an active use of biodiversity and ecosystem services,
- In the context of an overall adaptation strategy.

These three elements can be broken down into five key criteria, which can be used to ensure EbA measures are effective (Bertram *et al.* 2017) – EbA should:

- Reduce social and environmental vulnerability to climate change
- Generate social benefits and support the most vulnerable
- Restore, maintain or improve ecosystems and biodiversity
- Be mainstreamed into policies at multiple levels
- Support equitable governance and enhance capacities

The five criteria can help practitioners avoid maladaptation – whereby an activity is in fact detrimental to adaptation in the long-term, in a different aspect (socially, environmentally or economically) or for a neighbouring area. The criteria build on experience with EbA, CbA and CBNRM. Adapted from Bertram *et al.* (2017), under the three elements of EbA, the five criteria or principles for effective EbA can be explained as follows.

1.2.1 Effective EbA reduces social and environmental vulnerability to climate change

EbA should explicitly address current and future climate change and variability. It should be based on assessments of climatic vulnerability, hazards and risks to people, and the adaptation benefits derived from ecosystem services.

5 The Sendai Framework for Disaster Risk Reduction 2015–2030 outlines targets and priorities for action to prevent new and reduce existing disaster risks and losses in lives, livelihoods and health and in the economic, physical, social, cultural and environmental assets of persons, businesses, communities and countries over the next 15 years (UNISDR 2015) .

EbA uses the best available science on climate change and ecosystems, alongside local and traditional knowledge, to strengthen the social and ecological resilience and adaptive capacity of vulnerable people. People living in vulnerable ecosystems are able to observe climatic and ecosystem changes first hand and may have historical knowledge of trends. Indigenous and traditional communities have developed tried and tested strategies and institutions for sustainable and adaptive resource management over millennia. According to the Intergovernmental Panel on Climate Change (IPCC), 'indigenous, local and traditional knowledge systems and practices, including indigenous peoples' holistic view of community and environment, are a major resource for adapting to climate change' (IPCC 2014b).

1.2.2 Effective EbA generates social benefits and supports the most vulnerable

EbA reduces vulnerabilities of people through the sustainable use of biodiversity and ecosystem services and by producing societal benefits in a fair and equitable manner. It addresses the needs of people who are particularly vulnerable to climate change impacts, especially those who directly depend on or use natural resources. EbA delivers direct or indirect benefits that increase peoples' resilience to climate change, including enhanced food security, shelter, risk reduction, provision of fresh water and medicine, and local climate regulation.

In order for EbA to support adaptive capacities it needs to distribute short, medium and long-term benefits. Benefits should be distributed fairly among the target groups. EbA should create incentives for continued stewardship of biodiversity and ecosystems by local communities, including economic, cultural and tenurial incentives. Community leadership and direct benefits from ecosystem services are important to secure local buy-in, along with short-term economic benefits.

1.2.3 Effective EbA restores, maintains or improves ecosystems and biodiversity

In line with the CBD's ecosystem approach,[6] EbA supports the stability, resilience, connectivity and multiple roles of ecosystems as part of larger land and seascapes. It encompasses measures such as ecosystem management, reinforcement and restoration of natural infrastructure, as well as the management of threats associated with the effects of climate change or human activities.

Because climate change can force changes in ecosystem composition and structure, it is important that the health and stability of ecosystem services are maintained, improved and monitored. EbA supports the sustainable use of resources and diversification of land and livelihood options such as multi-cropping and agroforestry. It can include the introduction of species that are better adapted to climate change, as long as they do not endanger native species or become invasive. EbA measures should reduce climate vulnerability for people at an appropriate scale – at least local scale but ideally ecosystem or landscape/seascape scale.

1.2.4 Effective EbA can be mainstreamed into policies at multiple levels

EbA should be integrated into existing policy frameworks so that interventions can be sustainable and scalable, rather than short term and stand alone, and can help millions of people vulnerable to climate change, beyond project beneficiaries/target areas. This means getting support for EbA and local decision making in higher-level planning and policy processes.

As part of a larger adaptation strategy, EbA should become an integral part of key policies and implementation frameworks for sustainable development, agriculture, land use, poverty reduction, natural resource management, climate change adaptation, and disaster risk reduction. Local and national government actors (see Box 3) should be actively engaged from the start to secure buy-in and promote support for implementation and wider mainstreaming. EbA approaches should include a monitoring and reviewing component that allows learning and adapting based on lessons learnt from on-the-ground implementation.

6 The ecosystem approach is a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way (CBD 2016).

1.2.5 Effective EbA supports equitable governance and enhances capacities

EbA enhances governance of natural resources, biodiversity and ecosystem services, by following a community-centred, participatory and gender-sensitive approach. It embraces transparency, empowerment, accountability, inclusion and active participation at the local level. In addition, it supports fair and equitable user access, rights and responsibilities.

The ability to adapt to climate change hinges on the ability of local people (comprising different groups, genders, customary bodies, etc) to take on their rights and responsibilities and to be represented by officials at all levels who are accountable to them. Ownership by local ecosystem managers ensures that benefits emerge and are sustainable. Active community participation and leadership in EbA planning and implementation generates the capacity, empowerment and ownership needed for long-term sustainability of EbA processes (Raza Rizvi *et al.* 2016). This can be achieved by applying participatory action research (PAR) principles (see Box 4). Local institutions for collective resource management at landscape level (which generally equates to ecosystem level) should be established or strengthened. Strong local governance needs to be supported by higher-level governance structures, policies and an enabling environment.

Box 3. Who are the main EbA stakeholders?

- **Local communities:** Communities involved in EbA projects, disaggregated by gender, or other forms of important social differentiation in the local context, where appropriate and possible.
- **Implementing partners:** The bodies responsible for project implementation on the ground, including local communities, NGOs or civil society organisations, private sector, local government, local academic institutions or project partner field staff.
- **Local authority level:** Key government and/or local authority or district/province/state officials who are involved with the project (or make local-level decisions) at the field level.
- **National-level policy and decision makers** connected to the project/programme, in particular those related to the relevant national Climate Change Adaptation Committee (or similar institution). Although these stakeholders might not have detailed project implementation knowledge, they are important partners to acquire a general understanding of the context within which EbA projects operate and identify opportunities for bringing the lessons to scale.

Adapted from Reid *et al.* (2017).

Box 4. Principles of participatory action research

Participatory action research (PAR) includes a number of research methodologies (eg action research, action learning) which aim to pursue action and research outcomes at the same time. It recognises that active participation leads to appropriate design and stimulates action. The following PAR principles should inform the design and implementation of EbA interventions:

- **Active participation:** Local community researchers participate actively in decision making throughout the research process, from the design of projects and activities to analysis of the results.
- **Capacity building:** Workshops are held to build the capacity of local community researchers to jointly design action-research activities and to facilitate the action-research themselves, as far as possible.
- **Empowerment:** Local cultural concepts and traditional knowledge are used alongside science as equally valid and complementary knowledge.
- **Inclusion:** Active participation of women, youth, elders and marginalised groups is ensured.

1.3 Comparing EbA in mountain, coastal and dryland ecosystems

There are clear differences in the climatic hazards faced by mountain, coastal and dryland ecosystems. Even within the three ecosystem types, there are a range of contexts in terms of exposure to hazards (eg depending on aridity or altitude), ecosystem health, socioecological systems and population density. EbA interventions thus need to be tailored to specific local contexts. However, there are also some broad similarities in terms of the types of EbA intervention needed in different ecosystems, and lessons can be learnt from comparisons between the three ecosystems.

- In all three ecosystems, agricultural biodiversity is important for adaptation, as well as ecosystems and 'wild' biodiversity. In mountain and dryland ecosystems, resilient local crop varieties reduce risk in the face of more extreme and variable climates, while in coastal ecosystems, genetic resources are important for salinity tolerance.
- In coastal and mountain regions, ecosystems play an important structural role in DRR (often providing food and income as well).
- In drylands, water management is particularly important (especially groundwater) and ecosystem restoration can be more challenging due to water constraints. Above ground water management is also important in both dryland and mountain ecosystems but may be less critical in coastal ecosystems.

In all three ecosystems, the management of EbA interventions by local people is important. EbA interventions should be implemented at landscape or ecosystem level and led by collective community institutions. The overall **process** of planning and implementing EbA interventions is very similar for mountain, dryland and coastal ecosystems. Participatory processes at community and landscape level, building on traditional knowledge as well as science, and multi-stakeholder engagement are important for effective EbA in any context. Investment in participatory processes builds local capacity, institutions and ownership for effective EbA interventions and sustained impact beyond projects.

In many cases, EbA must balance the needs of multiple resource user groups – from vulnerable communities, to industry – and of different users within communities. Understanding differentiated vulnerability within communities is important, as some stakeholders are often more vulnerable than others or vulnerable in different ways.

It is also clear that generating economic benefits is key for successful EbA in any ecosystem, to secure community buy-in and make EbA economically viable and sustainable. Actively engaging local government early on, and effective M&E, are key to promoting government support and mainstreaming of EbA interventions in wider adaptation strategies and economic planning, to generate impacts at scale.

1.4 Key steps in EbA planning and implementation

This section provides a brief overview of the step-wise approach to EbA. It introduces the eight key steps for EbA planning and implementation, which are further elaborated in Part III. Steps 1-7 relate to EbA at landscape/ecosystem level, and Step 8 deals with mainstreaming EbA into government policy and programmes. These steps are not set in stone: some steps could be combined, the sequence may be adjusted and there may be interaction between phases in a learning and iterative process. The overall process and each step should be designed with vulnerable communities and adapted to the local context.

Step 1. Exploring viability and mobilising stakeholders:

This preliminary step aims to help users assess the feasibility and potential for EbA in a specific local context. It involves engaging all key stakeholders, including government and communities, conducting a preliminary stakeholder analysis and a community-level free prior and informed consent (FPIC) process, and establishing a local steering committee and facilitation team.

Step 2. Understanding the ecosystem and livelihoods context:

This step aims to identify the most important ecosystems and ecosystem services essential for livelihoods through participatory research with communities.

Step 3. Analysing climate risks and vulnerability:

This entails a participatory assessment to understand climate and non-climate threats to ecosystem services and livelihoods and a more in-depth scientific vulnerability and impact assessment (VIA), to inform the design of EbA measures. This step also aims to generate early livelihoods benefits and community buy-in.

Step 4. Understanding the role of ecosystem services in adaptation:

This step aims to identify ecosystem services and related sustainable management practices that can be used to reduce the climate risks identified and enhance adaptive capacity.

Step 5. Developing an EbA strategy and designing EbA actions:

This step aims to identify priority EbA actions and develop site-specific implementation protocols that address climate risks and vulnerabilities and maximise co-benefits, through participatory processes and based on an understanding of policy opportunities (and constraints).

Step 6. Implementing EbA actions on the ground:

This step aims to support the implementation of site-specific EbA protocols which are based on proven effective measures in each ecosystem type, such as restoration of biodiversity and forests, water and ecosystem management, and conservation of genetic diversity, and which are developed using traditional knowledge as well as science.

Step 7. Monitoring and evaluation for learning:

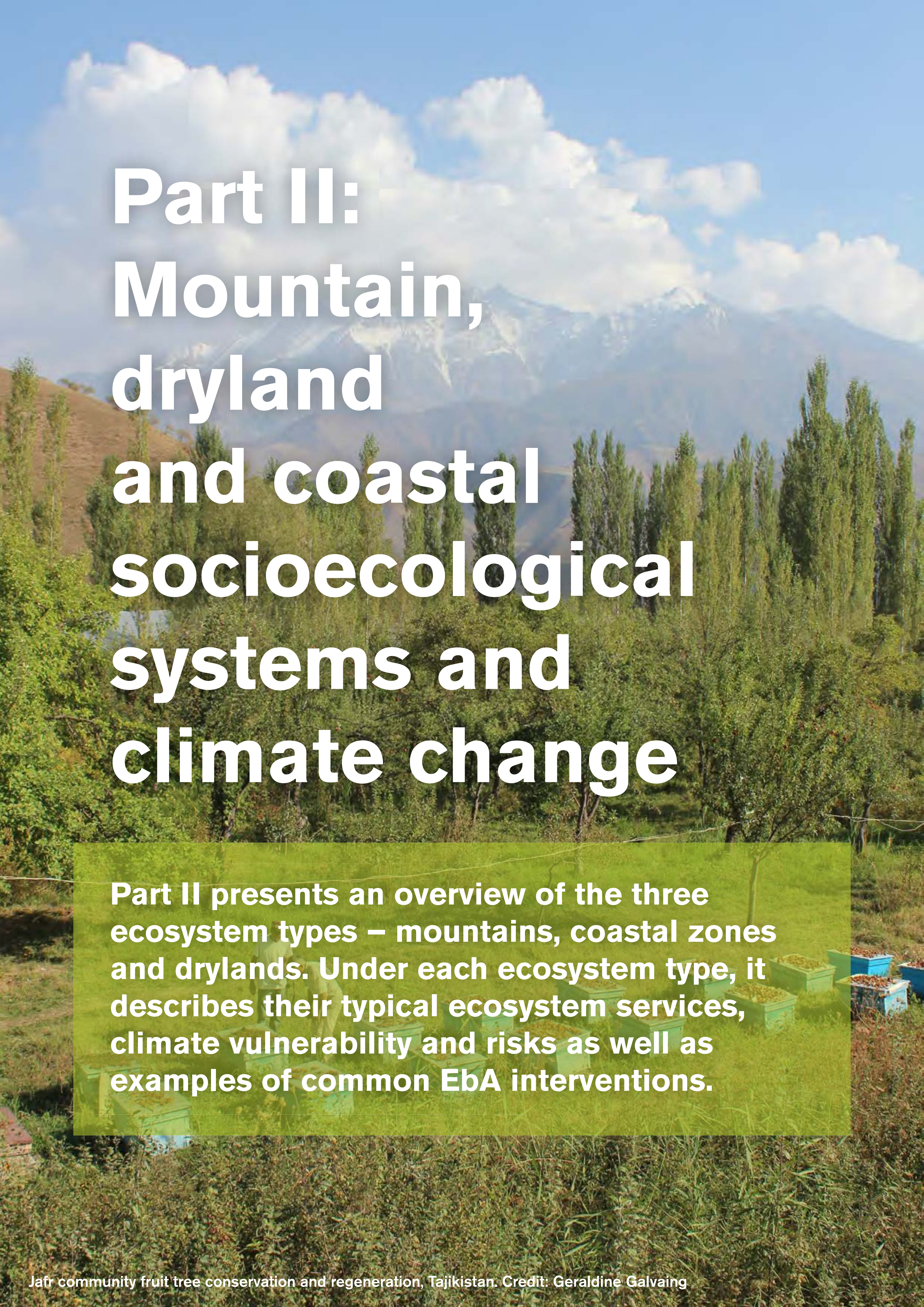
This step aims to assess the impacts of EbA activities on ecosystems, livelihoods and social capital (eg institutions and capacity), including co-benefits and costs, in order to promote flexible and forward-looking adaptive management and learning by all stakeholders.

Step 8. Mainstreaming EbA and promoting synergies:

This final step seeks to ensure that EbA initiatives are continued and have impacts beyond the project level by promoting the integration of EbA into wider policy and decision-making processes at local and national level.

Part II: Mountain, dryland and coastal socioecological systems and climate change

Part II presents an overview of the three ecosystem types – mountains, coastal zones and drylands. Under each ecosystem type, it describes their typical ecosystem services, climate vulnerability and risks as well as examples of common EbA interventions.



Jafr community fruit tree conservation and regeneration, Tajikistan. Credit: Geraldine Galvaing

2.1 Introducing mountain socioecological systems

2.1.1 Mountain ecosystems and their services

Mountains cover about 22 per cent of the world's land surface. They are generally considered to be areas above 1,000 metres in height. Areas above 2,500m are generally termed high-altitude zones, but there is no standard definition. Mountain ecosystems and climates vary widely with altitude. They directly support about 823 million people living in mountain areas in developing countries (Romeo *et al.* 2015). Mountain ecosystems provide essential ecosystem goods and services, such as water, energy, and forest and agricultural products, both for mountain people and downstream populations. They provide an estimated 60–80 per cent of the world's freshwater, supplying major cities not only in mountain areas, but also in lowlands often located far away. Mountains also sustain a large proportion of the world's biodiversity hotspots, high levels of genetic diversity of crops and livestock, and rich cultural diversity and traditional knowledge about biodiversity and ecosystems.

Agriculture and forestry are often the main sources of livelihoods in mountain areas, along with livestock grazing in pastures at higher altitudes. Mountain communities typically rely on mixed crop-livestock systems and use a diversity of locally adapted crops to grow food in different micro-climates and to reduce risk. Healthy ecosystems play an important role in reducing disaster risk in mountain areas. Mountain forests and vegetation act as physical barriers to prevent or slow landslides, rockfalls and avalanches. They also prevent soil erosion, reduce flood risk, enhance water provision and contribute to local food security (eg nuts and fruits). Mountain ecosystems include shrublands that provide medicinal plants, and lakes and rivers that provide fish, as well as floodplains, wetlands and drylands. Mountains provide important cultural services, such as spiritual well-being for indigenous mountain communities, and recreation and tourism.

2.1.2 Climate vulnerability and risks in mountains

Mountain regions are often characterised by harsh climates and rough topography, with steep slopes that are prone to soil erosion and landslides. Mountain peoples are among the world's poorest and most marginalised (Nyman *et al.* 2015). They often face ethnic or religious discrimination and live in remote areas with poor infrastructure and access to markets. Although many mountain regions are sparsely populated (eg the high Andes) and are experiencing out-migration, some regions, such as Mount Elgon in Uganda, have a high population density and are seeing rapid population growth (Nyman *et al.* 2015). Out-migration can provide income from remittances, but also reduces the agricultural workforce and can increase the burden on women.

Almost half of those living in rural mountain areas are vulnerable to hunger and face poverty and malnutrition (Romeo *et al.* 2015). Several non-climatic drivers of degradation are typical to mountain areas, such as deforestation which accelerates erosion and enhances water run-off, landslides and floods; and unsustainable land use, construction of roads, dams or mining which can further exacerbate these hazards (Nyman *et al.* 2015).

Climate change is adding to these pressures. Mountain regions have experienced above-average warming in the 20th century, and high mountains are highly temperature-sensitive regions (IPCC 2014b). Rising temperatures are causing mountain glaciers to melt. In the Peruvian Andes for example, glaciers have already shrunk by 40 per cent since 1980. Glacier recession has been linked to an increase in extreme events, such as landslides, lake outburst floods, mudflows and rockfalls (IPCC 2014b, Nyman *et al.* 2015). Glacier recession also reduces water availability. Many Latin American cities depend on water supplies from the Andes, so glacial melt is a growing challenge. Rising temperatures have also led to a significant rise in soil pests in many mountain regions and have caused dramatic shifts in the altitudinal ranges of some flora and fauna, putting some species and crop varieties at risk of extinction.

More erratic rainfall has been observed in mountain areas, as well as more intense precipitation, which can destabilise slopes and further erosion, causing landslides and flooding (Nyman *et al.* 2015). Rainfall is expected to increase in the inner tropics and decrease in sub-tropical dry zones (Kohler *et al.* 2014). Mountain farmers are already reporting shifts in seasons and declining productivity due to more extreme and variable weather. Reduced rainfall and freshwater availability often degrades ecosystems, reducing the supply of ecosystem services for people.

2.1.3 EbA interventions in mountains

EbA in mountains, as elsewhere, should build on the existing sustainable management practices, institutions and traditional knowledge of local people. Mountain people tend to have extensive traditional coping mechanisms because they are accustomed to a high degree of climate variability eg between years, seasons, times of day and slopes (Nyman *et al.* 2015). They live in risk-prone environments and have developed time-tested approaches and methods to cope with various risks. Cultural and spiritual values of indigenous mountain people can also play an important role in EbA by promoting conservation and equity values, and social cohesion at landscape level.

The types of EbA intervention required in mountains vary depending on altitude and topography (eg whether it is a plateau or steeply sloped area). Nevertheless, the following EbA interventions have proven to be effective in many mountain ecosystems, while generating multiple benefits for vulnerable people:

- **Restoring natural forests and vegetation using native species:** Restoration on slopes can help control soil erosion, conserve water resources by reducing run-off, maintain soil nutrients and increase productivity. It can also reduce the risk of landslides, rockfalls, avalanches and flooding, while regulating local climates (eg large-scale reforestation can contribute to enhanced cloud formation and rainfall). Using species of fruit and nut trees, medicinal plants or broom grass can also generate economic and health benefits. A combination of trees and vegetation can provide benefits in the short, medium and long term. Replanting forests and vegetation can protect watershed catchments to secure water provision for local people and downstream populations. Restoring grasslands can increase provision of grazing and forage during dry periods, while restoring riparian zones can reduce flooding to surrounding farmland and maintain water quality (Nyman *et al.* 2015).
- **Water conservation and management:** Mountain communities often depend on rainfed agriculture and traditional water sources such as natural springs and ponds for irrigation and drinking. Many water sources are diminishing as temperatures rise and rainfall becomes more erratic. In some cases, water sources are being further disrupted by non-climatic threats such as unsustainable road construction and mining. In Parbat, Nepal, the Global EbA in Mountains Programme[7] addressed these challenges by implementing water source conservation and restoration interventions with an added climate lens, reconstructing ponds and related basins, constructing new water-collection tanks and conserving traditional water sources through community user groups (Nyman *et al.* 2015). The project also built stone lids on the water-collection tanks to prevent evaporation and contamination. Underground pipes to maintain downstream flow despite the new road were also installed. These 'grey-green' EbA measures[8] have improved water availability during dry periods and improved water quality for the community and livestock.
- **Agroecology and diversification:** Mountain ecosystems tend not to be suitable for modern intensive agriculture because of their harsh and variable climates, rough topography and steep slopes. Diversified agroecological farming practices, which conserve and restore agro-ecosystems, can increase productivity and reduce risk in mountain areas. For example, organic manure enhances soil fertility and moisture, agroforestry improves soil fertility and reduces erosion, and natural pest control can reduce water pollution and benefit health. Diversification of crop species and varieties, and the use of resilient local varieties, reduces the risk of crop failure in the face of growing climatic variability and extreme events (eg drought, frosts, pests and diseases). It can also improve nutrition, diversify incomes, and reduce input costs. In the Potato Park Peru in the high Andes of Peru, a strategy of potato diversification has increased productivity despite a dramatic rise in soil pests due to increased temperatures. Incomes have nearly doubled through landscape-based microenterprises, and strong local institutions, capacity and ownership have been built through a highly participatory approach that links traditional and scientific knowledge (Asociación ANDES 2016).

General implementation protocols for these EbA interventions in mountain socioecological systems are provided in Part III, Step 6.

7 A flagship programme of UNEP, UNDP and IUCN implemented in Nepal, Peru and Uganda, with support from the German Ministry for Environment (BMU).

8 'Grey-green' EbA measures are those where the management of ecosystems is combined with built infrastructure to create hybrid adaptation (or grey-green) approaches, using the best characteristics of both ecological and engineering options (UNEP 2018).

2.2 Introducing coastal socioecological systems

2.2.1 Coastal ecosystems and their services

Coastal ecosystems extend along 1.6 million kilometres of coastline in 123 countries (UNEP 2006). They have direct connections with both terrestrial and large marine ecosystems. About one-third of the world's population live in coastal zones (UNEP 2006). Coastal ecosystems have biological, economic, social and cultural values (see also Figure 1). They provide numerous services which are helpful not only for nature but also for the dependent livelihoods, including:

- Provisioning services (eg seafood)
- Regulating services (eg precipitation)
- Supporting services (eg nutrient cycling)
- Cultural services (eg recreation)

Coastal ecosystems are also home to a wealth of flora and fauna. Mangroves provide habitats for numerous species including some endangered species such as the hawksbill turtle (Gaos *et al.* 2012). Coral reefs are a natural wonder and home to about a third of the world's marine fish species (Moberg and Folke 1999). Coastal and marine resources also often have important cultural significance for local people while traditional knowledge about local ecosystems and climatic hazards can help people adapt to climate change (Leonard *et al.* 2013).

Figure 1. Coastal ecosystem services

Source: Susanne Moser. This figure appears in chapter 25 of the Climate Change Impacts in the United States: The Third National Climate Assessment report (https://data.globalchange.gov/report/nca3)

http://nca2014.globalchange.gov/report/regions/coasts/graphics/coastal-ecosystem-services

Estimates for the economic contribution of these ecosystems ranges from billions to trillions of dollars (Costanza *et al.* 1997, Martinez *et al.* 2007). Through their provisioning services, these coastal ecosystems support the lives and livelihoods of many of the world's poorest communities:

- Fish alone support 57 million livelihoods directly, mostly in developing countries, and supply important protein (FAO 2016)
- Mangroves, coral reefs, seagrass and other ecosystems provide important nutrients and foods for fish
- Mangrove forests also provide wood and non-wood products such as honey, dyes, fodder and herbal remedies
- Coastal ecosystems are also important for providing cultural services and supporting tourism. Coral reefs, mangrove forest and beaches support the tourism industry. They are a means of recreation, aesthetic enjoyment, artistic and spiritual fulfilment and intellectual development (UNEP 2006)
- A particularly important regulatory service of coastal systems is protection from environmental disasters
- Mangroves can help to weaken wave energy to reduce the impacts of cyclones and storm surges (Spalding *et al.* 2014)
- Carbon sequestration through coastal plants and algae is of utmost importance for reducing global warming

2.2.2 Climate vulnerability and risk in coastal systems

In spite of their importance, coastal ecosystems are among the most threatened in the world (Agardy *et al.* 2005) due to both climatic and non-climatic drivers. The increased level of greenhouse gases is responsible for increased temperature, ocean acidification, intense storms and heatwaves. Some of these are creating storm surge-induced flooding and sea-level rise, which in turn contribute to land erosion and salinity intrusion.

Increased water temperature increases the metabolism rates of aquatic species and can be fatal to those already living at or near the higher threshold levels (Wong *et al.* 2014), negatively impacting on the dependent livelihoods. It particularly causes coral bleaching and changes in the distribution of aquatic species especially shifting towards the poles (Wong *et al.* 2014). The increased level of carbon dioxide is increasing acidity, which has negative impacts on many calcifying organisms such as oysters, shellfish and coral (Wong *et al.* 2014).

The people dependent on these species will be negatively impacted due to reduced production. For example, there will be less availability of brood shrimp and prawn species due to reduced pH, which are used in hatcheries for producing post-larvae. Consequently, the hatchery and shrimp and prawn aquaculture industry will be negatively affected. Sea-level rise can cause drowning of some coastal plants (eg mangroves) and land-based resources of humans. Extreme weather events such as storms, flooding and heatwaves impact on both aquatic and land-based coastal resources. The fishing industry is extremely sensitive to storms while storm surges can wash away coastal land-based properties impacting on thousands of lives, houses, boats, nets, livestock, crops etc (see Islam *et al.* 2014).

Ecosystem-based adaptation (EbA) in coastal ecosystems is gaining importance in order to provide a win-win solution both for the coastal ecosystems and dependent people. EbA in coastal areas, as mountains and elsewhere, should build on the existing sustainable management practices, institutions and traditional knowledge of local people, including ability to predict disasters (Mallapaty 2012). EbA practices can improve the resilience of coastal ecosystems, produce more ecosystem services to help coastal people to secure better livelihoods, increase their adaptive capacity and reduce exposure to some climatic hazards. In particular, they can increase incomes through the production of more natural resources such as fish and mangroves. While this handbook cannot cover all possible options, the following two EbA interventions are representative in many coastal ecosystems (see also Steps 5 and 6).

2.2.3 EbA interventions in coastal zones

Restoring and conserving mangrove forest: Mangrove forests are found in 123 countries and territories and cover more than 150,000 km^2 globally (Spalding *et al.* 2010). They provide important ecosystem services, reduce disaster risk and help people adapt to climate change in a number of ways. These include:

- Reducing coastal flooding, wave inundation and land erosion
- Dissipating the energy of powerful tropical storms
- Attenuating waves and reducing and capturing sediment to counteract land erosion
- Increasing provisioning services for dependent livelihoods (eg honey, medicine, prawn post-larvae, crabs and fish), supporting services (eg nutrient cycling) and regulating services (eg rainfall) for the associated ecosystem.

But mangroves are threatened by both climatic and non-climatic threats. Climate change impacts have already resulted in either the loss or degradation of 35 per cent of mangroves worldwide (Doney *et al.* 2012). Mangroves can be damaged by sea-level rise, increased levels of salinity and temperature, land erosion, and more intense storms and flooding. If mangroves cannot keep up with sea-level rise, they can leak some of their stored compounds which will emit more greenhouse gases to the atmosphere (Wong *et al.* 2014). Restoring and conserving mangrove forests can be done in a range of ways such as reducing non-climate pressures (eg pollution) and encouraging higher temperature and salinity tolerant plant species (UNEP 2016).

Mangrove ecosystem in Mindanao, the Philippines. Credit: © World Agroforestry Centre/Robert Finlayson

Restoring and conserving coral reefs: Many studies have projected the impacts of global warming and climate change on coral reefs mainly due to increase in temperature and acidity. These impacts have already resulted in either loss or degradation of 30 per cent of the world's coral reefs (Doney *et al.* 2012). Some of the possible future impacts include (UNEP 2016):

- Increased water temperature, which can affect coral growth and reproduction rates, frequency and intensity of coral bleaching events, prevalence of disease and associated coral mortalities.
- Increased water acidity, which can impact on the calcification and reef-building processes.
- With increased sea levels, some coral reefs may not be able to keep up with the photic zone (ie the surface layer of the ocean that receives sunlight).
- Increased intensity of tropical storms, which can damage the physical structure of reefs and biodiversity.
- Impact on other terrestrial systems due to climate change, which can damage coral reefs (such as increased freshwater runoff and sediment).

The damage or destruction of corals has serious negative consequences for coastal ecosystems and dependent livelihoods. Coral reefs support a rich array of biodiversity: their loss means the loss of important biodiversity and associated livelihoods. Restoring and conserving coral reefs is thus necessary and may be done by reducing non-climate pressures (eg pollution) and encouraging temperature tolerant species (UNEP 2016). Restoring and conserving coral reefs can also help people adapt to climate change in the following ways:

- Coral reefs can reduce the height and power of storm waves decreasing flooding and coastal erosion (UNEP 2016).
- Biodiversity of coral and other associated species (eg invertebrates and fish) can increase many of the most beautiful and colourful species, increasing tourism opportunities and supporting local livelihoods (Pratchett *et al.* 2009). For example, 10 to 12 per cent of fish caught in tropical countries, and 20 to 25 per cent of fish caught in developing countries, are from coral reefs (Garcia and Moreno 2003). Restored coral reefs can thus help increase peoples' resilience and adaptive capacity in the context of climate change (UNEP 2016).

2.3 Introducing dryland socioecological systems

In drylands, annual rainfall is generally low, highly variable in time and space, and there are high evapotranspiration rates due to sunshine and wind. This means that unless stored underground, water evaporates quickly. Climatic variability is often extreme, involving droughts, floods, heatwaves and sudden downpours. Yet the comparative advantages of these environments and the role of pastoralism as a major livelihood and driver of EbA in the drylands have often been overlooked. In terms of gross domestic product (GDP) and other development indicators, drylands include both the richest and poorest parts of the planet, and also some of the most intractable and violent areas of conflict.

Wet season grazing in southern Ethiopia. Credit: Kelly Lynch

Drylands are considered to account for 40–45 per cent of the land surface of the planet (UNCCD 2017).[9] They may be defined in various ways, including the conventional definition that relies on use of an aridity index (AI). This focuses on the ratio between water availability (from annual rainfall) and the rate at which it will evaporate. Hyper-arid areas (with an AI of less than 0.05) are considered desert and have not always been

9 See also more precise and detailed discussion in: Safriel *et al.* (2005).

included in calculations of the extent of the drylands (Safriel *et al.* 2005). In addition, significant surface and sub-surface waterbodies and wetlands punctuate drylands. Yet these are obscured in spatial analyses that present average conditions over large territories where there are very few meteorological stations.

Piped water systems for drinking and irrigation have been introduced in many drylands, which have changed dryland ecosystems, creating new opportunities and challenges for adaptation to climate change. Dryland cultures are richly diverse but share an ingenuity for adaptation to extreme climates. This is often combined with a respect for ecosystems, particularly water resources which are precious for sustaining life in the drylands.

2.3.1 Dryland ecosystems and their services

Dryland ecosystems provide an array of provisioning services such as spring water, foodstuffs (including cereals, meats, milk, honey and many fruits) and fuels (including sub-surface oil, gas and thermal power, fuelwood, and solar and wind energy) (Adeel *et al.* 2005, Cohen 2009). Regulating and supporting services circulate the water, nutrients and other elements, breaking down waste materials and contaminants and purifying the environment and its services for human well-being.

Dryland ecosystems also provide cultural services that are important to livelihoods and recreational and spiritual uses. Some of the world's most important natural heritage sites and biosphere reserves are located in drylands, as well as many revered places of pilgrimage. Drylands are also home to a wealth of fauna and flora, many of which are endangered.

Extensive livestock production systems in drylands support the livelihoods of some of the world's poorest people. These systems generate significant domestic and export revenues, provide an important safety net during crisis periods (Alary *et al.* 2014) and also offer an alternative paradigm for the development of inclusive green economies (McGahey *et al.* 2014). For example, not only does camel milk make the difference between survival and malnutrition for drought-stricken children in the Horn of Africa, but the camel milk export sector has also been growing particularly fast and making a difference to the lives of people across sub-Saharan Africa (King-Okumu *et al.* 2015, Avezou 2017, Scott 2017).

Past estimates of the economic value in the dryland ecosystems of the Horn of Africa alone have been upward of US$30 billion per year (IUCN 2010, ECONorthwest 2010). However, these estimates are understated because there has been a tendency for national statistics and international assessments (eg UNCCD 2009, ELD 2017) to focus predominantly on the agricultural output,[10] and only look at direct values, ignoring the significant contribution of indirect values and values of other sectors to local, national and regional economies (Hesse and MacGregor 2006; Behnke 2010).

2.3.2 Climate vulnerability in dryland ecosystems

Drylands are often characterised by extreme climates. With skilful construction and cultivation practices, however, they can be very habitable and fertile places, with reduced vulnerability to climatic extremes. Traditional buildings integrate natural materials, plants and water into the design of the built environment. In this way, natural processes enable cooling under high temperatures (Bahadori 1978, Rojas-Fernández *et al.* 2017). Building design that works with the ecosystem to maximise 'passive' cooling (a low or no-energy approach to building design that does not require high energy-demanding engineered solutions) can reduce energy consumption by 20–50 per cent (FEMP 2003).

Drought, famine, pests and diseases in drylands are likely to increase with climate change. Some drylands are covered in dense metropolises, such as Cairo and Islamabad, including major industries and service centres. Others are sparsely populated, such as the rangelands of the Sahel, or are cultivated with changing configurations of rainfed or irrigated crops. Dryland farmers frequently report shifts in seasons, drought and growing climatic variability and uncertainty (IFAD 2016, Pedrick *et al.* 2012, Swe *et al.* 2015). And as dryland societies rely more on surface and groundwater for irrigation and other uses, upstream and downstream effects and conflicts can create additional management challenges (King-Okumu *et al.* 2017).

10 See also discussion here: www.iied.org/drylands-volatile-vibrant-under-valued

Global climate models (GCMs) projections show that drylands are likely to continue expanding during the 21st century due to increases in evaporation and longer and more severe dry periods (Schlaepfer *et al.* 2017). Under scenarios of faster warming and more pronounced drying, the size of drylands in East and West Africa could increase by as much as 40 per cent by 2050 (Cervigni and Morris 2016). In addition, demand for water is predicted to grow (UN Water 2017b), which will further increase water stress and drought hazards. About 500 million people already live in areas where water consumption exceeds the locally renewable water resources by a factor of two (Mekonnen and Hoekstra 2016). Water scarcity, vegetation die-off and land degradation are also predicted to reduce ecosystem services and impact dryland livelihoods.

2.3.3 EbA interventions in drylands

EbA interventions in drylands should draw on the knowledge and experiences of the people who live there. They are often able to work in harmony with ecosystem processes to respond to droughts and disasters, to conserve and restore degraded forests, to steward soil and water and genetic resources and to build sustainable settlements. EbA interventions should also apply scientific methods and databases for decision making. In this section, three types of dryland EbA practices involving sustainable water and land management are presented. These can be used separately or combined to address growing climate challenges, while generating multiple benefits for vulnerable people.

Watershed or basin management for DRR: At the basin or watershed scale, it is possible to identify whether water shortages are long or short-term problems, driven by climate change or other localised pressures. A single basin or watershed may include higher and lower rainfall areas and a complex network of surface and sub-surface waterbodies (see the example of Zeuss-Koutine watershed in Box 5).

There are many examples of cases where high levels of water extraction, deforestation or other pressures on ecosystems in the upstream areas of a watershed are causing drylands in the downstream areas to become more prone to droughts or floods. Ecosystem-based adaptation involves recognising and reducing these pressures on the ecosystem. On the other hand, where drylands are located upstream of large economic water users, such as the growing coastal cities across Africa, the management of these dryland ecosystems affects the quality and quantity of drinking water supplies that reach the downstream areas.

Watersheds often include a range of different land and water-user groups – urban water users, industry, agriculture and tourism sectors – whose needs may be conflicting. Therefore, coordination mechanisms among users can provide more options for ecosystem-based adaptation. If different groups of users need to use the water resource during different seasons – as is the case for farmers, fishermen and pastoralists in the Inner Niger Delta in Mali – climatic changes affecting the pattern of the seasons can cause disruptions to agreed use patterns (Morand *et al.* 2012). This can lead to conflict and the need for renegotiation of resource access. Watershed management is often complicated by administrative boundaries, which cut across the basins or the watersheds.

Coordination across stakeholder groups requires the establishment of working relationships and the availability of reliable information. This is particularly critical at the level of transboundary or conflict-ridden basins. Where there is misinformation or uncertainty, users who suspect others of taking more than their share of water may feel less inclined to abide by agreed quotas themselves.

Box 5. Watershed management and water harvesting, Zeuss-Koutine, Tunisia

In the Zeuss-Koutine watershed, Tunisia, if rainwater captured in the soil profile exceeds the water holding capacity, it will percolate downwards and recharge the groundwater reserves flowing through the Zeuss-Koutine aquifer, serving the urban population in the cities of Medenine, Tataouine, Jarzis, Jerba and Benguerdene (Ouessar *et al.* 2004 & 2009).

The Tunisian government has invested directly in increasing recharge to the aquifer through the construction and maintenance of artificial recharge structures in the upper part of the watershed (Hadded *et al.* 2013). Since demand exceeds supply, part of the shortfall is made up by two desalination plants that have already been constructed to treat brackish water, and further water treatment facilities are considered likely to be needed in future. These will use additional energy and produce additional waste products (King and Jaafar 2015).

Traditionally, in the upper reaches of the watershed, rainfall and water-harvesting structures (known as jessour) support arboriculture, intercropping of barley and, in some cases, natural vegetation for grazing by livestock (Abdelli *et al.* 2017). Further down, in the plain, water-harvesting structures are known as tabia. Harvesting rainwater to support trees and fodder for livestock can simultaneously increase the recharge of groundwater (Adham *et al.* 2016, Ouessar *et al.* 2004 & 2009).

Innovation and application of traditional water and land-management practices: To manage the uneven spatial and temporal distribution of water, dryland societies have traditionally used practices involving harvesting rainwater during rainy seasons (Rockstrom *et al.* 2002, Sietz and Van Dijk 2015). These practices involve moulding the shape of the earth to channel water to where it can be conserved. It can then be stored to increase availability of water and other ecosystem services during dry seasons and drought periods. Water-harvesting and soil conservation practices range from large terraced systems that may extend across a landscape of hillsides (see also mountain systems), to individual water pans, subsurface dams (Ryan and Elsner 2016), and small bunds that conserve water in the root zones of individual trees and plants. Guidance materials focusing on these practices are available (see Mekdaschi Studer and Lininger 2013, WI 2017). In India, traditional water-harvesting systems include the khadin system in Rajasthan, percolation tanks in Maharashtra, and gravity-fed channel and tank systems in Tamil Nadu (Sinha *et al.* 2013).

There is growing recognition of the role of these traditional water and land-management practices in contributing to groundwater recharge, and the generation of other ecosystem services due to enhanced water availability (Everard *et al.* 2018). In urbanised dryland ecosystems, innovative adaptations of traditional water-harvesting practices can also involve using large impermeable surfaces, such as rooftops to capture water or ensuring that water is collected in natural or engineered drainage systems, instead of having too many impermeable tarmacked and concrete surfaces. This can help to conserve water, reduce risks of flooding, and avoid erosion, contamination and destruction of property. Although water-harvesting practices are often seen as a 'decentralised' adaptation, they are best implemented through a watershed-level approach that considers upstream and downstream interests and impacts.

Conservation or restoration of landscapes and genetic resources (plants and animals): Genetic materials in dryland ecosystems include well-adapted plant and animal species that are able to tolerate periods of water stress, or to migrate across the landscape in search of water, food and shelter (Kim *et al.* 2016). This enables productivity and dependent livelihoods to be sustained, even under drought and other extreme climatic conditions. Herders can moderate the numbers and proportions of camels or small ruminants to reflect the composition of available forage species they observe in their ecosystems (Wako *et al.* 2017, Aboul-Naga *et al.* 2014).

Adaptation involving conservation of resilient vegetation and tree-planting[11] includes arboriculture, reforestation and agroforestry. Agroforestry systems can maintain agricultural production to provide regular income streams, while providing additional ecosystem services from trees (eg water cycling). Cactuses, shrubs and trees can all contribute to creating a microclimate that will encourage soil formation and protect more delicate plants in their shade.

Combating sand encroachment in Mauritania. Credit: EbA South project

In recent years, dryland crop scientists and practitioners have explored in situ conservation techniques which make use of the natural gene banks in the ecosystem (inside soils, plants and animals). This is a practical way to implement ecosystem restoration with resource users, using tried and tested plant and animal varieties that local people know how to raise, process and market (Nabhan 2007). In desert areas, naturally occurring oases can be cultivated using manure from livestock to enrich the soils and support a wide array of sensitive species. Once date palm trees are established, their shade improves living conditions for other plants and animals and they can also provide useful building materials, fuel and other services for human settlements (see Box 6).

Restoring and conserving vegetation such as trees is often a long-term process that requires a sound understanding of local access rights, as well as cultivation practices that will enable trees and crops to survive under dry conditions. Revegetation and restoration can be challenging in dryland ecosystems, particularly if heavy degradation has already taken place. Seedlings and young plants may sometimes require substantial investments in protecting, watering and nurturing (Ramón Vallejo *et al.* 2012). Using plants for sand dune stabilisation is a good example of a dryland EbA intervention and compares favourably to other methods (eg those involving use of concrete or petrol). For example, the United Nations Environment Programme's (UNEP) EbA South project has supported the introduction of trees to prevent the communities from sand encroachment in Mauritania (Lafdal and Soule 2017).

Box 6. In situ conservation of well-adapted species makes sense for Siwa Oasis, Egypt

Agrobiodiversity in Siwa Oasis has remained remarkably unchanged since the 1890s, despite attempts to introduce many desert-adapted crop landraces and wild species from North America, and new high-yield varieties. Several indigenous date varieties are still recorded in Siwa. The introduced varieties mostly did not stand the test of time due to high salinity, heat and freshwater scarcity. Reasons for this include local knowledge of traditional crops, the pride and pleasure local people derive from their traditional cuisine and authentic bi-Siwi ingredients, and the growing economic potential of adapted cultivation and construction practices.

The attraction and comfort of the Siwan building style and townscape owe much to the use of natural materials, including both hewn and living date-palm trunks inside the buildings (Tawfik 2016). The trees also provide shade, windbreaks and fresh breezes in the surrounding streets and gardens. Dates from Siwa have been recognised as a sustainably harvested heritage food by Slow Food International, and these healthy luxury products have also done well on Egyptian and regional markets. From 2016, international date festivals have been held in the United Arab Emirates, awarding ten prizes per year, each of 30,000 Egyptian pounds.

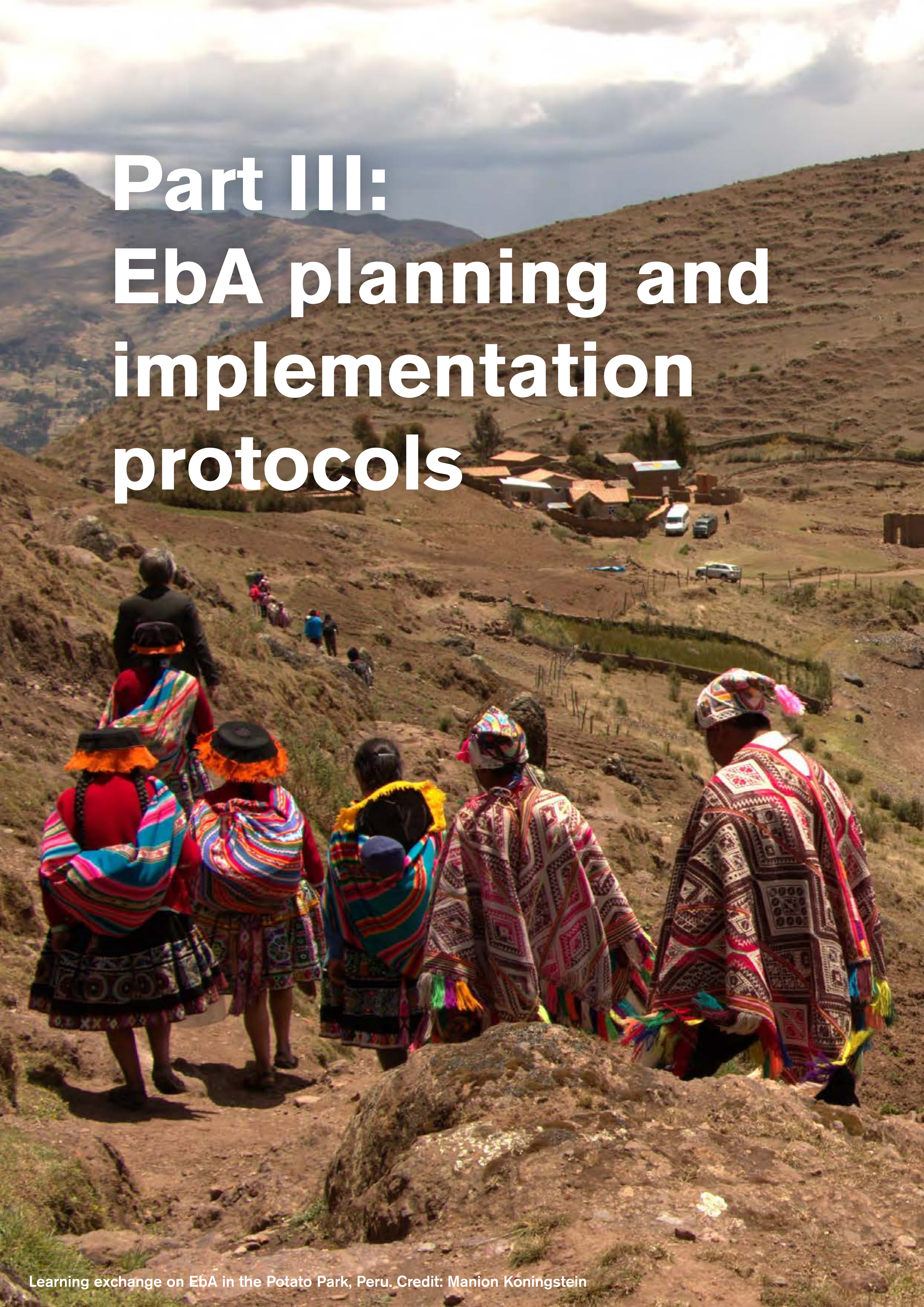
The ingenuity of the Siwan people continues to expand the economic value of their ecosystem-adapted date-palm production. The numbers of date-processing factories in Siwa is still growing. One of the latest products is a caffeine-free coffee-substitute made from ground date seeds. The vogue and premium for these products are enhanced by consumers' knowledge that their authentic flavours and textures are due to the ecosystem-based cultivation practices used to produce them.

Source: based on Nabhan (2007) and Malim (2018).

11 For an example of tree planting in the drylands, see: www.wetlands.org/blog/why-do-we-work-in-drylands

Hand-picking dates from a date palm in the Siwa Oasis, Egypt. Credit: Caroline King-Okumu

Part III: EbA planning and implementation protocols



Learning exchange on EbA in the Potato Park, Peru. Credit: Manion Koningstein

Part III provides step-by-step guidance for planning and implementing EbA interventions on the ground, structured around the eight key steps in the project cycle. Each step provides general guidance applicable to all ecosystems, including the objectives, a brief overview and key sub-steps, followed by specific guidance and examples for mountain, coastal and dryland socioecological systems. The expected outcomes and useful tools and resources are also highlighted for each step. Step 6: Implementing EbA actions on the ground provides general implementation protocols for two to three key types of EbA intervention that have proven effective in mountain, coastal and dryland ecosystems.

STEP 1: EXPLORING VIABILITY AND MOBILISING STAKEHOLDERS

Objective and actions

The first step in an EbA process is to assess the feasibility and potential for EbA in a particular area and socioecological system and start mobilising stakeholders. This should ensure that EbA is conceived correctly and can be implemented and sustained. This preliminary step is particularly important if there has been no prior engagement with local communities in the proposed target area. Participatory processes and the importance of indigenous knowledge should be emphasised throughout this step.

Background research to explore the viability of EbA in a particular area as well as the policy context/feasibility (eg to determine if local organisations can be established by law), should be undertaken before a stakeholder mobilisation process is carried out. This process should include meetings with key stakeholders to explore EbA viability and raise awareness, a preliminary stakeholder analysis, and a community free prior and informed consent (FPIC) process to allow target communities to give or withhold consent for the project (see also Glossary). It also entails establishing a steering committee and facilitation team.

Exploring viability and engaging key actors

Discussions should be held with national and local government, technical experts, non-governmental organisations (NGOs) and local communities to explore the potential for EbA in a particular area. If there is no existing relationship with the communities, discussions should be facilitated by a local NGO or community-based organisation (CBO) trusted by the communities. A meeting should be held to bring together the authorities and members of all the communities in the target landscape to:

- Discuss the project idea, raise awareness about climate change and other threats, and explore existing adaptive capacity and the role of EbA.
- Assess the potential to establish/strengthen collective management at landscape/ecosystem level, including existing local institutions, conflicts and ways to enhance social cohesion.
- Identify potential entry points and possible geographic boundaries/scope for EbA.

The questions in the Checklist 1 can be used as a general guide to assess feasibility, which can be tailored to the local context. The questions can be explored through meetings, focus group discussions (FGDs) and key information with communities, and interviews with governments and technical experts. If answers are yes to questions (a) – (f) and no for (g) then this indicates that the EbA intervention should be pursued, but if the answers are mixed, further assessment and consultation may be needed to determine feasibility and overcome shortcomings.

Checklist 1. Key questions for assessing EbA feasibility

Ask the target community, experts and government the following questions:

(a) Will EbA ensure the resilience of the ecosystem itself?

(b)Will EbA enhance local livelihoods?

(c) Will EbA improve the community's resilience to climate change now and in future (eg up to 2050)?

(d) Will EbA generate cultural benefits?

(e) Are there supportive policies, laws and structures for EbA?

(f) Are there supportive local institutions to implement EbA? If not, is there potential to establish them?

(g) Are there any obstacles that would restrict the implementation and sustainability of EbA?

EbA should be designed and implemented at scales required for conserving or restoring ecosystems and their services, which is usually at landscape level rather than village level. However, for EbA to be community-led and self-sustaining, it needs to be implemented at a scale at which community institutions can operate, without imposing undue travel and time costs or other constraints to collective decision making. Neighbouring communities in a landscape may already have shared customary institutions which can be built on and strengthened. The landscape itself may define the boundaries for collective ecosystem management, and communities may have traditional territories or collective land titles that define administrative boundaries at landscape level (eg in Latin America). Collective management of very large areas may require external support for coordination and linkages between community-managed landscapes.

Preliminary stakeholder analysis

A preliminary analysis of the EbA stakeholders should be carried out, in order to understand:

- Stakeholders who have an influence (positive or negative) on ecosystem management at different levels, from the community to the national level, who can facilitate or hinder the EbA process.
- The key groups of stakeholders in the target ecosystem or landscape, their livelihoods, culture/ethnicity and estimated population size.
- Stakeholders who depend on the target ecosystem for their livelihoods but are vulnerable to climate change-related hazards and impacts.
- The capacity and motivation of different stakeholders for ecosystem management.
- Existing relationships, social cohesion, local institutions and governance systems at village and landscape level.

Rapid rural appraisal (RRA) with the ecosystem-dependent communities can be used to get an initial understanding of the vulnerabilities and capacities of different groups. Communities are not homogenous and some community members may be more vulnerable than others, or vulnerable in different ways. The RRA process should be designed for the local context, taking into account communication needs for local languages and dialects and illiterate people. Stakeholder influence mapping and social network analysis can be used to identify different stakeholders that influence ecosystem management.

Obtaining FPIC consent and co-defining EbA goals

The principle of free prior and informed consent (FPIC) recognises that all peoples have the right to self-determination and the right to freely pursue their economic, social and cultural development (United Nations 2007). FPIC is enshrined in the UN Declaration on the Rights of Indigenous Peoples and is particularly important when working with indigenous peoples and traditional communities. It involves providing full information about a proposed project, including any proposed use, documentation and publication of traditional knowledge, and allows a community to give or withhold consent for a project. Where project ideas are already pre-conceived, FPIC provides an important opportunity for communities to shape project goals and objectives, to ensure their needs are addressed and their customary laws and rights are respected. FPIC should be obtained from each community authority in the landscape and should involve a participatory process designed by communities (see also Box 7).

Establishing a steering committee and facilitation team

This sub-step includes:

- Establishing an EbA steering committee to direct the process, which involves the leaders of each community in the ecosystem/landscape, and which is supported by community researchers, NGO partners, local government and technical experts.
- Assembling an EbA facilitation team involving community researchers appointed by community authorities, NGO/CBO facilitators and technical experts.
- Providing training to community researchers so that they can co-design and facilitate each step of the EbA process. This should include on-the-job training in the field as well as theoretical training and discussion beforehand.

It is important to actively engage local government from the start, including in the EbA planning process, to promote support and funding for EbA initiatives. Involving local government is also important for working at scale. Sound EbA often needs to consider landscape or ecosystem-wide management at very large scales and few NGOs or CBOs work at such scales. Ideally, local government representatives should participate in the EbA steering committee (see also Box 8). However, there may be weak relationships or even mistrust between remote communities and local governments, particularly where indigenous peoples have historically been marginalised.

The EbA management model should be tailored to local circumstances. One option could be to have a local EbA management group made up of community authorities and community researchers, supported by technical experts, and a separate coordinating body that links communities with local government. External facilitators can help to build trust between communities and government, by creating a space for reciprocal exchange and a better understanding of the common interest of everybody involved.

Key outcomes for Step 1

- Decision on whether to start a particular EbA intervention
- Consensus on the way forward and a shared vision established between different stakeholders
- Steering committee and facilitation team established, and agreement on roles and responsibilities of different stakeholders

Tools and resources for Step 1

FGDs and semi-structured interviews

www.nature.com/articles/bdj.2008.192

Gill *et al.* (2008)

Participatory action research in the Potato Park and FPIC

http://pubs.iied.org/14618IIED

Swiderska *et al.* (2012)

Participatory learning and action (PLA) tools

www.iied.org/participatory-learning-action-pla

IIED

Rapid rural appraisal (RRA)

www.fao.org/docrep/w3241e/w3241e09.htm

Crawford (1997)

Stakeholder influence mapping

http://bit.ly/2GJoKX8

Mayers and Vermeulen (2005)

MOUNTAINS: MOBILISING STAKEHOLDERS

Engaging with mountain communities in rural areas can be challenging for cultural and historical reasons. Mountain peoples often belong to indigenous or traditional cultures with different languages, dialects, worldviews and values, and tend to be economically and politically marginalised. Hence it may be necessary to work with local NGOs and CBOs trusted by the community, spend time building trust and mutual understanding, and follow local etiquettes. Community priorities and worldviews should be discussed, as well as key project concepts like EbA and 'ecosystem services'. Equivalent local concepts should be sought where possible and used to frame the EbA process. For example, the Andean worldview is represented by the *ayllu* concept, which consists of three realms: the wild, the domesticated and the spiritual, which have to be in balance to achieve well-being – ecosystem services can be explained in relation to these three realms.

Mountain communities celebrating National Potato Day in Peru. Credit: Asociación ANDES

Bringing together different mountain communities can bring logistical challenges if communities are widely dispersed and served by poor infrastructure, as well as social challenges if conflicts exist between different communities or resource user groups. However, participatory processes with an emphasis on shared culture and livelihood resources can help to build social cohesion (see Box 8). Where communities are from different ethnic groups, it may be more difficult and take more time to build collective institutions for landscape management. Successful mountain EbA is likely to require involvement of all neighbouring communities in a valley, catchment or watershed, including both highland and lower areas, given upstream-downstream linkages and interdependence.

Box 7. Collective landscape management in the Potato Park, Peru

The Potato Park in Peru is an indigenous territory of 9,600ha in the high Andes near Cusco, which is sustainably managed by six Quechua communities. It was formally established in 2002 with support of the NGO Asociación ANDES. Previously, serious resource conflicts existed between neighbouring Quechua communities. ANDES helped to bring the communities together using the potato as a symbol of shared cultural heritage and key staple crop. Emphasis on indigenous peoples' culture, identity, history, spirituality, food, knowledge, concepts and worldviews, and investment in participatory action research processes, have built social cohesion and strong local institutions, and capacity for collective ecosystem and genetic resource management, ensuring long-term sustainability and impacts. The park is managed by an association of Potato Park communities, composed of representatives of each community authority, with technical support from community researchers and ANDES.

The six communities are experiencing more extreme and variable weather. Rainfall has become more erratic and communities have observed more extreme weather events such as frost and drought since the park was established in 2002. Soil pests and diseases have increased significantly due to rising temperatures. Meteorological data confirms that temperatures have become more extreme in the Cusco region in the past 40 years, and indicate more extreme droughts associated with El Niño. Diversification of native potatoes has been a key strategy to reduce the risk of crop failure and has led to increased potato productivity despite severe climate change impacts.

ANDES conducts FPIC processes at the start of each participatory action research project and each main activity, and holds training workshops to build the capacity of community researchers to co-design the research and facilitate the research themselves. It also facilitates collaborative research and two-way capacity building between indigenous farmers and scientists from the International Potato Center for genetic resource conservation and climate adaptation (see also Step 6, mountains section).

Source: Swiderska and INMIP (2017)

COASTAL: MOBILISING STAKEHOLDERS

An effective EbA intervention is one that can increase the resilience and adaptive capacity of coastal ecosystems and vulnerable people while at the same time helping to maintain livelihoods using coastal ecosystems services. Coastal ecosystems include areas such as mangrove forests, sand dunes, seagrass beds, coral reefs, lagoons, beaches and fishing grounds. Different groups of people can depend on a particular coastal ecosystem. For example, a mangrove forest ecosystem can support livelihoods of people such as fishers, hunters, honey collectors, fuelwood collectors, oyster collectors, shellfish post-larvae collectors, tourist businesses and fish culturists (in cages and pens). A coastal ecosystem can support multiple livelihood activities for a range of communities. To make coastal EbA effective, these dynamics need to be taken into account.

The preliminary stakeholder analysis should identify stakeholders whose livelihoods depend on coastal resources and are vulnerable due to their exposure to climatic hazards such as storms, sea-level rise and coastal flooding. Many have limited capacity to adapt. Some community members may be more vulnerable than others, or vulnerable in different ways. For example, in coastal Bangladesh it was found that women and children are affected more during cyclone periods. For women, the wearing of special clothing (*sharee*) and long hair hindered their swimming capability, making them more vulnerable during this time (Alam and Collins 2010).

Bangladesh. Credit: Md Monirul Islam

DRYLANDS: MOBILISING STAKEHOLDERS

Actively engaging different dryland stakeholders in EbA planning and implementation entails designing activities with their needs in mind, which will affect their location, timing and duration. It may also mean making provisions for childcare arrangements. Recent experiences in stakeholder engagement in the arid lands of Kenya have demonstrated that if women know that they are welcome, they will participate in public meetings – even in areas where these are traditionally male dominated (see example in Jarso *et al.* 2017). In areas where the population includes a range of migration patterns (seasonal or permanent), identifying and engaging all key stakeholders can be particularly complex. In some dryland contexts, bringing stakeholders together can be time consuming and challenging if there are logistical or cultural challenges, or in contested territories (eg Israel and Palestine, parts of the Omo Basin in Ethiopia).

Participatory network mapping has been applied in many different ways in dryland contexts to visualise and explore actor linkages (eg Mayers 2005, Schiffer and Hauck 2010, Stein *et al.* 2014). The simplest tools have often proved to be the most effective – but their effectiveness depends on the attitude of the facilitator and his or her ability to build a rapport among the group. For example, in a social network analysis in the Blue Nile, Ethiopia, relationships between different stakeholders (different government authorities, donors, NGOs, enterprises etc) were mapped visually to generate narratives about the interplay among actors and discuss their implications for ecosystem management (Stein *et al.* 2014). EbA project steering committees should bring together different stakeholders, particularly local communities and local government, to co-define project goals (see Box 8).

The village of Dana in the Dana Biosphere Reserve, Jordan. Credit: Caroline King-Okumu

Box 8. Establishing a steering committee and facilitation team, Dana Biosphere Reserve, Jordan

The Dana Biosphere Reserve was established by the Royal Society for the Conservation of Nature (RSCN) in Jordan in 1989 in Wadi Dana, Tafilah Governorate, southern Jordan, 200 km south of Amman City. Tafilah, Shawbak and Mu'an are the closest major cities, all within a 30 to 40-minute drive from the reserve. The inhabitants of Dana either follow nomadic lifestyles and practices to breed goats and sheep using extensive grazing, or are settled in or around the reserve. The productivity of the rangelands fluctuates from year to year according to the climatic conditions. The reserve's management has observed that the changing and increasingly variable climate was making land-management planning difficult due to the lack of databases on the changing conditions that could be used to develop collective management strategies (Smadi 2014). Key challenges included the maintenance of water levels in the wells and the condition of the grazing areas.

According to the wishes of its stakeholders, the reserve set out to combine conservation and development, so that protection of nature would go hand-in-hand with improving the social and economic conditions of local people and contributing to their welfare. Development activities included the production of unique handicrafts and organic food items and thriving eco-tourism activities. These nature-based businesses are a source of employment and income diversification. For example, the reserve management made a regular commitment to buy 80 per cent of the produce from the terraced gardens around Dana village and established a workshop to process it into high-value soap and other cosmetics. The reserve also established workshops for leatherwork and silver work and opened three ecotourism facilities that each employ local staff and generate an income of around US$40,000 per year. This is enough to cover the running costs of the reserve, making it sustainable from a financial as well as an ecological perspective. The conservation activities have helped to sustain ecosystem services such as water for climate adaptation, and diversification of local livelihoods has reduced vulnerability by reducing the dependence on livestock raising as the only source of income.

RSCN established a steering committee to direct the process, which involves representatives from each community authority in the reserve, as well as NGO partners, local government and technical experts. Local government representatives have participated in the steering committee from the start, including in the planning process. They promote support and funding for EbA initiatives. This has enabled consideration of landscape and ecosystem-wide management at a large scale. Building relationships and trust between remote communities and local government has been critical from the outset. Indigenous peoples have been able to assert their right to self-determination at Dana and work with governments in decision making.

External facilitators and rangers have helped to build trust between communities and government. A coordinating body links community with local government. Site assessment, learning and international knowledge-exchange activities were boosted from 2003–2014 with support from an international cooperative research project, Sustainable Management of Marginal Drylands (SUMAMAD), supported by the Flemish government of Belgium and led jointly by the United Nations Educational, Scientific and Cultural Organization (UNESCO), the United Nations University and the International Center for Agricultural Research in the Dry Areas (ICARDA).

Source: Smadi (2014) and SUMAMAD project

STEP 2: UNDERSTANDING THE LIVELIHOODS AND ECOSYSTEM CONTEXT

Objective and actions

Having identified the stakeholders (Step 1), this step aims to understand their livelihood strategies and how ecosystems and their services support livelihoods and well-being. This step serves as the basis for understanding how climatic and non-climatic threats contribute to ecosystem and livelihood vulnerability. It may be a stand-alone step, or conducted as part of a participatory vulnerability assessment (Step 3).

Participatory livelihoods and ecosystem services assessment

Discussions and participatory rural appraisal (PRA) exercises (eg participatory livelihoods and resource mapping) should be conducted with local communities to further understand the different livelihoods groups, the importance of different ecosystem services for the livelihoods and well-being of the different groups, and the ecosystems that provide these services. Ideally, members of all the communities/villages in the landscape/ecosystem should participate. Representatives of different stakeholder groups, backgrounds, gender and age groups should be given equal opportunity to express their perceptions and knowledge. Checklist 2 provides a series of key questions which should be addressed through the PRA exercises.

Checklist 2. Key questions to address during PRA exercises

What are the main characteristics of the ecosystem/landscape?

What are the key livelihood activities in the socioecological system?

What are the key livelihood groups?

How are ecosystem services important for livelihoods and well-being, including subsistence, fodder, income, DRR, fuel, cultural and spiritual values, health and shelter?

What is the level of dependence of the different livelihood groups on different ecosystem services and biodiversity?

Is there any difference in the level of access to these resources by different groups (wealthy/poor, male/female, young/old)?

What are the ecosystems that supply important services?

How have the levels of ecosystem services changed over time, and why?

A livelihood and resource mapping exercise at landscape level can be a useful starting point to identify and discuss the main natural resources (ie ecosystem services) used by communities at household level, on farms and in the landscape. Participatory mapping using transect walks and Global Positioning System (GPS) tools can help communities and external experts to start assessing the condition of different ecosystems as they walk through the landscape. The resulting maps can also be used to identify potential resources in the landscape for sustainable use and collective microenterprise development to generate early livelihoods benefits and secure community buy-in.

FGDs involving different livelihood groups may be useful to understand the importance of different ecosystem services (if there is more than one livelihood group). Historical timelines can be used to assess trends in ecosystem services. Participatory hazard mapping may also be useful for identifying the role of ecosystems in regulating the level of hazards such as flooding, mudslides and wind, that can impact on crops and infrastructure (see Step 3).

Key outcomes for Step 2

- **Information on different livelihood groups/sources, the most important ecosystem services and the ecosystems that provide these.**
- **A map showing ecosystem services/resources, access to the resources by different community groups and the condition of different ecosystems.**
- **Initial baseline data on ecosystem health, livelihoods and vulnerability, based on local knowledge.**

Tools and resources for Step 2

Participatory rural appraisal (PRA):

www.fao.org/docrep/003/x5996e/x5996e06.htm

Crawford (1997)

Understanding the context:

www.adaptation-undp.org/sites/default/files/downloads/viag_guidance.pdf

Munroe *et al.* (2015)

Participatory resource mapping to develop microenterprises:

http://pubs.iied.org/14670IIED/

Swiderska and INMIP (2017)

Participatory mapping tools (eg mapping traditional knowledge and resource use, conflict resolution)

http://pubs.iied.org/14507IIED

Rambaldi, G *et al.* (2006)

Integration of participatory mapping tools (eg mapping traditional knowledge and resource use) with available information from OpenStreetMap and remote sensing:

www4.unfccc.int/sites/nwp/pages/item.aspx?ListItemId=25554&ListUrl=/sites/nwp/Lists/MainDB

http://asal-wiki.geodata.soton.ac.uk/index.php/RADIMA_Wiki

MOUNTAINS: SECURING EARLY LIVELIHOOD BENEFITS

The Potato Park in the high Andes near Cusco is a sustainably managed landscape (see Box 8). It provides an example of how resource mapping can be used to identify ecosystem-based goods and services to generate early livelihood benefits. Following participatory mapping of biocultural resources in the landscape, the Potato Park communities have established collective microenterprises for a range of landscape-based products and services, such as medicinal plants (herbal teas and personal care products), agroecotourism, native potatoes (potato shampoo), traditional gastronomy and handicrafts/textiles (Swiderska and INMIP 2017). This has strengthened local institutions, incentives and knowledge for collective landscape/ecosystem management, generated additional income to increase resilience to shocks, and increased the economic viability of biodiversity-rich agroecological farming systems. Household incomes have nearly doubled, largely due to agroecotourism (Asociación ANDES 2016).

The Potato Park microenterprises are largely made up of women, who are generally poorer and more vulnerable than men. Ten per cent of the revenue from microenterprises is invested in a community fund and distributed equitably to communities based on their contribution to sustainable management. The fund also provides a safety net for the poorest people (eg widows and orphans). An inter-community agreement for benefit sharing guides the distribution of funds based on customary laws. Sustainable management of the Potato Park landscape also helps to ensure water provision for downstream populations, including the city of Cusco.

Landscape-based products and services for livelihoods diversification in the Potato Park, Peru.
Credit: Asociación ANDES

COASTAL: UNDERSTANDING THE RANGE OF ECOSYSTEM-BASED LIVELIHOODS

Coastal communities' livelihood activities often include a range of occupational sectors, such as fishing, selling marine products, tourism, farming, cash crops, collection of marine organisms from shallow or intertidal areas, salaried employment, and casual labouring. The resources they get from the ecosystem can include both income-generating (eg fish) and non-income generating resources (eg reduced disaster risk, food for consumption).

There are often different sub-groups within a coastal livelihood group. For example, in coastal fishing communities there are commissioning agents, middlemen, traders, boat and net owners, technology suppliers, credit providers, boat captains and crew, fish processors, and fishing gear makers and menders. The level of dependence on ecosystems varies not only between different coastal occupational groups but also within a given category. For instance, there are often full-time, part-time and occasional fishers. Oyster collectors may work throughout the year but profits may be lower at different times. As in many communities, access to resources often varies among different sub-communities of a coastal ecosystem and different groups within a community. Factors like social status, political influence, age and gender often create unequal access to resources. For example, in some South Asian countries the caste system often prevents equal access to coastal fishery resources and to development assistance (Salagrama 2006).

Bangladesh. Credit: Md Monirul Islam

DRYLANDS: UNDERSTANDING COMPLEX LIVELIHOOD STRATEGIES

In drylands, it is important to be aware that people may frequently change occupations or supplement their livelihoods in times of stress by practising a complex range of different activities. For example, not all young men who normally farm in the dryland ecosystems of the Northern Sahara will always practise only this livelihood activity (Alary *et al.* 2014). Therefore, it is always important to ask the questions like: what did you do before? And, what do you hope to do in the future? It is also important to keep in mind that these are personal questions that the people may feel reluctant to give complete answers to. Therefore, at the beginning it must be made clear what the answers will be used for, so that all stakeholders can understand the intention. Less direct questions can also be asked about livelihood types and incomes, in addition to casual observations.

Gender can influence livelihood options in all ecosystems – including in the drylands. Male-dominated facilitation and stakeholder groups tend to focus the discussion on male-dominated agricultural activities. But drylands can include a wide range of non-agricultural livelihoods involving women and men, for example: dairies, hotels and hospitality industries, construction industry, transportation of people and commodities, intermediaries, agents, advocates, lawyers or technicians etc. Some livelihoods are traditionally predominantly practised by women, such as camel milk trading in the Horn of Africa (Musinga *et al.* 2008, Mwaura *et al.* 2015), and the collection of medicinal or aromatic plant products, such as the baobab in West Africa (Ba *et al.* 2006).

It is important that the project team should be ready to question assumptions about livelihood strategies through an inclusive discussion with members of all parts of the community, including women, youth and minority groups.

Besides the occupations identified above, important industries in many of the most marginalised dryland areas concern the provision of services and relief, including drought and famine relief and project-based international support. In areas where humanitarian emergencies frequently occur, 'boom-and-bust' patterns may be inherent features in the local economies and livelihood strategies (Hesse *et al.* 2013). EbA is still possible in these contexts. A recent EbA review (Emerton 2017) includes examples of projects in humanitarian crisis situations, including drought-stricken Sudan (Khogali and Zewdu 2009) and Niger (Vardakoulias and Nicholles 2014).

Participatory resource mapping (Smith *et al.* 2000) and database development (Jarso *et al.* 2017) can incorporate consideration of changing ecosystem service conditions and uses during emergencies such as droughts and floods. Of all the ecosystem services, mapping water sources is essential to understand dryland ecosystems and livelihoods. This should include seasonal sources as well as permanent ones. Energy options and costs are often a related factor mediating water resource scarcity.

Participatory mapping and database development for strategic planning in Isiolo County, Kenya
© Caroline King-Okumu and Ibrahim Jarso

STEP 3: ANALYSING CLIMATE RISKS AND VULNERABILITY

Objective and actions

Having identified the main ecosystem services important for livelihoods in Step 2, this step aims to assess their vulnerability to climatic and non-climatic hazards and threats, including actual and projected changes in climate, and how climate change will exacerbate other threats (eg mining, logging). Addressing specific climate change hazards is essential to make EbA measures additional to existing practices.

This step also aims to assess adaptive capacity based on all assets (human, ecological, economic, physical) and understand different sources of vulnerability. It entails a rapid participatory vulnerability assessment, and a more formal and science-based vulnerability and impact assessment. It may also seek to generate early livelihoods benefits to secure community buy-in.

Rapid vulnerability assessment

A preliminary (or rapid) participatory vulnerability assessment is important to identify the key ecosystem services and ecosystems to focus on and narrow the scope for a more in-depth vulnerability and impact assessment (VIA). Consultations, workshops and PRA exercises, such as participatory hazard mapping using a vulnerability matrix should be conducted to understand communities' perception of climate change impacts and vulnerability and identify initial proposals to address vulnerability using ecosystem services and biodiversity.

Ideally, this process should involve all the communities in the landscape to gather local knowledge and strengthen the basis for collective management. Scientists, ecosystem specialists and local authorities can help communities to prioritise proposals to reduce local vulnerability, taking climate projections and existing studies on ecosystem services into account. The results of the rapid vulnerability assessment can be used to design measures to reduce vulnerability and generate early livelihood benefits for communities, which is important to secure community buy-in (see also Step 3 Mountains section).

Participatory vulnerability matrix: assessing vulnerability to hazards

A participatory vulnerability matrix exercise can be conducted to assess the vulnerability of different stakeholder groups to climatic and non-climatic threats, for example by using the climate vulnerability and capacity analysis (CVCA) vulnerability matrix tool developed by CARE (see Tools and resources, Step 3). This exercise entails the following steps:

- A group of about 8–10 community members can attend a PRA session. At the start of the session, a matrix needs to be prepared on a blackboard, on a large paper sheet or on the land, depending on the location (see Table 1).
- The group should then be asked to identify five resources, including ecosystem services, that are most important for their livelihoods. These priority resources should be listed down the vertical side of the matrix (such as food, forests, water).
- Participants should then be asked to identify the most significant hazards to these livelihood resources (such as drought or landslides). The discussion should not be limited to only climate-related hazards, but if participants do not identify climatic hazards, they should be prompted. The participants should share their observed climatic hazards, both slow creeping changes and extreme events. The five most important hazards should be listed horizontally across the top of the matrix.
- The group should then be asked to score the level of impact of a particular hazard on livelihoods resources (for example 3 = significant impact, 2 = medium impact, 1 = low impact, 0 = no impact).
- While coming to a consensus on the scores, the participants will explain how the scores differ and how the hazards create impacts.

Table 1. Vulnerability matrix – a fictional mountain community example

Livelihood Resources**	Hazards*				
	Drought	Overharvesting	Logging	Landslides	Rising temp
Food crops	3	0	0	2	3
Medicinal plants	2	3	1	2	2
Forests	2	2	3	1	2
Water	3	1	2	2	3

Notes:
*Include both climatic and non-climatic hazards
**Include both ecosystem services and other livelihood resources that are important to the community

Scientific data on climate change projections obtained from the IPCC, World Meteorological Organization (WMO) or trusted sources should also be shared with participants to explore likely future hazards and impacts on livelihoods. If there is more than one projection and they differ considerably then all of them should be shared. The scores given to different hazards can be adjusted taking future projections into account.

Vulnerability can also be assessed using an index-based or indicator-based approach. Participatory exercises can be complemented with FGDs and household interviews for a more in-depth and quantitative understanding of local climate trends, vulnerability and adaptive capacity (see sections below on VIA and establishing a baseline for monitoring and evaluation). In areas inhabited by indigenous peoples, biocultural approaches to local climate vulnerability assessment, that use indigenous peoples' own concepts and methods, can provide an empowering and culturally appropriate way for communities to assess climate change impacts on their territories and plan adaptation responses that build on traditional knowledge as well as science. Such local assessments can also provide much needed information about climate change trends at local level and promote understanding of the holistic indigenous vision that considers these trends and their impacts comprehensively (see Box 9 and Asociación ANDES and IPCCA, undated).

Box 9. Climate vulnerability assessment using a biocultural approach

The Indigenous Peoples' Biocultural Climate Change Assessment (IPCCA) Initiative has developed a methodology for local biocultural assessments, which seek to build bridges between indigenous knowledge and mainstream/scientific knowledge. Information is collected on:

- Local biocultural context, including trends in practices and their relationships with the local ecosystem, current and historical weather conditions,
- Local perceptions of resilience and well-being, and
- Potential impacts of climate change based on local perceptions.

Scientific and technical information on climate change and its impacts on the local site is also gathered through literature searches and interviews with experts. Impacts on interlinked biocultural systems are explored (ie biodiversity, landscapes, traditional knowledge and culture), taking account of non-climatic sources of ecosystem degradation and vulnerability. Future visioning exercises are undertaken to develop adaptation strategies that address likely climate change impacts.

Source: Asociación ANDES and IPCCA (undated)

Vulnerability and impact assessment (VIA)

Depending on the availability of existing data (eg on ecosystem functions, climate change impacts and future projections of ecosystem services supply), a more comprehensive VIA or additional scientific studies may be needed, building on the rapid assessment. A formal VIA may also be important to provide a more scientific assessment of climate change impacts on ecosystem services at a larger scale appropriate for EbA (eg at watershed or catchment level) with a focus on the provision of ecosystem services in the medium and long term.

VIAs can complement and validate the results of participatory assessments to enable the design of longer-term climate-focused EbA measures, building on initial 'no regrets' measures. The latter have been defined as measures which:

- Do not worsen vulnerability to climate change
- Increase adaptive capacity, or
- Have a positive impact on livelihoods and ecosystems regardless of how the climate changes.

Integrated management at ecosystem scale can better address climate hazards such as floods, while providing livelihood benefits such as improved livestock yields and agricultural production (Nyman *et al.* 2015). Comprehensive analysis provided by VIAs can also promote EbA mainstreaming in government planning processes (Step 8).

VIAs assess vulnerability of ecosystems and people by:

- Measuring sensitivity, exposure and adaptive capacity in a particular area,
- Assessing climate change implications for ecosystem functions (structure and processes) that provide ecosystem services for livelihoods and well-being, and
- Determining the extent to which climate change will have an impact, to inform the planning and implementation of EbA measures.

The analysis can be predominantly **qualitative**, comparing exposure and sensitivity across different livelihoods groups and areas. Where appropriate information is available, a **quantitative** indicator or modelling approach can be used to provide a more scientifically rigorous (but resource-intensive) assessment. Indicators of sensitivity, exposure and adaptive capacity can then be used to map composite vulnerability across an area and identify the most vulnerable areas.

Assessing current exposure and sensitivity involves identifying the key characteristics of ecosystem functioning for ecosystem service supply, and then identifying the climatic parameters that influence this functioning. The way in which a particular ecosystem supplies a service is determined by ecosystem structure, ecological interactions and species composition. Information on climatic parameters should be gathered from sources such as meteorological stations and government agencies, to assess the exposure of ecosystems by identifying observed variability and trends in these parameters. Guidance on how to gather such information is covered by established VIA methods and tools (see Munroe *et al.* 2015 and Step 3 Tools and resources).

Assessing adaptive capacity and differential vulnerability

The adaptive capacity of individuals, households and communities is shaped by access to and control of resources needed for adaptation, including natural, human, social, physical and financial resources. Local communities may have low access to financial resources, but significant natural, social and human resources – such as biodiversity, customary institutions and traditional knowledge for adaptive ecosystem management. However, access to natural resources, land and social networks/information for adaptation may not be evenly distributed among stakeholder groups. Hence it is important to also identify underlying causes of vulnerability, such as poor governance, gender-based inequality over resources use, or access to basic services. These should be taken into account when planning EbA interventions. CARE's climate vulnerability and capacity analysis (CVCA) framework (CARE 2009) facilitates analysis of adaptive capacity, or 'differential vulnerability', along with its more recent *Planning for resilience* handbook (CARE 2015) (see also Step 3 Tools and resources).

Across ecosystems, women may be more vulnerable than men if they earn less, are less able to travel to find work, or have a growing work burden due to male out-migration. However, women's vulnerability differs in different ecosystems and cultural contexts. Elderly people may be among the most vulnerable (along with widows, orphans and disabled people). However, women and elderly people may also be very knowledgeable about ecosystem management and climatic trends and impacts.

Establishing a baseline for monitoring and evaluation

The data collected in Steps 2 and 3 can provide a baseline for monitoring and evaluation (M&E). M&E indicators should be identified at this stage, and further baseline data can be collected through FGDs (qualitative data) and household surveys (quantitative data) on key indicators. Indicators should be selected with communities, taking into consideration other aspects which communities may want to monitor (such as the Sustainable Development Goals). Community researchers should be trained to facilitate baseline surveys and collect data, and to store the data in community databases (see Checklist 3 and Step 7 on M&E).

Checklist 3. Key indicators for establishing a baseline

Key indicators may include:
- Ecosystem health (such as diversity of species)
- Ecosystem services (such as water, genetic diversity)
- Livelihoods (such as income)
- Food security (such as yield, resilience)
- Adaptive capacity (such as knowledge, capacity, institutions)
- Health and well-being (such as social cohesion and cultural and spiritual well-being)

Key outcomes for Step 3

- **Participatory/local assessment of vulnerability of ecosystems and livelihoods to climatic and non-climatic hazards**
- **Scientific/formal vulnerability and impact assessment**
- **Baseline data on key indicators for M&E (qualitative and quantitative)**

Tools and resources for Step 3

CRiSTAL: Community-based risk screening tool – adaptation and livelihoods
www.iisd.org/cristaltool
IISD

CVCA: Climate vulnerability and capacity analysis
https://careclimatechange.org/tool-kits/cvca
CARE (2009)

Index-based vulnerability assessment
https://link.springer.com/article/10.1007/s10113-013-0487-6
Islam *et al.* (2014)

Integrating ecosystem considerations into climate change VIA to inform EbA Indicator-based vulnerability assessment
www.adaptation-undp.org/sites/default/files/downloads/viag_guidance.pdf
Munroe *et al.* (2015)

EbA planning tool ALivE: Adaptation, Livelihoods and Ecosystems
www.iisd.org/project/ALivE
UNEP-IEMP and IISD (2018)

Inventory of tools and methodologies relevant for EbA practitioners
http://bit.ly/2F46Vom
UNEP-WCMC *et al.* (2015)

Local assessments: methodological toolkit
http://ipcca.info/toolkits/ipcca-methodological-toolkit.pdf
Asociación ANDES and IPCCA (undated)

Mountain EbAs
'No regrets' measures for mountain EbA
http://bit.ly/2EPtldQ
Nyman *et al.* (2015)

Poverty-forest tool kit
www.iucn.org/content/profor-iucn-poverty-forest-tool-kit
PROFOR-IUCN

Practitioner guidance on supporting CbA to climate change
http://careclimatechange.org/publications/planning-for-resilience-in-vietnam
CARE (2015)

Soil and water assessment tool
http://swat.tamu.edu
See also Arnold *et al.* (2012)

VIA of a mountain EbA programme, Peru
http://adaptation-undp.org/sites/default/files/downloads/via-english.pdf
Dourojeanni *et al.* (2014)

Water evaluation and planning system
www.weap21.org
See also Huang and Cai (2009)

MOUNTAINS: ANALYSING CLIMATE RISK AND VULNERABILITY

Rapid vulnerability assessment and 'no regrets' measures

The UNDP, UNEP and IUCN Global EbA in Mountains Programme in Peru, Uganda and Nepal conducted rapid vulnerability assessments early on to understand the role of ecosystem services in supporting livelihoods and the drivers of ecosystem degradation, using different methods and tools (Nyman *et al.* 2015). Local perceptions of climate variability were used along with existing data on climate projections. Based on this, 'no regrets' adaptation measures were identified to generate early livelihood benefits for communities. The 'no regrets' measures were implemented at community level and then scaled up to landscape level or modified after a formal VIA.

In Peru, the project focused on two Andean communities near Lima - the Nor Yauyos-Cochas Landscape Reserve and the Canchayllo community. The reserve's management plan provided good information on ecosystems and ecosystem services. Consultations were held with local villagers through field visits and workshops to understand their own interpretation of vulnerability and identify preliminary proposals to address vulnerability.

The two communities identified the need to improve water availability in the upper area, and grassland and livestock management. As they rely primarily on livestock farming and subsistence agriculture, access to water and pasture is key. A shift to cattle farming had caused degradation of the native grassland ecosystem. Climate change scenarios also suggested possible impacts on grassland and water resources, including issues of water storage and regulating impacts of temperature extremes.

'No regrets' measures were designed using an integrated participatory rural appraisal approach involving PRA and RRA methods (eg timelines, trend lines, interviews, focus groups and participant observation) and scientific knowledge. Weak social organisation was identified as a driver of degradation, and activities to strengthen institutional and technical capacity were identified as priorities. Native grassland management, improvement of ancestral hydrological structures and conservation of upper microwatersheds, wetlands and watersheds were also prioritised as potential 'no regrets' measures (Nyman *et al.* 2015).

In Uganda, a participatory vulnerability assessment was conducted in the Sanzara community, Mount Elgon, to develop social baselines. Two tools were used to carry out rapid assessments of potential climate impacts and see what adaptation measures communities were already undertaking (CRiSTAL and CVCA, listed in Tools and resources for Step 3).

Five-year timelines and trends were developed based on available national-level climate data. A problem and solution matrix put forward the main challenges linked to climate change – flooding and drought were the two problems prioritised. The matrix showed how these affected livelihoods and different categories of people. A list of 'no regrets' activities was identified based on the assessment and ongoing activities, and pro-poor activities were prioritised. The PROFOR-IUCN poverty-forest toolkit was used to identify livelihood dependency on natural resources (listed in Tools and resources for Step 3). Water shortage was identified as a key challenge for local livelihoods and resilience.

The assessment found that addressing water shortage through a proposed gravity flow scheme (GFS), would provide early benefits for communities, and build adaptive capacity to manage natural resources as a community. This involved constructing a concrete reservoir to capture river water high in the catchment and piping it down to agricultural fields located in a rain shadow (a dry area where mountains block rain-producing weather and cast a dry 'shadow') that is likely to worsen with climate change. The GFS was used as an incentive and entry point to create a platform for planning sustainable management of the entire catchment to enhance social and ecosystem resilience. Through this GFS platform, various 'no regrets' measures (including riverbank restoration, soil and water conservation and integration of agroforestry in the farming system) were designed as a means to secure community buy-in and commitment, which were then used to make the case for broader-scale EbA measures, such as watershed restoration, that were adopted later on.

Vulnerability and impact assessment (VIA)

In Peru, The UNDP, UNEP and IUCN Global EbA in Mountains Programme assessed the impacts of climate change on ecosystem goods and services – water, natural grasslands and agricultural area – in 11 districts. In each district, the VIAs analysed:

- Future climate scenarios
- Hydrology (surface water run-off)
- Ecosystems and ecosystem services, and
- Impacts of human pressure and demand on their supply: medicinal plants, fuelwood, animal protein and fibre, scenic beauty and tourism, forage and water.

These were analysed based on population growth, and changes in future supply of ecosystem services due to climate change. This was modelled using the future distribution of species considered key for such services. Socio-economic characteristics were also examined as these can influence the vulnerability of a population and its ability to adapt to future changes, including percentage of poverty, dependence on ecosystems, medical service coverage and level of education.

Sanzara Gravity Flow Scheme. Credit: IUCN Uganda

COASTAL: ANALYSING CLIMATE RISK AND VULNERABILITY

A vulnerability matrix exercise can be useful to understand the livelihoods resources and climatic and non-climatic hazards faced by coastal ecosystems and communities – see the example in Table 2.

Table 2. Vulnerability matrix – a fictional coastal community example

Livelihood Resources**	Hazards*				
	Cyclones	Storm surge	Fire	Land erosion	Conflict
Mangrove forest	2	3	1	2	0
Land	0	2	0	3	2
Fishing boat	3	3	1	1	1
House	2	3	3	3	1
School	2	3	1	3	0

Notes:
*Include both climatic and non-climatic hazards
**Include both ecosystem services and other livelihood resources that are important to the community

Vulnerability and impact assessment (VIA)

A vulnerability assessment of mangroves to climate change and sea-level rise impacts was done by Ellison (2015). He used three dimensions of vulnerability:

- Exposure to stresses
- Associated sensitivity
- Related adaptive capacity

Ellison measured the variables of each dimension at sites in Africa and the South Pacific. This vulnerability assessment of mangrove systems integrated biotic and abiotic factors (living and non-living things) along with human management components. These include determining mangrove forest health, adjacent ecosystem resilience, the extent and effects of human impacts, and the environmental conditions of different mangrove settings.

DRYLANDS: ANALYSING CLIMATE RISK AND VULNERABILITY

Participatory vulnerability assessment in the drylands will reveal management strategies and capacities to respond to hazards that occur in water-stressed environments. These may include gradual and extended increases in scarcity or sudden shocks such as floods or fires. Often, there is a complex layering of hazards that are combined, including some that are climate-related and others that are not (Huang and Cai 2009, Karlberg *et al.* 2015).

Having established a relatively simple variation on the two-dimensional vulnerability matrix (eg for different producer groups as seen in Box 10), it can be of interest to discuss the additional complexity of factors and coping strategies involved. Such exercises are inevitably subjective and will be influenced by participants' perceptions of the objective of the exercise, for example, whether they might get emergency relief or get taxed etc (Hesse 2018).

If the anticipated climate change impacts concern drought, floods and water scarcity, but there are information gaps about these phenomena (as for vulnerability to groundwater depletion in many dryland contexts), then more attention could be paid to building local scientific capacities for projections of future hydrology, water storage and water resource management during the VIA.

GIS can help to build on participatory resource maps (generated in Step 2) to incorporate analysis of population growth and other factors anticipated to affect vulnerability. Relevant characteristics which are often considered include (but are not limited to):

- Percentage of people living in poverty
- Dependence on ecosystems
- Medical service coverage
- Levels of education

If georeferenced datasets from the national census are available (eg as in Mwangi 2015), these can be used to analyse the spatial distribution of these factors in different areas of the system, and to consider the possible causal effects and dynamics affecting the vulnerability of populations in particular areas.

Box 10. Scoring scale for vulnerability and resilience to climate extremes and hazards in Mopti, Mali

Participants in participatory assessments of resilience and vulnerability in the region of Mopti included resource users, local decision makers and staff members of the available technical services and NGOs. The purpose of the assessment was to prepare for a discussion of possible investments to build resilience. The project was supported by the UK Department for International Development (DFID) programme Building Resilience and Adaptation to Climate Extremes and Disasters (BRACED) through an initiative led by the Near East Foundation, Innovation Environnement Dévéloppement (IED) Afrique and IIED on decentralised climate funds (DCF).

The participants identified three broad climatic zones in the region of Mopti ranging from dry to more humid areas. They then considered the vulnerability of different production sectors in selected administrative units (*cercles*) representative of each climatic zone.

To assign a score for the resilience of producers in each of the areas, the facilitator asked the participants to visualise a sliding scale from vulnerability to resilience and describe characteristics of increasing vulnerability in one direction along this scale, as opposed to characteristics they associated with decreasing resilience in the other direction of the scale.

Participants were then able to categorise the position of different groups of producers in relation to this sliding scale. This enabled them to assign scores for the different levels of resilience, and to debate and discuss factors or strategies enabling different groups to become more resilient. The scores were recorded in a matrix, differentiating the vulnerability and resilience among different climatic zones within the region (Table 3). The activity also produced a rich descriptive qualitative report prepared by the NGO staff members who facilitated the activity.

Table 3. Matrix for categorising resilience of production systems by climatic zone, Mopti, Mali

Climatic zone	Administrative unit ('Cercle')	Agriculture	Livestock raising	Fishing
Dry and semi-humid	Douentza	2	2	2
Dry	Koro	3	2	-
Humid	Mopti	2.5	3.5	2

Source: Keita and Koulibaly (2016)

Donors can reinforce systematic data sharing – as Danida does for water resource assessments it has supported in Kenya.[12] Stakeholders can then also shed light on areas where additional data collection may already be under way or would be welcomed as part of the VIA or the EbA intervention itself.

To understand vulnerability to climate hazards such as flooding, groundwater recharge and transmission of contaminants or salinity threats, GIS-based tools can also be helpful. They enable users to overlay maps of topography, geology, and human activities, including waste-emitting activities, high-input agricultural production or settlement types etc (see for example Jarray *et al.* 2017, Box 2). GIS tools can also accommodate analyses across a range of different scales and enable information on factors such as water resource and vegetation conditions, health effects or migratory patterns to be filtered according to timing in relation to different seasons or specific climatic events.

These databases can later provide a basis for mapping EbA interventions and their effects, and creating monitoring and evaluation systems. Baseline datasets established at this stage might include:

- Characteristics of water resource availability
- Productive activities
- Product values (including consideration of both input requirements and output values)

Researchers have explored how to combine participatory mapping techniques with remotely sensed information to create decision-making support tools. Studies of this kind have been undertaken by students and faculty members with Bedouin communities in the Western Desert of Egypt (SEI 1995). One such study used participatory GIS to identify local knowledge of fresh and saline groundwater sources at the Omayed Biosphere Reserve in Egypt (Salem 2003). This provided the basis for subsequent hydrogeological investigations, and interventions providing support to Bedouin households to treat the brackish water using solar-powered stills (Salem 2014).

12 See eg Geekan Kenya Limited (2016).

STEP 4: UNDERSTANDING THE ROLE OF ECOSYSTEM SERVICES IN ADAPTATION

Objective and actions

This step aims to identify ecosystem services most important for reducing vulnerability and risk to the hazards identified in Step 3 (both climatic and non-climatic), and to understand the role of socioecological systems in generating ecosystem services. Participatory assessments with communities often need to be complemented with scientific studies. The vulnerability assessment in Step 3 should already provide an indication of which ecosystem services are likely to be most important and may be enough to identify the type of EbA measures required.

Identifying priority ecosystem services for adaptation

Communities in a particular ecosystem or landscape can be asked to explore the different roles that ecosystem services can play in adaptation. This can be done through a PRA exercise which, if relevant, may be divided into stakeholder groups to identify priority ecosystem services for adaptation and DRR for different groups (see also Checklist 4).

The role of **socioecological systems** – defined as coupled human-environment systems – in generating ecosystem services should also be explored. Some ecosystem services may be the product of socioecological systems, such as traditional farmers domesticating and improving genetic resources to create new locally adapted genetic diversity. Similarly, traditional resource management systems may conserve and sustainably manage wild ecosystems and related ecosystem services. The revival or strengthening of such socioecological institutions and practices can provide the basis for EbA.

Checklist 4. Key questions for identifying priority ecosystem services for adaptation
Which ecosystem services are vital for coping with current climate extremes (variability) and for recovering after a potential disaster?
List all adaptation services provided by the key ecosystems (such as freshwater supply, flood control, erosion control)
What are the main drivers of change affecting these services (besides climate change), and which plausible trends can be expected for the ecosystems providing these adaptation services in two, five and ten years from now?
Which ecosystems are the most important when considering the current and future dependence of livelihoods on their services? (food security, DRR, adaptation or cultural well-being etc)

Understanding ecosystem boundaries

The assessment should not only consider provisioning services (such as food, water and fuel) and cultural services, but also regulating services (such as climate and flood regulation) and supporting services (such as soil formation). Ecosystem boundaries (such as watersheds) and tipping points (beyond which the ecosystem can no longer provide the services needed for adaptation) need to be considered, as well as services needed by downstream populations which may be far away in lowland areas.

Scientific studies may be required to enable full consideration of these issues and provide an understanding of the scale at which ecosystem management or restoration is needed. EbA will often need to be implemented at a very large scale, to provide the full range of benefits (such as climate regulation). While communities should still play an important role in EbA, it may be necessary for governments or NGOs to ensure sufficient coverage by community initiatives and linkages between them.

Key outcomes for Step 4

- **The most important ecosystem services for climate change adaptation are understood**
- **The scale at which EbA should be implemented is understood**

Tools and resources for Step 4

Participatory rural appraisal (PRA)

www.fao.org/docrep/003/x5996e/x5996e06.htm

Crawford (1997)

Economics of Land Degradation Initiative

http://www.eld-initiative.org/index.php?id=111

ELD

Ecosystems Protecting Infrastructure and Communities (EPIC) project final report, Chile (Spanish)

www.iucn.org/sites/dev/files/content/documents/reporte_final_epic_chile_2017_final.pdf

Cortés-Donoso *et al.* (2017)

Millennium Ecosystem Assessment: dryland systems

www.millenniumassessment.org/documents/document.291.aspx.pdf

Safriel *et al.* (2005)

SDGs indicators for water access, availability, water use efficiency, water stress and others

UN Water, Integrated monitoring guide for SDG 6, www.unwater.org/publications/integrated-monitoring-guide-sdg-6

UN Statistics Division, System of Environmental-Economic Accounting (SEEA), https://unstats.un.org/unsd/envaccounting/seea.asp

World Bank, Natural capital accounting, www.worldbank.org/en/topic/environment/brief/environmental-economics-natural-capital-accounting

The Economics of Ecosystem and Biodiversity

www.teebweb.org

TEEB

VIA of a mountain EbA programme, Peru

http://adaptation-undp.org/sites/default/files/downloads/via-english.pdf

Dourojeanni *et al.* (2014)

EbA planning tool ALivE: Adaptation, Livelihoods and Ecosystems

www.iisd.org/project/ALivE

UNEP-IEMP and IISD (2018)

MOUNTAINS: IDENTIFYING PRIORITY ECOSYSTEM SERVICES

The Ecosystems Protecting Infrastructure and Communities (EPIC) project in Chile provides an example of how scientific studies can be used to understand the role of ecosystems in reducing risk in mountain areas.

The goal of the EPIC project was to promote the conservation of ecosystem services within the national policies and programmes for disaster risk reduction and climate change. As part of the first components, the project explored the role of good forest ecosystem management in reducing the risk of avalanches and landslides. It generated evidence of the role of forest ecosystems in DRR and climate change adaptation through a study on the quantification and improvement of the protective capacity of forests against snow avalanches. The study involved dendrochronological sampling (tree-ring dating), the reconstruction of spatio-temporal patterns of past events, reconstruction of avalanche run-out zones based on dendrochronological data and available records, and avalanche simulation with rapid mass movements (RAMMS) computer modelling (flow height). The project also explored local perceptions on forest ecosystem services, climate change and local risks from natural hazards. The results were used to position ecosystem-based disaster risk reduction (eco-DRR) at national level through multi-stakeholder dialogues. EPIC was implemented by IUCN, in collaboration with the Ministry of Environment (and its Regional Secretariat in Biobío) and the Swiss Institute for Snow and Avalanche Research (SLF), with support from the Regional Government of Biobío.[13]

Biosphere Reserve Corredor Biológico Nevados de Chillán-Laguna del Laja – Chile (EPIC's project site). Credit: © IUCN / Marcelo Vildósola Garrigó

13 For further information, see: Cortés-Donoso, E, Podvin, K and Casteller, A (2017) Reporte final: Ecosistemas para la Protección de la Infraestructura y Comunidades en Chile. Quito y Santiago de Chile: UICN, SLF y MMA. X+53pp. www.iucn.org/sites/dev/files/content/documents/reporte_final_epic_chile_2017.pdf; Monty, F, Murti, R, Miththapala, S and Buyck, C (eds) (2017) Ecosystems protecting infrastructure and communities: lessons learned and guidelines for implementation. IUCN, Gland, Switzerland. x + 108pp. https://portals.iucn.org/library/node/46966

COASTAL: IDENTIFYING PRIORITY ECOSYSTEM SERVICES

The two projects below provide examples of how ecosystem services can be used for adaptation and risk reduction in coastal areas.

Integrated coastal area management in West Africa

The West African Canary Current Large Marine Ecosystem faces future climate change threats including increased intensity of tidal waves and storm surges, erosion and sedimentation (ACCC undated). To help the dependent communities increase their adaptive capacity and resilience to climate change, the Integrated Coastal Area Management project was piloted in five sites in Mauritania, Senegal, Gambia, Guinea Bissau and Cape Verde between 2008 and 2012. In these sites the coastal ecosystems include lagoon, beach, reserve and shoreline ecosystems. The project included both structural and ecosystem-based approaches to adaptation:

- In Cape Verde, the selected site was the Ribeira Lagoon on Maio Island. The lagoon is very important for its biodiversity, including turtles and birds, but particularly vulnerable to coastal erosion. Here, the intervention included an anti-salt dyke, soil rehabilitation and reforestation.
- In Guinea-Bissau, the biodiversity-rich Varela Beach was selected and the interventions included reforestation and rehabilitation of tourism. The programme also included studies on coastal erosion in Varela Beach, and Varela's coastal biodiversity and plan for the monitoring of species protected under international conventions.
- In Gambia, the selected site was a reserve located to the south of the River Gambia estuary. This area faced significant coastal erosion but its biodiversity was very rich (with protected endangered species). An eco-tourism camp was built to reduce the impacts of human activities and climate change on biodiversity in this area.
- In Mauritania, the Nouakchott shoreline was selected due to its dynamic nature and because of its high importance for biodiversity. Both mechanical stabilisation of dunes and afforestation techniques were used for adaptation.
- In Senegal, the Palmarin coast was selected because of its very high rate of erosion and the adaptation action involved strengthening of plant cover.

This programme resulted in the regeneration of natural mangroves, regrowth of the vegetation along the coastline and an increase in bird nests and animal burrows. It found that compared to hard engineering options, integrated resource management generally had fewer risks and a greater success rate. The cost of integrated resource management was also generally lower than the engineered alternatives, such as building sea walls, boulder barriers or gabions.

Coastal afforestation in Bangladesh

To reduce climate-induced vulnerability in coastal areas by enhancing the resilience of communities and protective ecosystems, the government of Bangladesh implemented the Community-Based Adaptation to Climate Change Through Coastal Afforestation project in 2015.[14] In four pilot sites, the project restored and replanted degraded mangrove and wetland areas. The areas include two very low-lying islands and two coastal sub-districts on the mainland.

Nine mangrove species were introduced in these areas over four years. At the end of the project in 2013, a total of 8,500ha of mangrove areas were created or restored including 112ha of dyke plantations, 322ha of mound plantations, 615km of strip plantations, and a 150ha model demonstration plantation of the nine mangrove species.

The communities were also trained in mangrove nursery production and community-based nursery and plantation management improved technologies for agriculture, aquaculture and livestock. These interventions resulted in multiple socioeconomic and environmental benefits. These included cash incomes and livelihood diversification for more than 85,000 people and improved protection from increased siltation, storms and tidal surges along 14km of coastline.

14 The project was the first global Global Environment Fund (GEF) Least Developed Countries Fund adaptation project (C4Ecosolutions 2015).

DRYLANDS: IDENTIFYING PRIORITY ECOSYSTEM SERVICES

Assessment of priority ecosystem services and socioecological institutions for adaptation should take into account both extensive (such as mobile pastoralism) and more intensive uses of drylands. Ecosystem services in extensive rangelands include provisioning services from livestock, plants and wild animals (Ericksen *et al.* 2011, King-Okumu *et al.* 2015, Shine and Dunford 2016), and supporting and regulating services – such as carbon sequestration and water storage. Studies of these poorly understood services tend to reveal higher values in unconverted rangelands than have previously been recognised (O'Farrell *et al.* 2011).

A series of assessments have been devoted to understanding ecosystem service value that is generated through extensive rangeland systems in drylands, where livestock raising by pastoralists is combined with other uses of wild plants and landscapes such as for medicinal and other uses. This enables populations to shift their uses of resources (such as water and pasture) across large territories, migrating in response to the climate and ecosystem conditions. This contrasts to more static intensive production systems, where crops or livestock are raised on a single plot of land, and inputs are delivered to them, rather than the other way around. Some of these studies have been motivated by proposals to convert rangeland areas to uses that are seen as more productive – such as for irrigated agriculture (Behnke and Kerven 2013), nature conservancies for tourism, mineral extraction and transport, or permanent settlements including schools and permanent water supply systems for growing populations.

Accounting for water storage and recharge effects at the watershed level can make a major difference to assessments of ecosystem services in the rangelands and other dryland ecosystems. An assessment in the grasslands of the Andean mountains in Peru (Gammie and Bievre 2015) demonstrated the value of these regulating services in increasing flows of water to the desert city of Lima (using methods in Fang *et al.* 2014). However, such assessments rely on the availability of water resource accounting and monitoring systems and the political will to support studies, which require time, resources and local participation.

Recent economic analyses (eg by Behnke and Kerven 2013) have reassessed the underestimated value of ecosystem services in the rangelands, compared to the frequently overestimated value of alternative land uses for dryland ecosystems, such as irrigated agriculture. Optimistic proposals for rangeland conversion can entirely overlook risks of failure in schemes to 'develop' the 'wasted' resources in the rangelands. They have also tended to focus too narrowly on immediate productive value, and to ignore the demand for inputs and environmental externalities that can also be created through intensified uses. For example, conversion of rangelands to irrigated agriculture raises water demands and emission levels (King and Jaafar 2015). But in assessments that do not consider effects on supporting and regulating services, these omissions can remain unnoticed. Lifecycle analyses of provisioning services, livelihood implications and associated value chains can reveal hidden trade-offs among ecosystem service generation under different adaptation options.

Understanding the boundaries of dryland socioecological systems may require consideration of very large scales, particularly where pastoralist livelihood systems depend on migration over large territories to access water and pasture. These adaptive management systems, and the local institutions that regulate access to and use of resources, are vital for survival in highly variable and extreme dryland environments (Krätli 2015). EbA interventions should seek to understand and strengthen such existing pastoralist strategies that depend on sustainable use of ecosystem services, including hardy livestock breeds. This may require participatory mapping of pastoralist territories to inform EbA planning and raise awareness of local authorities (Jarso *et al.* 2017).

STEP 5: DEVELOPING EBA STRATEGIES AND DESIGNING ACTIONS

Objective and actions

This step aims to develop an EbA strategy and to identify and design priority actions which reduce climate risks and vulnerabilities and maximise co-benefits, based on participatory processes, an understanding of relevant government policies and multi-criteria analysis.

Developing an EbA strategy

- A strategy for EbA should be developed based on the information gathered in the previous steps, including the climate vulnerability assessment (Step 3) and analysis of the role of ecosystem services in adaptation (Step 4).
- EbA strategies should include the key findings of the vulnerability and ecosystem services assessment, and identify strategic objectives, priority actions and expected outcomes (short, medium and long term), as well as timeframes for implementation. They should also establish a monitoring and evaluation system and plan and identify key indicators for M&E (see Step 7).
- EbA strategies should be developed through a bottom-up process which actively involves vulnerable communities and should be linked to wider adaptation strategies at local and national levels.
- A combination of community-level planning and multistakeholder dialogues may be required. Community planning processes at landscape level should be designed and facilitated by local communities to generate local ownership and sustainability.
- Once a list of possible EbA options has been identified, each option should be assessed through an inclusive community or multistakeholder process, which considers the strategic objectives of different stakeholders.
- A policy review and multi-criteria analysis may be useful to help stakeholders select priority actions which are most strategic and generate multiple benefits in the short, medium and long term.
- Available time, funds and other resources for implementing activities should also be considered.

Understanding relevant policies

The strategy should be designed to take advantage of supportive policies and to address policy constraints to implementation of community-led EbA at landscape level (see Checklist 5). For example, policies on community-based natural resource management may support EbA, while those on mining or agriculture may threaten community land rights and agroecological farming systems. Collective land tenure can be an important incentive for collective resource management and facilitate EbA through the pooling of land. Laws that allow communities to register collective organisations are also important to support the recognition of collective institutions, and allow communities to enter into formal agreements with other organisations and establish community funds for EbA.

Checklist 5. Key questions for reviewing existing policies, opportunities and barriers

A review of relevant government policies and political and institutional factors should be conducted to gain a deeper understanding.

- What are the opportunities and barriers to EbA implementation?
- What are the strategies to facilitate implementation?
- Are there political champions to promote EbA, such as environment ministers?
- Is the policy environment enabling?
- Do government actors have the capacity they need to enforce agreed rules?
- Is cross-sectoral institutional collaboration adequate?
- Does the government prioritise the issue?

Multi-criteria analysis can be used to assess different EbA options against environmental, social and economic criteria to help identify actions that have the greatest multiple benefits (and lowest costs). It can also be used to promote active community participation and integration of local knowledge and priorities into EbA decision making (see Box 18).

Designing priority actions

Priority EbA actions, such as conservation, sustainable management and restoration activities, should be designed with active community participation. The first step is to establish a group of community researchers, which includes at least one representative from each community in the landscape who is appointed by the community authority. Capacity-building workshops should be organised to explain the technical and policy issues to community researchers, and enable them to co-design EbA activities and facilitate their implementation. Key stakeholders and collaborators for implementation, and their roles and responsibilities, should be identified. Various PRA and RRA tools can be used to help design EbA activities.

Key outcomes for Step 5

- **EbA strategy developed, and priority actions identified and designed**
- **Indicators of M&E of adaptation measures identified**

Tools and resources for Step 5

EbA planning tool ALivE: Adaptation, Livelihoods and Ecosystems
www.iisd.org/project/ALivE
UNEP-IEMP and IISD (2018)

Focus group discussions and interviews
www.nature.com/articles/bdj.2008.192
Gill *et al.* (2008)

Household survey design
www.ihsn.org/
IHSN

Knowledge-based participatory action research
http://pubs.iied.org/pdfs/17400IIED.pdf
Swiderska and Tenzing (2017)

Local assessments: methodological toolkit
http://ipcca.info/toolkits/ipcca-methodological-toolkit.pdf
Asociación ANDES and IPCCA (undated)

Prioritising adaptation measures and multi-criteria analysis
http://climate.blue/download/Factsheets/FS_Cambio%20Climatico_Adaptacion.pdf
Revised version forthcoming

Methodology for prioritising adaptation measures

http://climate.blue/download/Factsheets/FS_Cambio%20Climatico_Adaptacion.pdf
GIZ–SEMARNAT (2017)

‘No regrets’ measures for mountain EbA

http://bit.ly/2EPtldQ
Nyman *et al.* (2015)

Participatory learning and action (PLA) tools

www.iied.org/participatory-learning-action-pla
IIED

Participatory rural appraisal (PRA)

www.fao.org/docrep/003/x5996e/x5996e06.htm
Crawford (1997)

Rapid rural appraisal (RRA)

www.fao.org/docrep/w3241e/w3241e09.htm
Crawford (1997)

SDGs indicators for water access, availability, water use efficiency, water stress and others

UN Water, Integrated monitoring guide for SDG 6, www.unwater.org/publications/integrated-monitoring-guide-sdg-6

UN Statistics Division, System of Environmental-Economic Accounting (SEEA), https://unstats.un.org/unsd/envaccounting/seea.asp

World Bank, Natural capital accounting, www.worldbank.org/en/topic/environment/brief/environmental-economics-natural-capital-accounting

Stakeholder influence mapping

http://bit.ly/2GJoKX8
Mayers and Vermeulen (2005)

Theory of change

http://bit.ly/2orWPUP
Bisits (2015)

MOUNTAINS: STRATEGIES AND ACTIONS

Developing a mountain EbA strategy

In Uganda, the Global EbA in Mountains Programme used VIAs to enable a more integrated landscape level planning process, building on earlier participatory assessments. The gravity flow scheme was nested in a broader catchment and riverbank management plan, and tree planting was integrated into broader landscape restoration. Information from the VIA was used as the basis for the development of new catchment management plans and district development plants for Mount Elgon, helping to ensure the sustainability of EbA measures.

In Peru, EbA strategies could be developed as part of community 'life plans'. The Ministry of Culture is promoting the development of life plans for resilient development by indigenous communities, and linkages with regional development plans.

Box 11. Examples of EbA actions for mountain ecosystems

- Disaster Risk Reduction (DRR): reforestation or forest conservation to stabilise slopes and reduce the risk of landslides and avalanches
- Watershed protection: reforestation or forest conservation in watersheds to enhance water provision and soil conservation
- Reforestation along river banks and flood plains to reduce flooding and siltation
- Water conservation, management and harvesting (eg grey-green measures)
- Agroforestry to enhance soil fertility and moisture and shade for crops
- Agroecological farming practices, including enhancing habitats for natural pest control, and using organic fertilisers and compost to boost soil fertility and moisture
- Mixed cropping to enhance soil fertility and nutrition; and genetic diversification using resilient local landraces to reduce the risk of crop failure
- Plant/animal breeding and selection by farmers and participatory breeding with scientists
- Use of medicinal plants and wild foods to boost health and nutrition
- Restoration and management of highland pastures for livestock and carbon storage
- Sustainable landscape management for conservation of wild resources, water, agroecosystems and grazing lands, including strengthening collective land tenure and institutions

Understanding relevant policies

In the Potato Park in Peru, the ability to legally register a Potato Park Association representing the six communities and the recognition of their collective land tenure have been key to successful EbA. Rising temperatures and pests and diseases have forced the lower planting line for potatoes upwards by 200 metres in the last 30 years (Asociación ANDES 2016). Despite this, potato productivity has been maintained and slightly increased since 2002, thanks to a strategy of genetic diversification. Formal registration of the Potato Park Association enabled the six mountain communities to enter into a legal agreement with the International Potato Center for repatriation of 410 native potato varieties which had been collected from the area in the 1960s but had since been lost. The pooling of land through the establishment of the park has enabled them to test the potato varieties in different parts of the landscape and subject them to evolutionary pressures in different microclimates to speed up adaptation. It has also enabled the revival of the traditional rotational farming system to allow the regeneration of agroecosystems.

COASTAL: STRATEGIES AND ACTIONS

Developing a coastal EbA strategy

Adaptation priorities for coastal ecosystems and people need to be defined considering the analysis of the context, vulnerability profile (such as storms or erosion), their sensitivity and capacity of the coastal systems to adapt, and ecosystem services (such as fish, wood or protection from storms) based on Steps 2–4.

In the Coastal Climate Adaptation and Development project in Ireland,[15] potential adaptation options were identified under different scenarios of future climate and socioeconomic change at a stakeholder workshop (Falaleeva *et al.* 2013). The necessary resources were then identified including human and financial. The adaptation actions put forward for possible implementation were assessed against both contextually specific and prioritisation criteria. Actions categorised as viable, desirable and 'no-regrets' by the screening and prioritisation process were entered into a detailed action plan. The detailed plan outlined co-implementation co-financing and shared responsibility for adaptation actions. It also included indicators of implementation and effectiveness, temporal and value-driven evaluation points, and the description of thresholds of concern. Implementation of the action plan was coordinated by local coastal resilience group members and supported by the Irish Coastal Resilience Network.

Box 12. Examples of EbA actions for coastal ecosystems

EbA actions in coastal ecosystems may include:

- Restoring and conserving mangrove forests, coral reefs, sand dunes, salt marshes and coastal wetlands
- Establishing marine protected areas
- Enhancing coastal vegetation
- Protecting seagrass
- Salt-tolerant coastal agroforestry and agriculture
- Fish habitat improvement
- Floating vegetables or aquaponics cultivation
- Ecosystem-based fisheries management

15 See www.epa.ie/pubs/reports/research/climate/CCRP_28.pdf

DRYLANDS: STRATEGIES AND ACTIONS

Developing a drylands EbA strategy

Planning ahead in dryland ecosystems can prove challenging because of the diversity of factors, including climate-driven crises such as drought or floods and other humanitarian and social crises. In Iraq for example, formal adaptation planning has seen a slower start than in neighbouring countries. However, strategic planning for EbA can happen even in challenging contexts and EbA planning can sometimes be integrated within crisis response planning.

There are some dryland environments in which stakeholders' responses to proposed EbA actions may be lively and critical of national governments or international agencies and actors as well as of other local stakeholders. Skilful facilitators can ensure that questioning of existing practices is constructive, and leads to the identification of feasible adaptation solutions. Where facilitation is successful, EbA options that are likely to be acceptable to all stakeholders will be identified.

In the biosphere reserve at Dana in Jordan (see Box 8), resource users' knowledge and needs were incorporated into planning of land and resource uses. As described in Step 3, practical demonstration and participatory discussions showcased the potential for innovative solutions to be implemented at the local level with resource users in the Omayed Biosphere Reserve in Egypt. This attracted government attention and created opportunities for scientists and practitioners to inform national strategic processes on scope for desalination and groundwater management.

In Kenya, insights from participatory resilience assessments with customary rangeland management associations were transferred through national adaptation planning to inform national strategies for green growth and economic development.

Understanding relevant policies

Analysis of governance systems can be critical to ensure that EbA strategies address any gaps in capacity to implement and manage EbA interventions (Boxes 15).

Box 13. Examples of EbA actions for dryland ecosystems

EbA actions for dryland ecosystems may include:

- Watershed planning and conservation to integrate urban water needs and supply systems with the surrounding watersheds and user groups
- Disaster preparedness and early warning to prevent and ensure alternatives for damaging maladaptations that occur during drought emergencies – such as vegetation removal, overextraction of water, breaking resource-use conventions, invasion of reserves and private properties or conflicts
- Water harvesting: conservation and recharge of groundwater for use during dry periods and droughts using water-harvesting practices and configuration of vegetation to maximise water capture and percolation (accompanied by monitoring and knowledge-building activities to improve understanding of sub-surface resources and processes)
- Floodplain management to harness and conserve floodwaters and prevent damage due to flash flooding
- Conservation and restoration of forests and other natural vegetation to stabilise slopes (including sand dunes), prevent landslides, protect and restore watersheds and regulate water flows to prevent flash flooding
- Conservation and restoration of rangelands to enhance vegetation cover, hydrological processes, carbon sequestration, livestock productivity and landscape amenities
- Agroecological farming and agroforestry systems to cope with increasingly variable and extreme climates (such as shade trees to create microclimates or soil improvements using manure)
- Integrating human settlements with well-adapted low energy vegetation and drainage systems
- Integrating plants and water for cooling and airconditioning within settlements and buildings

Box 14. Analysis of governance issues for a territorial approach to EbA in the Senegalese Ferlo

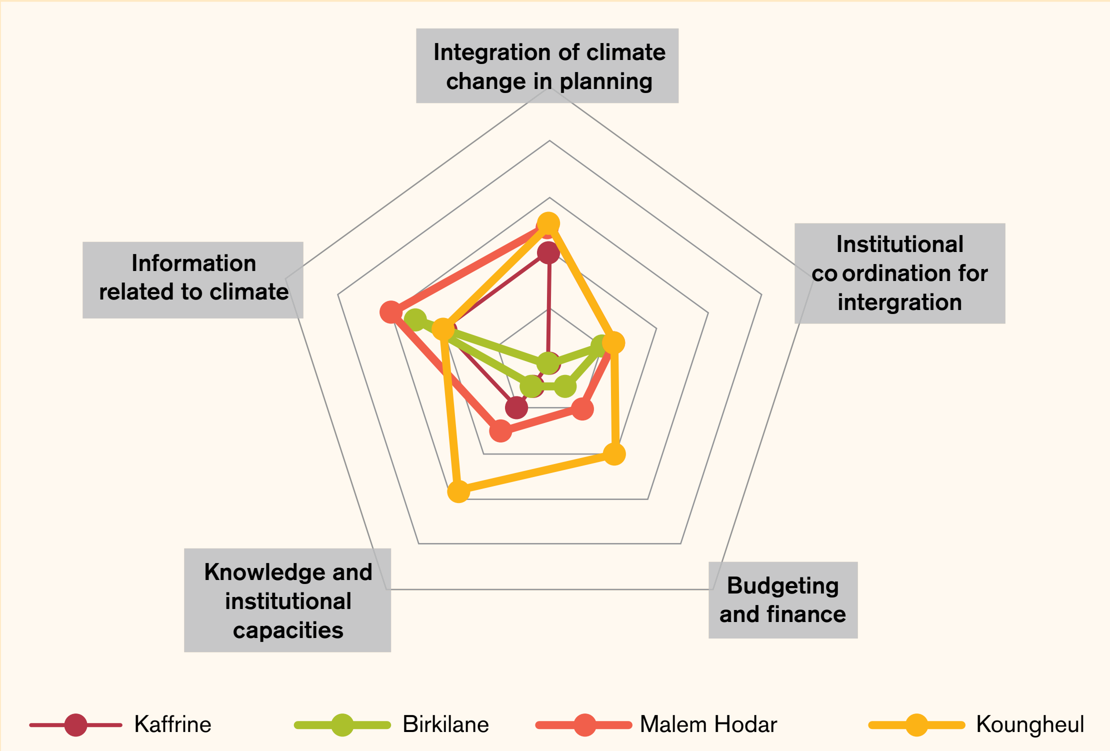
The decentralised climate funds (DCF) approach was developed in the Kaffrine Region in Senegal through a bottom-up process where local communities identified and prioritised investments in public goods to build their own resilience. Local government was involved to promote support and manage funding for implementation with the oversight of local adaptation committees.

The strategy process was designed and facilitated by community authorities and community researchers, with technical support from a trusted NGO (IED Afrique) as an external facilitator. The process required discussions in community assemblies and inter-community meetings involving key stakeholders. It also involved a policy review.

A multi-criteria 'dashboard' analysis was subsequently undertaken to help communities in the Kaffrine Region to analyse their current governance system. A series of indicators enabled members of local collectives to evaluate the management of climate risks at the level of administrative departments and assign scores. This created a rapid visual analysis of the decentralised institutional capacities for management of the climatic challenges in different communities in the Kaffrine region (Figure 2).

Source: based on Keita and Koulibaly (2016)

Figure 2. Rapid visual analysis of decentralised institutional capacities for managing climatic challenges, Ferlo, Senegal



Source: adapted from Keita, A and Koulibaly, P (2017). Tools for resilience assessments and climate-sensitive local planning. NEF, New York.
www.neareast.org/download/materials_center/RA_Working_Paper_En.pdf

STEP 6: IMPLEMENTING EBA ACTIONS ON THE GROUND

Objective and actions

This step aims to guide the implementation of EbA actions. It provides general protocols for EbA implementation in vulnerable mountain, coastal and dryland ecosystems, in the sub-sections that follow. Local communities should play a central role in developing and implementing EbA implementation protocols, with support from scientists and external experts, to generate local ownership and capacity, and create local employment. EbA actions should include income generation to provide incentives and resources for implementation (see also Steps 1 and 2).

Key outcomes for Step 6

- EbA activities implemented jointly with communities and other stakeholders
- Community institutions and capacity building for implementation strengthened
- Capacity of scientists and experts for collaborative research with communities strengthened

Tools and resources for Step 6

Mountains

The Global EbA in Mountains Programme in Nepal, Peru and Uganda
http://bit.ly/2EPtldQ
Nyman *et al.* (2015)

The Potato Park community-led genetic reserve and biocultural heritage territory
http://pubs.iied.org/14670IIED
Swiderska and INMIP (2017)

The Stone Village, China, and customary water management systems
http://pubs.iied.org/14669IIED
Reilly and Swiderska (2016)

The Potato Park action research methodology and participatory plant breeding (PPB) in China:
http://pubs.iied.org/14618IIED
Swiderska *et al.* (2012)

Coasts

Climate-resilient coral gardening

http://panorama.solutions/en/building-block/climate-resilient-coral-gardening

Panorama

Coral reef rehabilitation

http://bit.ly/2sYdNih

Edwards (2010)

Grassroots reef rehabilitation

http://bit.ly/2F9O0se

Reef Ball Foundation (2008)

Drylands

Adaptive watershed training programme

http://bit.ly/2FwXmfs

IISD (2017)

EbA implementation

https://portals.iucn.org/library/node/46966

Monty *et al.* (2017)

Traditional approaches for water management in drylands

http://bit.ly/2F65Z2R

Adeel *et al.* (2008)

MOUNTAINS: IMPLEMENTATION PROTOCOLS FOR EBA

The following implementation protocols focus on EbA actions which are typically important in mountain areas: restoration of forests and vegetation for watershed protection, risk reduction and grazing; water conservation and management; and use of agroecology and genetic diversity for adaptation to climatic variability and risk. Each protocol sets out some of the key steps involved in implementation and provides specific examples.

Restoring natural forests and vegetation using native species

Replanting forests and vegetation can protect and restore watershed catchments to secure water provision, reduce erosion and risk of landslides, rockfalls, avalanches and flooding, while regulating local climates and increasing grazing and forage. Species such as fruit and nut trees, medicinal plants or broom grass, can generate economic and health benefits. Broom grass can also be used to stabilise and regenerate slopes after a landslide (see Box 15). A combination of trees and vegetation can provide benefits in the short, medium and long term.

Box 15. Cultivating broom grass for multiple benefits in Nepal and India

In Nepal, broom grass cultivation conducted as part of the Global EbA in Mountains Programme not only helped generate adaptation benefits, but also provided an opportunity to enhance the livelihoods of participants from the Panchase Women's Network. An additional co-benefit has been that the programme-supported efforts have been integral in creating a stronger social bond between these women across traditional caste barriers (Nyman *et al.* 2015). In the eastern Himalayas, India, Lepcha communities have domesticated broom grass to reclaim the land after a massive landslide in 1968 destroyed paddy fields and water sources. Broom grass has become an important cash crop in the area (Rastogi *et al.* 2014).

Planting indigenous crops from the local area is likely to ensure they are well adapted, but resilience to future changes in climate also needs to be considered. Traditional knowledge can help identify suitable native species and local seed sources, and to develop propagation and planting protocols. Ensuring participation of different groups is important to avoid negative impacts for vulnerable people, such as if land is taken over for replanting.

Key implementation steps

Implementation protocols for restoration will vary depending on the particular focus and context, but the following general steps can be applied:

- Establish a restoration management group involving farmer-researchers from different communities to lead the process and collaborate with scientists.
- Identify the area needed for restoration to yield ecosystem services – such as watershed or catchment, unstable slopes, degraded pasture – informed by a vulnerability assessment.
- Identify native species for restoration. The selection of native species should be done with communities, taking into account water requirements, adaptation to local conditions and projected future climatic changes (such as temperature and rainfall), species diversity and ecosystem composition.
- Assess existing vegetative cover and calculate the quantity of seeds and seedlings needed.

- Obtain seeds of native species and varieties. Seeds should ideally be sourced from formal gene banks as they can provide disease-free seeds, and communities should be supported to establish agreements with gene banks for repatriation of native varieties which were collected from the local area. If gene banks cannot provide such varieties which are locally adapted, diverse native seeds should be collected from communities in the target landscape and surrounding area, with the help of knowledgeable local farmers and elders.
- Multiply seeds. Greenhouses or herbal groves may be needed to multiply seeds and nurture seedlings. Communities can be trained to produce botanical seeds that are disease-free and small laboratories can be established in communities for this purpose.
- Develop propagation and planting protocols – such as on whether/how to use cuttings or plant seedlings, when and where to plant. Seedlings may need to be regularly watered, protected from animals and regularly weeded until they are well established.
- Planting and restoration. For large-scale projects such as reforestation across watersheds, community members, including women, should be employed and receive payment to assist with implementation. In the Andean reforestation programme of Apurimac, Peru, for example, participation of the whole community is ensured by rotating labour every 15 days (see Box 16).
- Establish a community seed bank. It is advisable to establish a community seed bank where the seeds can be stored in the short and medium term to support community restoration efforts and adaptation needs.

Box 16. Reforestation in Apurimac, Peru

The regional government of Apurimac manages a large regional reforestation programme which aims to plant more than 33 million trees on mountain slopes in the Peruvian Andes. The programme aims to prevent problems caused by excessive rains, such as erosion and risk of landslides and flooding, and improve climate regulation and soil regeneration through watershed management, while contributing to climate change mitigation.

The programme uses traditional knowledge and local seeds, since reforestation is an ancestral practice, and native varieties help to maintain ecosystem services. Using the traditional reforestation approach is both environmentally and socially sustainable as it enables peoples' participation. The programme uses traditional species that have multiple benefits for communities and low-cost technologies that communities can maintain in the long term.

The programme employs some 17,000 people in reforestation, of whom 33 per cent are women. It is financed by the central and regional government, but managed by community forest management groups, with the government providing coordination support.

Source: Regional government of Apurimac, in Swiderska and INMIP (2017)

Water conservation and management (grey-green EbA)

As discussed in Section 2.1.3, mountain communities often depend on rainfed agriculture and traditional water sources for irrigation and drinking. Many mountain communities have customary water management systems, consider their water sources as sacred places, and regularly repair irrigation channels and collectively maintain drinking water sources. It is important that water conservation and management schemes build on existing customary water management systems (see Box 17), and ensure community participation in planning and implementation of any new structures to encourage maintenance. In the Eastern Himalayas (India), for example, government water projects have built water tanks, but there is little sense of ownership and responsibility for maintaining them. Irrigation channels have been built in some villages, but a lack of regular maintenance is causing serious landslide problems (Swiderska and INMIP 2017).

Box 17. Customary management in the Stone Village, Yunnan, China

In the Naxi Stone Village, Southwest China, an ancient water management system provides water for drinking, irrigation and fire control to 14 villages in the watershed. Customary laws ensure fair water allocation to all fields and households, by day or night, depending on their location in the mountain valley. Irrigation water allocation during the spring sowing time is critical and the process is guided by agreed customary laws principles of equal sharing and mutual help. The water committee appoints one or two water managers to take care of water allocation by day and night, and the water is normally allocated from uphill fields to lower terraces. The water managers deal with any water conflicts based on customary laws.

The Stone Village's ancient soil-based irrigation channels were lined with concrete to conserve water and speed up water flow (grey-green EbA), with support from the local government. This system has prevented water scarcity and conflict despite recurring spring droughts in Yunnan for nine years out of the last ten, whereas neighbouring villages without such a customary water management system have been more affected by drought. The system is overseen by a water management committee and integrates related rituals. This level of drought has not been seen before and is thought to be the result of climate change impacts on the Himalayas (Tibetan plateau).

Sources: Reilly and Swiderska (2016), Yiching Song (2018).

Key implementation steps

Implementation protocols for water conservation and management will vary depending on the particular activities/structures prioritised. However, the following general aspects can be considered:

- Support customary institutions for sustainable and equitable water resource management
- Support and strengthen existing structures such as irrigation channels
- Ensure any new infrastructure is designed with active community participation
- Promote rainwater harvesting and groundwater recharge mechanisms
- Support afforestation using indigenous trees, well-placed to cope with future climate change impacts
- Educate different user groups about judicial water management, upstream and downstream

Agroecology and genetic diversity for climate adaptation

Mountain ecosystems tend not to be suitable for modern intensive farming practices because of their harsh and variable climates, rough topography and steep slopes. Diversified agroecological farming practices, which conserve and restore agroecosystems, can increase productivity and reduce risk in mountain areas. Diversification of crop species and varieties, and the use of resilient local varieties, reduces the risk of crop failure in more variable and extreme climates, and can improve nutrition and diversify incomes. Traditional knowledge is important for identifying agroecological practices and resilient local varieties. Implementation protocols for adaptation based on genetic diversity and agroecology are illustrated here through two examples.

Establishing a genetic reserve – the Potato Park, Peru

The Potato Park area has experienced significant adverse impacts from climate change (see Box 7). Due to increased soil pests correlated with rising temperatures (see Step 5), farmers have to cultivate potatoes at higher and higher altitudes for them to survive, and some potato varieties can now only be planted at the top of the mountain (higher than 4,000 metres), beyond which there is no more land, putting them at risk of extinction.

Establishing the Potato Park has enabled six communities to stop genetic erosion, more than double potato diversity to about 650 different varieties (1,400 varieties according to traditional classification), increase potato productivity and almost double incomes. Some farmers grow more than 100 varieties of potato – this is an ancestral practice to reduce risk. The park has 18 varieties with high tolerance to frost and drought and one which is virus resistant, and purple potatoes rich in iron and antioxidants that can be used to make bread to reduce child malnutrition (Swiderska and INMIP, 2017).

The territory also conserves evolving populations of three wild potato species, and a large diversity of other Andean crops and wildlife. It sustains co-evolutionary processes, including selection and breeding by farmers using highly resilient wild potatoes in highland areas to enrich on-farm populations. Farmer-researchers are testing potatoes for frost resistance and other variables important to farmers and then multiplying the seeds of resilient varieties for local distribution. They are monitoring the impacts of climate change in high-altitude transect plots at different elevations, with pest traps and devices to monitor temperature, rainfall, relative humidity and ultraviolet radiation, in collaboration with scientists from the International Potato Center. Participatory plant breeding (PPB) has also been initiated to support adaptation and prevent loss of potato varieties.

The park has strengthened traditional biodiverse agroecological farming practices across the landscape. It has revitalised the holistic Andean worldview, customary laws and cultural and spiritual values which promote conservation and equity values. It has created strong local ownership and community pride in their park – an evolving gene bank for local, national and global adaptation. These impacts will ensure long-term sustainability but have taken time to build – 5–10 years of sustained and flexible support for highly participatory action research processes.

The Potato Park, Peru where adaptive management and potato diversification has increased productivity. Credit: Asociación ANDES

Key implementation steps

The Potato Park experience has highlighted the following key steps for implementing a genetic reserve (which should be adapted to the local context):

- Strengthen or establish a democratically elected, legitimate community institution for collective management involving all the communities in the landscape, based on customary laws.
- Establish a group of community researchers appointed by each community authority to lead and facilitate implementation (and report back to community authorities).
- Legally register the collective institution so that it can enter into formal agreements with other actors directly and can establish a community fund.
- Support highly participatory action research processes to inventory genetic resources, map biocultural resources in the landscape, create community registers of traditional knowledge relating to biodiversity and ecosystems, and establish a baseline on wild relatives (using GPS).
- Establish microenterprises involving members of different communities, especially women and vulnerable groups.
- Support development of an intercommunity agreement based on customary laws to guide the management of the park. Establish a community benefit-sharing fund, into which a percentage of microenterprise revenues are invested to support landscape/ecosystem management.
- Establish a repatriation agreement and promote seed exchange with neighbouring communities to enhance native crop diversity. Establish a community seed bank to provide access to genetic diversity for adaptation and recovery after extreme events.
- Conduct collaborative research with scientists to monitor changes in climate and in key staple crops and develop adaptation responses (eg PPB).
- Engage with policymakers and advocate for supportive policies to recognise and protect the Potato Park community-led landscape management model.
- Throughout the process, use and strengthen traditional knowledge and customary laws (such as reciprocity, equilibrium, solidarity) to promote social cohesion, strong local ownership, conservation and equity values, and promote spiritual values and revival of traditional rituals associated with the landscape and ecosystems.

Participatory plant breeding for adaptation

PPB brings together farmers and crop breeders to jointly develop new varieties which are tailored to particular local conditions. By making use of resilient local varieties and gene bank varieties, it can develop new varieties which respond to climatic risks, drawing on traditional knowledge and science.

Local varieties are often highly resilient. For example, maize landraces survived the big spring drought in Southwest China in 2010, while hybrid maize did not. PPB also supports diversification to reduce risk by raising farmers' and breeders' awareness of the importance of conserving genetic diversity and improving the yield and quality of local varieties. PPB is more cost-effective than conventional breeding and faster (Ceccarelli 2009). The time varies depending on the crop (eg 2–4 years for maize).

Participatory plant breeding in Southwest China. Credit: Centre for Chinese Agricultural Policy

PPB facilitated by the Centre for Chinese Agricultural Policy (CCAP) in Guangxi Province (Southwest China), has strengthened food security in harsh mountain areas by developing eight drought-tolerant maize varieties with 15–30 per cent higher yields than local landraces. They have spread rapidly and spontaneously to neighbouring villages. Some 1,000 local landraces have also been conserved in situ, providing options for adaptation. A linked community-supported agriculture programme, supplying ecological restaurants in urban areas, has tripled farm incomes and spurred the revitalisation of traditional agroecological practices (such as duck-in-rice, where communities use ducks as a weed and pest control strategy), reviving many heritage varieties of crops and livestock that were previously threatened. New farmers' organisations and women's seed fairs have strengthened social capital and empowered women. The programme also facilitated a change in China's Seed Law, to support farmers' seed systems (Song *et al.* 2016).

Key implementation steps

PPB generally involves the following key steps, with farmers and scientists making decisions jointly at each step in the process, for mutual learning and community empowerment:

- Identify a good facilitator (eg a social scientist who understands PPB) and institution to ensure active farmer and scientist participation and build the capacity of both farmers and scientists for successful collaboration.
- Identify target innovative farmers and communities and a like-minded plant-breeding scientist and institution as core PPB partners to work with.
- Identify and develop together the common objectives of PPB and desired traits (eg resilience, yield, taste), design the participatory varietal selection (PVS) and PPB field trails.
- Establish community registers of local varieties, community seed banks, and seed diversity in farmers' fields.
- Select good landraces to improve through PVS by farmers in the communities.
- Identify promising parent lines for breeding – from both local communities and gene banks.
- Undertake conservation, establish links to pre-breeding populations, and undertake selection for genetic enrichment in the field and for formal breeding.
- Carry out cross-breeding experiments and selection of offspring in the field and on station.
- Carry out participatory testing on farm and on station and evaluate the resulting varieties.
- Support community-based seed production and seed fairs for sale and exchange of seeds.
- Establish agreements between breeding institutions and farming communities to share benefits from PPB varieties if farmers cannot register new PPB varieties jointly with breeders by law.

COASTAL: IMPLEMENTATION PROTOCOLS FOR EBA

In this section, implementation protocols for two coastal EbA interventions are outlined – mangrove restoration and coral reef restoration.

Mangrove restoration

The overall importance of restoring mangrove forest as an EbA has been discussed in Part II. To make a mangrove restoration project successful, it is important that the local people can own the process and the project is both environmentally and socioeconomically sustainable. If local people are forbidden to interact with the restored mangrove system, this can create conflict. For example, in one case in Vietnam, conflict arose due to the loss of livelihoods of marginal groups, especially women, who used to harvest non-cultivated seafood such as crab and clams on the mudflats (Powell *et al.* undated).

Key implementation steps

- Establish a mangrove restoration management group involving community researchers from different communities to lead the process and collaborate with scientists.
- Identify the area needed for restoration to yield ecosystem services – such as mudflats, coastal areas suitable for mangrove plantation, degraded mangrove areas or eroding coastline.
- Identify native species for restoration. The selection of native species should be done with communities, taking into account tidal requirements, adaptation to local conditions and projected future climatic changes (such as sea-level rise, salinity intrusion, storm surges, land erosion, temperature and rainfall), and diversity of species (see Box 18 for some native species of Vietnam). If the native species are unlikely to thrive in current and future changing climate conditions, then genetically improved varieties that can grow well in such conditions may be useful.
- Assess existing mangrove areas and calculate the quantity of saplings needed.
- Obtain seeds of native species and varieties from local communities in the target landscape and surrounding areas, with the help of knowledgeable local farmers and elders. If it has been predicted (in Step 3) that the native species would not cope with the environmental changes in the target area, then modern varieties may need to be obtained from a formal gene bank.
- Multiply seeds: greenhouses or herbal groves may be needed to multiply seeds and nurture seedlings. If gene bank collections are used, communities can be trained to produce botanical seeds that are disease free and small laboratories can be established in communities for this purpose.
- Develop propagation and planting protocols such as how to use cuttings or plant seedlings, and when and where to plant. Seedlings may need to be regularly watered and weeded and protected from animals until they are well established.
- Planting and restoration. For large-scale projects such as reforestation across large coastal areas, community members, including women, should be employed and receive payment to assist with implementation.
- Establish a community seed bank. Whether the seeds are acquired from local sources or gene banks, it is advisable to establish a community seed bank where the seeds can be stored in the short and medium term to support the restoration efforts and adaptation needs of communities.

Mangrove restoration in Seychelles. Credit: EbA South project

Box 18. Mangrove restoration in Vietnam

A Community-based Mangrove Reforestation and Disaster Preparedness Programme was implemented by the Viet Nam Red Cross Society (VNRC) from 1994 to 2010 to restore destroyed mangrove forests and help disaster preparedness in eight coastal provinces of Vietnam. The species planted include *Kandelia candel*, *Sonneratia caseolaris*, *Rhizophora stylosa* and *Avicennia marina* as well as *Casuarina* and bamboo (only along the river banks and dykes).

The project cost US$8.88 million and 9,462ha of forest were created in 166 communes of which 8,961ha are mangroves (4.27 per cent of all mangroves in Vietnam today). Under this programme, more than 300,000 students, teachers, volunteers and commune wards were trained in disaster preparedness. Overall the project reached 350,000 direct beneficiaries and 2 million indirect beneficiaries. The programme created adaptation, resilience and direct economic and ecological benefits:

- Significant reduction of disaster risk: less damage to dykes after the project intervention. The savings due to avoided disaster risk has a protective impact value of US$15 million.
- Fewer costs for recovery from typhoons: costs reduced by US$80,000 to US$295,000 in the studied communes.
- Enhancement of communities' livelihoods: due to the mangrove afforestation, increased yields of shellfish, oysters and honey were reported, thereby providing more income, especially for the poorer communities. The assets located between mangroves and dykes such as shrimp farms and boats had greater protection. In the communes studied alone, the direct economic benefits were found to be between US$344,000 and US$6.7 million. This programme resulted in higher income for 60 per cent of respondents from mangrove communes, increasing their adaptive capacity.
- Sequestration of carbon: it is estimated that this programme alone will have absorbed 16.3 million tonnes of CO_2 by 2025, the value of which could be US$218.81 million.

Source: IFRC (2011).

Restoring coral reefs from physical damage

The overall damage and destruction of coral reefs and importance of restoring them as an EbA has been discussed in Part II. Like mangrove restoration, coral reef restoration projects need to be owned by the local community and be both environmentally and socioeconomically sustainable.

Key implementation steps

The key steps of a typical coral reef restoration project include:

- Form a plan and establish an implementation committee involving local people and researchers. Local people should include those who are dependent on coral and who have influence on the coral ecosystem.
- Collect small pieces of broken coral in shallow waters and reattach them to spiderweb cages (portable metal frames) – this is a process known as coral gardening. Use coral varieties that are particularly resilient to the climate change impacts of physical damage, bleaching and ocean acidification. If Step 3 assessments predict that it will be difficult for the existing coral species to thrive in the changing climatic and environmental conditions, then genetically modified suitable species may need to be developed for the gardening.
- Transplant the coral in the cages to large coral frames in places where the reef has been destroyed by cyclones or other climate change-linked hazards. Place the coral beds in around six metres of water, enough to keep them safe from cyclone swells, where they can grow into full-size coral colonies.
- Ensure periodic monitoring and maintenance (if needed) by the implementation committee or form a separate committee for this.

Coral gardening © SPC/GIZ Coping with Climate Change in the Pacific Islands Region (CCCPIR) Program

Box 19. Coral gardening for climate change adaptation in Vanuatu

The coral reefs of Vanuatu are currently under threat from ocean acidification and increase in ocean temperatures as well as from invasive species and human activities, affecting coastal protection and the island ecosystem.

To reverse these impacts, from 2014–2017 more than 3,000 men, women, boys and girls have participated in climate change coral gardening activities organised by the Nguna-Pele Marine and Land Protected Area Network throughout central Vanuatu. The objective of the programme is to enable community-based coral reef climate adaptation via an innovative and income-generating ecotourism activity. In this programme, small pieces of broken coral (varieties particularly resilient to the climate change impacts of bleaching and ocean acidification) were collected and reattached to portable metal frames. These frames were placed under six metres of water in the sites destroyed by cyclones or other hazards and from these, full-size coral colonies were grown.

Overall, this coral gardening programme has created new habitats for fish (thereby increasing the abundance of fish), increased income for local people and provided coastline protection from waves and cyclones.

- The newly grown corals were found to be resilient to Severe Tropical Cyclone Pam.
- Coastlines that were previously eroded are stabilising because the coral health has increased. The coral now provides a buffer against waves.
- Heat stress-tolerant coral varieties that were planted are becoming widespread.
- The abundance of coral-associated fish has increased, supporting livelihoods for local people. Seven island villages now have sustainable income flows.
- Gender equity has increased as more women and girls have proactively participated in the programme (marine climate change adaptation activity here is typically dominated by male fishermen and divers).
- Indigenous communities' knowledge of coastal management and coral sensitivity to climate change has improved through education programmes with more than 500 youths.

Source: Bartlett (2018).

DRYLANDS: IMPLEMENTATION PROTOCOLS FOR EBA

For dryland ecosystems, three types of EbA were identified in Part II: watershed or basin management, innovation and application of traditional water and land management practices, and conservation or restoration of landscapes and genetic resources. In this step, a brief introduction for each of these is provided, highlighting specific issues that require consideration in the context of dryland ecosystems. Key steps are then summarised, together with suggestions on how to overcome challenges likely to be encountered.

Watershed or basin management for disaster risk reduction

A strategic EbA approach to managing water stress includes consideration of all the parts of the watershed or basin that may mediate upstream-downstream flows across the system. Adaptation interventions can increase or reduce water stress in different parts of the basin (see the example from Bekaa Valley in Lebanon in Box 20). A range of basin-level studies have explored the effects of water harvesting under drought and non-drought conditions in the Zeuss-Koutine watershed, Tunisia (Box 5 in Part II).

General protocols and methodological guidance to assess water resource availability and management at the basin level are provided by UN Water in relation to SDG 6.4 on water-use efficiency and water scarcity (UNWater 2017a). These consider ecosystem water requirements and connect to ecosystem protection and conservation (SDG 6.6 on protecting and restoring water-related ecosystems) (Dickens *et al.* 2017), but they are not always explicit in their climate change focus.

Key implementation steps

- Secure research support to analyse available plans and assessments of watershed characteristics, including climatic variations, effects on water resource availability and uses. In the case study in Box 24, a series of assessments have been carried out using GIS and hydrological modelling tools.
- Establish collaboration between communities and scientists to plan and assess impacts of EbA. This interaction can be facilitated by a local research institute, with local students and visiting researchers from different locations, if applicable.
- Identify information gaps and challenges to monitor and evaluate planned EbA – such as effects on resource users' income and incentives to maintain EbA practices, as well as ongoing questions about water recharge quality and quantity under different climatic and adaptation scenarios.
- Encourage stakeholders, scientists and students to consider how best to fill these information gaps. This may require a progressive series of contributions from different researchers to build understanding of different aspects of the ecosystem function and the effectiveness of EbA.
- Encourage communities, NGOs and local government to understand and support scientists and to enable an effective evaluation of the impacts of the ecosystem interventions in drylands (including those proposed as EbA as well as non-EbA solutions). Review implementation plans in light of anticipated watershed effects under drought and non-drought conditions.

Bekaa Valley, Lebanon © Caroline King-Okumu

Box 20. Watershed management for drought risk reduction in the Bekaa Valley, Lebanon

Since the emergence of the conflict in Syria, the arrival of refugees in Lebanon's Bekaa Valley is estimated to have tripled the population. This has increased water demand and deepened local concerns over drought and water stress. The available water balance figures for the Upper Litani and the Upper Orontes basins were updated to take into account the estimated additions.

In 2016, there were 35,500ha of irrigated agriculture in the Upper Litani Basin and 12,400ha in the Upper Orontes Basin. Based on these findings, the volumes of agricultural water used were estimated at 250 million cubic metres (mcm) per year for the Upper Litani and 81mcm for the Upper Orontes. The updated estimates for domestic water demand (including for both Lebanese and displaced people) is small compared to agriculture. The overall estimated water budget for the Litani is negative, whereas the water budget for the Upper Orontes is positive. These basin-wide calculations mask hotspots of water stress at particular locations and times of the year. Deterioration in water quality further reduces the availability of surface water for domestic needs. This increases stress on groundwater reserves.

Hotspots for water stress were analysed by overlaying maps of water demand for domestic and agricultural uses and comparing demand to supply. These hotspots included some areas where displaced people had been staying around the urban centres of Baalbek, Zahle and Hermel. The analysis revealed a need to adapt to climate change, drought and water stress by enhancing integrated water management to accommodate both agricultural and domestic needs at these hotspot areas. Further consideration of ecosystem conditions, hydrological processes such as groundwater recharge, and seasonal water requirements at these locations could enhance the design and environmental sustainability of international humanitarian donor-supported strategies to increase domestic water supplies to the displaced and Lebanese populations in the Bekaa Valley (RoL 2017).

Source: Jaafar (2017)

Payments for ecosystem services (PES) can be used to encourage sustainable land and water management in the upper parts of a water-stressed catchment through provision of financial incentives for good practices to land users (Goldstein *et al.* 2011, Porras *et al.* 2013, Porras *et al.* 2007). Conserving water upstream by maintaining vegetation cover, avoiding over-extractions and pollution is a service to downstream water users that will maximise downstream flows of clean water, even under a changing climate, and could help to reduce or avoid drought emergencies and the need for other water sources – such as expensive treatment or desalination plants and water transfers to dryland cities such as Lima and Jaipur (Everard *et al.* 2018). PES schemes rely on a careful understanding of existing incentives and require careful design and management (Porras *et al.* 2013).

Innovating traditional water and land management practices

To manage the uneven spatial and temporal distribution of water resources that cause droughts and floods, dryland societies often adapt by capturing water during rainy seasons and storing it for use during droughts. To do this, they have traditionally used topographic features, earth and stones available in the landscape, as well as water-collecting plant species. Innovative approaches can enable land users to integrate versions of these traditional practices with new technologies and opportunities, including some that may be more suitable in areas that are urbanising (Stout *et al.* 2017). These can take into consideration the characteristics of the built environment, including rooftops, roads and airstrips.

Where implementation of these EbA practices involves significant requirements for voluntary or low-paid labour, a range of issues may affect their feasibility (Abdeladhim *et al.* 2017). These will include addressing land tenure issues as well as demonstrating land users' needs and observing any successful effects on productivity before investing any significant labour or cash. In countries where fossil fuels have been available at low cost, heavy machinery has been used to replace human labour for digging and constructing earthworks for water harvesting, land levelling and creating raised beds to improve drainage (Swelam 2017). However, these practices are not applicable in all contexts – especially where landholdings are small, or their ownership is insecure and contested.

Collective decision making and action is often needed to construct or rehabilitate water-harvesting structures such as sand dams (a wall built across a seasonal sandy riverbed to collect sand and water) as is the case in Makueni, Kenya (Box 21). Local adaptation funds offer a practical system for strengthening collective decision making and enabling communities to invest in the adaptation interventions that they know will work best for them and their environment.

Key implementation steps

- Conduct participatory appraisals to explore the perspectives of collective resource management institutions. In the case study in Box 21, a ward adaptation planning committee (WAPC) was established and developed assessments of vulnerability and resilience before identifying the proposal to invest in the sand dam.
- Identify local examples of success and failure. The WAPC identified and evaluated a series of proposals for investment before prioritising the proposal to invest in the sand dam.
- Facilitate collaboration between communities and technicians to assess success factors and barriers. The WAPC managed the implementation of the sand dam construction with support from the relevant government departments. They also established their own systems for monitoring and evaluation.
- Build capacity to overcome barriers and strengthen institutions, as required. Following the implementation of the project, members of the project team have taken part in national learning events.
- Share findings with relevant decision makers. Findings from the project have also been presented to the Kenyan government and the UNFCCC.

Box 21. Water harvesting at the Kya Aka sand dam, Makueni, Kenya

More than a dozen different water-harvesting practices are traditionally used in the semi-arid county of Makueni in Kenya. These include terracing (*fanya juu*), cut-off drains, retention ditches, harvesting of runoff from roads and rooftops, and sand dams (Recha 2016). During the rainy seasons, sand dams fill up with water within days of the first rains. This water then remains stored for use by people, livestock and plants during the subsequent dry seasons and droughts (Pauw *et al.* 2008). The sand dams store water in the ground (Borst and de Haas 2006, Hut *et al.* 2008, Quilis *et al.* 2009). Increased levels of water stored in the soil also improves the surrounding vegetation conditions (Ryan and Elsner 2016, Gies *et al.* 2014, Manzi and Kuria 2011).

A WAPC was established in Kithungo/Kitundu ward in Makueni's Mbooni constituency by the Adaptation Consortium through Christian Aid and Anglican Development Services Eastern, with support from DFID. The WAPC assessed options for building resilience to climate change in Makueni and decided to invest 1.1 million Kenyan shillings in constructing the Kya Aka sand dam. While the name of the dam means 'for women', the whole community benefits from the dam. The Kya Aka sand dam provides a sustainable water source for water users, reducing water-related stress and conflicts. The water users include households who need domestic water supplies to lead healthy lives, smallholder farmers and agriculturalists who use it to support crops and livestock for dietary diversity as well as income generation, public institutions that could not function without water supplies, and the local coffee factory. The populations of six villages benefit directly from the sand dam. In total, they amount to 298 households. Small-scale irrigation improves food security and income generation for these households.

In addition to the water supplies that the dam provides, it also recharges water to the river ecosystem, restoring the dependent flora and fauna and amenities for the local population, and recharging the aquifer beneath to benefit other users downstream, including those in other counties. Since the sand dam offers a sustainable supply of water, it prevents the population from resorting to other means to obtain water, which might involve mining aquifers or constructing expensive and environmentally damaging infrastructure and pumping systems.

Source: Muithya (2018).

The Kya Aka sand dam in Kenya © Lydia Muithya, Ada Consortium

Conservation or restoration of landscapes and genetic resources

Restoring drought-resistant shrub and tree species such as the acacia, the date-palm or the baobab is recognised as an EbA solution in many parts of the drylands (Box 22). However, implementation experiences gained over the years from efforts to restore degraded vegetation have shown many failures and mistakes. Often, the reintroduction of plants to areas with reduced vegetation cover requires considerable volumes of water to be applied, at least until the plants are well-established. This has been the experience in reforestation programmes pursued in Mauritania, Niger, Mali and elsewhere. Water harvesting (as described in previous section) offers one option to overcome these difficulties.

Local knowledge is usually a good source of guidance for landscape management and well-adapted genetic resources. However, the involvement of national technical agencies and statistical institutes is also required. For example, enabling communities to generate income from camel milk production in the Kenyan arid lands has required support from microcredit agencies, storage and transportation infrastructure, milk marketing boards and food safety standards agencies etc. The successful marketing of argan oil from forest conservation in the Moroccan drylands drew on local ecological knowledge (El Harousse *et al.* 2012). However, it also required years of investment and support for research, product development and marketing. EbA interventions can support international scientific cooperation to boost and accelerate these processes.

Key implementation steps

- Consult, revive/re-create/foster collective resource management institutions. The case study shown in Box 22 describes the work done by a range of NGOs and local communities, including interventions by the Near East Foundation in Mali, which were implemented with local government actors in the region of Mopti.
- Determine what the comparative advantages of indigenous plant and animal varieties are, what livelihood benefits they provide, and what the barriers to profitable cultivation of them may be.
- Consult with technical services including research and extension agencies to identify challenges such as any phytosanitary or animal health issues to be considered, problems concerning market access, processing or transportation.
- Formulate a strategy to enable sustainable cultivation of indigenous or other varieties, including for example clarification of responsibilities and capacity-building needs, and empower local actors to take responsibility for implementation.
- Encourage involvement of microenterprises. The case study in Box 22 highlights the complementarities between the agroforestry activities and the microenterprises that local women can establish for livestock fattening.

Box 22. Rehabilitating agroforestry in West Africa

Since the mid-1980s, it is estimated that farmers have rehabilitated 200,000–300,000ha of quasi-unproductive lands using an ecosystem-based adaptation approach (Munang *et al.* 2014). This involves farmers digging small planting pits called zaï on barren, degraded land and filling them with manure that contains the seeds of local trees and bushes that were eaten previously by the livestock. This naturally increases the number and diversity of on-farm trees and bushes (Belemviré 2003). The livestock provide walking seedbanks with preferences for palatable species.

The regenerated trees and bushes play a key role in restoring the productivity of degraded farmland and provide multiple ecosystem benefits: fodder for the livestock, fruit, fuelwood, timber, improved soil fertility, higher groundwater levels and decreased soil erosion. Farmers combine tree-planting techniques with soil and water conservation practices to slow down water runoff, prevent erosion and assist in recharging the groundwater by constructing stone lines (called contour bunds) on their farmland.

Farmers take part in implementing the labour-intensive processes required to harvest the water that the trees need to grow because the improvement of the soil can immediately increase crop productivity, as well as tree production. In years of average rainfall, farmers implementing these practices in Burkina Faso have produced 1,000kg of cereals on one hectare of land (Munang *et al.* 2014). However, when rainfall is poor, the crops will fail. This is why rural households and development programmes in West Africa often integrate other activities that communities can expect to bring benefits even during years of poor rainfall, such as livestock fattening or market gardening (see eg Somda *et al.* 2013).

Once they have had time to mature, the leaves and fruits from trees that grow in West African agroforestry systems can be collected by women and sold at local markets. Relevant high-value tree species identified in a recently established system in the Mopti region of Mali include baobab, African locust bean and tamarind (Keita 2017). In this case, as in various others across the region, rather than relying on livestock to plant the trees for them, women had intentionally selected the high-value species. These were raised in an irrigated nursery and then transplanted to agroforestry plots with technical support from local BRACED project staff of the Near East Foundation. Women in Mopti also requested support from local project staff to enable them to fatten livestock, create market gardens for vegetables and manage water supplies for their households.

For more information see: www.neareast.org/braced

Source: based on Munang *et al.* (2014), Somda *et al.* (2013) and Keita (2017)

STEP 7: MONITORING AND EVALUATION FOR LEARNING

Objective and actions

This step aims to assess the impacts of EbA measures on ecosystems, livelihoods and adaptive capacity, and to understand whether an EbA initiative is effective. Monitoring assesses whether planned activities to implement EbA measures are on track, while evaluation assesses how well the objectives of EbA measures have been met and whether they have been effective in reducing vulnerability and increasing resilience. M&E should aim to promote flexible and forward-looking adaptive management and learning by all stakeholders.

Developing indicators and a baseline for M&E

Effective EbA has been defined as 'an intervention that has restored, maintained or enhanced the capacity of ecosystems to produce services. These services in turn enhance the well-being, adaptive capacity or resilience of humans, and reduce their vulnerability' (Seddon *et al.* 2016).

There is no one-size fits all approach to M&E of EbA since the purpose, target groups, modes of information dissemination and available resources are very context specific (GIZ 2017). EbA projects should develop an outcome statement for each activity and identify factors that can influence the outcome. For each activity, the baseline and target should be identified and SMART[16] monitoring indicators should be developed (see eg Checklist 6). These should clarify what the project can be expected to achieve.

Checklist 6. Examples of indicators for M&E

Specific indicators for M&E will depend on the type of EbA activity implemented. However, broadly, these are likely to include:

- **Ecosystem services** such as water provision, genetic diversity, food, reduced soil erosion
- **Disaster risk reduction** (eg reduced risk of landslides or flooding, reduced exposure to risk of crop failure)
- **Increased livelihoods/income** resulting in increased resilience to shocks

Indicators should also assess the social and policy impacts of the EbA interventions, such as:

- **Enhanced local institutions** and capacity for collective resource management
- **Enhanced social networks** and access to information for adaptation (internal and external)
- **Empowerment** of women and vulnerable people and enhanced socioeconomic safety nets
- **Impacts on particular policies** or policy debates

Specific indicators for mountain, coastal and dryland ecosystems are highlighted in the sub-sections below. There are often many overlapping objectives and possible benefits from EbA interventions. It is important to develop indicators to assess both the primary adaptation objectives of a project and additional 'co-benefits' that contribute to improving adaptive capacity. For example, DDR may be considered the primary benefit that leads to enhanced resilience, but enhanced livelihoods also contribute to enhanced adaptive capacity. Such co-benefits may be important to particular stakeholder groups. For example, in an EbA project focusing on watershed management, reforestation may be employed for the primary benefit of watershed restoration and improving access to water as the overarching objectives. But NTFPs could support livelihoods as a co-benefit, and without these, the project may fail to gain local stakeholders' support.

Experience shows that it is important to focus on only a few, but essential, tangible outputs that can be measured during the life of a project (as ecosystem service outcomes may only emerge after a project ends), and to actively engage local actors from the beginning (GIZ 2017). Suitable indicators should be identified with local communities to ensure they are meaningful for them and help establish ongoing community monitoring systems. For many stakeholders, both at local and national levels, perceptions of the economic impacts of EbA will determine whether or not interventions are considered successful. However, communities will not necessarily volunteer to track and report these impacts. Relevance of indicators to local, national and international strategies and goals (such as SDGs) should also be considered as this can promote mainstreaming of EbA.

Human trade-offs should be explored, acknowledging that there may be costs (social or economic) for some groups, as well as benefits. There may also be trade-offs in terms of where benefits and costs accrue and when (short term versus long term). Some EbA benefits will only occur in the longer run. There is also a need to consider benefits or costs beyond the community where the project is being implemented. Project communities will not necessarily be aware of or prioritise monitoring of these, or have the capacities to track them. This means that project staff may need to seek information from beyond the target communities, and present it to them for further discussion. Ideally, cost-effectiveness should be assessed, which could involve a cost-benefit analysis and comparison to other investment options, to inform policymakers and planners. This should also address trade-offs (for example, some economic benefits will accrue while there may also be costs in other places or over time), and explore distribution of benefits over time, different geographic scales and between different community groups.

16 Specific, measurable, attainable, relevant and time-bound (SMART).

As well as monitoring adaptation action (such as number of awareness-raising workshops), and adaptation impacts/results (such as percentages of increases in crop yield), it may be useful to monitor climate parameters and climate impacts at the local level, to help track the climate context within which adaptation initiatives are implemented. Communities can be supported to establish weather monitoring systems (see the Potato Park example in Step 6 Mountains). Communities should also be given the opportunity to assess the performance of the supporting NGO or CBO and scientific partners, and provide feedback on factors such as their effectiveness, efficiency, and the level of community participation and information sharing, to facilitate learning and improvement.

Key monitoring and evaluation steps

The following steps can be used as a broad guide for developing indicators to assess an intervention, and can be adapted for participatory M&E with communities:

- Identify expected contributions to adaptation
- Develop a theory of change (ToC) which identifies long-term goals and maps the process to achieve them (see Box 23)
- Formulate context-specific indicators based on the theory of change and establish a baseline for these indicators at the start of the project
- Develop an M&E plan for data gathering, data analysis, storage and dissemination

It is often necessary to collect baseline data for key indicators at the start of the project (see also Steps 2 and 3), since national statistical systems may have limited scientific data on ecosystems and livelihoods in remote areas. Indicators and baselines for M&E will emerge from the vulnerability assessment (Step 3). Demonstrating impacts may also require baseline data collection in a control community with no intervention for comparison.

Box 23. What is a theory of change?

A theory of change (ToC) is an explanation of how and why you think change happens.
Typically, a ToC is presented as a diagram with the narrative text of a project proposal to:

- Give the big picture, including issues related to the environment or context that you cannot control
- Show different pathways that might lead to change, even if those pathways are not related to your programme
- Complete the sentence: 'If we do X, then Y will change because…'

For more information and discussion, see: http://bit.ly/2oAsUZM

Source: based on Bisits (2015).

Learning among community researchers and EbA project staff should be a continuous process during the EbA intervention, and should inform annual reviews so that activities can be adjusted as necessary. The M&E results and learning should be documented and the knowledge and lessons learnt should be shared with all key stakeholders, including communities, governments and technical experts. The impacts of interventions over a longer period of time can be assessed by repeating vulnerability impact assessments conducted at the beginning (Steps 2 and 3) to assess changes in adaptive capacity.

Key outcomes for Step 7

- **SMART indicators for EbA monitoring and evaluation have been identified with communities**
- **Baseline data reports have been generated (see also Steps 2 and 3)**
- **M&E plan and community monitoring system has been developed**
- **M&E reports and cost-benefit analysis have been created**

Tools and resources for Step 7

Developing and implementing community-based monitoring and information systems

http://bit.ly/2BRdlzO

Tebtebba Foundation (2013)

Developing a community monitoring and database system

http://pubs.iied.org/14670IIED

Swiderska and INMIP (2017)

M&E: how to measure successes of EbA

http://bit.ly/2GKNEps

GIZ (2017)

M&E of community-based adaptation to climate change

www.adaptationcommunity.net/?wpfb_dl=381

Leiter (2016)

Repository of adaptation indicators

http://bit.ly/2CKfG1E

IISD (2017)

Spatial conservation planning with Marxan

www.marinetraining.eu/content/spatial-conservation-planning-marxan

Marine Training.eu

Theory of change

http://bit.ly/2orWPUP

Bisits (2015)

SDGs indicators for water access, availability, water use efficiency, water stress and others

UN Water, Integrated monitoring guide for SDG 6, www.unwater.org/publications/integrated-monitoring-guide-sdg-6

UN Statistics Division, System of Environmental-Economic Accounting (SEEA), https://unstats.un.org/unsd/envaccounting/seea.asp

World Bank, Natural capital accounting, www.worldbank.org/en/topic/environment/brief/environmental-economics-natural-capital-accounting

Household survey design

www.ihsn.org

IHSN

MOUNTAINS: MONITORING AND EVALUATION

As discussed in Checklist 6, indicators and baselines of particular relevance for mountain socioecological systems may include:

- Ecosystem services such as water provision, genetic diversity, food, reduced soil erosion
- Disaster risk reduction (such as reduced risk of landslides or flooding, reduced exposure to risk of crop failure)
- Increased livelihoods/income resulting in increased resilience to shocks
- Enhanced local institutions and capacity for collective resource management
- Enhanced social networks and access to information for adaptation (internal and external)
- Empowerment of women and vulnerable people and safety nets

For the Global EbA in Mountains Programme in Nepal, a baseline socioeconomic survey was conducted across the Panchase conservation area, covering climate patterns and changes, demography and socioeconomy (eg household income), and ecosystems and ecosystem services (including forests and biodiversity) (UNDP Nepal 2014). In Mount Elgon, Uganda, the project collected baseline information on land use, livelihoods, existing EbA measures and practices, current capacity for EbA, and essential and desirable ecosystem services, for both M&E and detailed project design. The study entailed desk reviews, interviews with district officials and other stakeholders, and RRA and interviews with communities (Hafashimana *et al.* 2012). In Peru, the project for landscape restoration in the Andes developed 25 indicators to assess social impacts, ecosystem impacts and ecosystem service impacts, and to measure exposure and sensitivity of communities. In order to ensure sustained monitoring, a set of eight tangible social and ecological indicators were selected (four of each) which could be monitored in the short to long term with available time, equipment and human resources, such as family income and grassland conditions. A key lesson learnt was that it is crucial to engage local stakeholders in M&E from the start (GIZ 2017).

COASTAL: MONITORING AND EVALUATION

For EbA in coastal ecosystems the following indicators may be applicable: resilience and adaptive capacity, and impacts on ecosystems, livelihoods, institutions and policy, and economic impacts.

Ecosystem impacts

- Ecosystem services such as provisioning services (forest products, honey, fish stocks associated with coral reefs, shellfish stock), enhanced water quality, aquaponics and reducing soil erosion

Resilience and adaptive capacity

- Reduced exposure to land erosion, reduced damage due to storm surges and cyclones/typhoons, increased capacity of coastal plants and animals to live in a more saline and acidic environment
- People and their assets can cope with storms, storm surges, salinity intrusion, land erosion
- People's physical, financial, human, natural and social capital have increased
- Greater awareness of and preparedness for disaster
- Enhanced social networks and access to information for adaptation (internal and external)
- Reduced vulnerability of women and children

Livelihoods impacts

- Increased capital including physical (property, vehicles, fishing boats, fishing gear), financial (especially income), human (especially use of information and technology, better health and education), natural and educational (especially greater awareness of disasters)
- Increased access to different livelihood assets
- Increased empowerment of women and vulnerable people and improved social safety nets (such as unemployment benefit, healthcare, shelters)

Institutional and policy impacts

- Enhanced local institutions and capacity for sustainable coastal zone management
- Enhanced social networks and access to information for adaptation

Economic impacts

To determine value for money and to help improve management, an assessment should be done using cost-benefit analysis, especially if resources are limited. Has the particular coastal EbA intervention been a good investment or not compared to other EbA options? What are the distribution of benefits over time, at different geographic scales and between different community groups? Knowing the costs associated with a particular EbA intervention also enables planners to budget and to help secure sufficient funds for the effective long-term management of coastal ecosystems. Software such as Marxan can be used to design cost-effective conservation strategies.[17]

17 Marxan is a decision support software for conservation planning. It is used in 184 countries to build marine and terrestrial conservation systems.

DRYLANDS: MONITORING AND EVALUATION

Underinvestment in national statistical systems and educational institutions has affected institutional processes in many dryland ecosystems. Consequently, there can be major challenges in identifying scientific baselines for ecosystem conditions and productivity. Because of this, allocating sufficient resources for effective M&E of EbA interventions is important.

In dryland ecosystems, indicators and baselines may include:

- Ecosystem health (such as presence of sentinel species, depth of surface water bodies and/or depth to water table at critical times of year)
- Ecosystem services (such as flow rates from natural springs, extent of palatable vegetation available for grazing at critical times of the year, microclimate regulation due to conservation of trees and sustainable building practices)
- Economic or livelihoods impacts (such as income and school attendance rates)
- Food security (prevalence of child malnutrition, milk production, survival and yield of selected staple crops, fruit production from trees)
- Adaptive capacity (such as indicators referring to knowledge and institutions)

Ecosystem services

As a minimum, these should include indicators of water resource conditions since these underpin the socioecological system. Relevant indicators might include:

- Water levels in surface or groundwater bodies at particular times of year
- Extent of tree cover
- Dry season milk production
- Household water service levels and breakdown rates
- Expenditure on purchase of water

Often, these effects are omitted from M&E systems due to feasibility issues and lack of data – especially at community level. Other on- and off-site effects of EbA interventions on ecosystem functions and health, such as pollution or siltation, may also require monitoring. Indicators related to the SDGs include an indicator for calculating the balance between water availability and extraction (SDG indicator 6.4.2). This is relevant in many dryland EbA contexts. Adopting indicators of interest to national and international processes in the EbA strategy can contribute to mainstreaming EbA into national planning.

Economic impact

Tracking of financial impacts on household incomes is often a delicate matter. Some basic insights about questions that households will (and will not) answer is available from the International Household Survey Network (see Step 7 Tools and resources). Communities may be more comfortable tracking the community-level production of relevant commodities or services rather than detailing who has made how much income from the project. In dryland ecosystems, stakeholders may be wary of attempts to conduct data collection and cost-benefit analyses. A wiser (and cheaper) approach is to begin from rapid participatory cost-benefit assessments, and gradually collect more specific data when required (see Box 24 for an example of a survey following a vulnerability impact assessment).

Climate data is often sparse and poorly managed in crisis-prone dryland areas. This means that each new project starts from scratch, and the majority fail to effectively mainstream their M&E processes with local and national statistical systems. EbA projects should recognise the need to invest time and effort in improving local data management systems. Investing resources to enable local government and technical services to track and refine these systems would contribute to successful EbA planning and to the sustainability of the project's outcomes.

Box 24. Ex-ante assessment of economic impact from an EbA in Oman

In 2016, the Omani government was preparing a pipeline to bring desalinated water from the coast up to the mountain area of Jabal Akhdar, at a cost of about US$75 million. The cost of desalinating the water was estimated to be US$3.6/$m^3$ (ESCWA 2009).

Identified ecosystem-based alternatives included reuse of local wastewater as well as continued recommendations for increased water harvesting. Al-Kalbani *et al.* (2016) deepened his analysis by conducting a survey which revealed that the annual cost per household of buying bottled water had reached US$124–1,088 (average US$390) per household: about 14 per cent of a farmer's average annual income (US$2,708). Additional water was also supplied by truck when water supply networks were shut down or when dams were empty. Households were charged US$7.77–15.55 per 300 gallons (1.36m^3) for this additional water, depending on their distance from the groundwater source. Hotels and businesses might be willing to pay more. An ex-ante assessment would suggest that EbA could contribute to saving some of these costs.

Source: Al-Kalbani *et al.* (2016)

STEP 8: MAINSTREAMING EBA AND PROMOTING SYNERGIES

Objective and actions

This step seeks to ensure that EbA initiatives are supported by an enabling policy and institutional environment and have impacts beyond the project level, by promoting the integration of EbA into wider policy and decision-making processes at local and national level. Mainstreaming strategies should be built into the design of EbA projects.

Promoting mainstreaming in policies and plans

While EbA measures such as mangrove forest and coral reef restoration are crucial for resilience, adaptation and livelihoods improvement for vulnerable communities, they are not sufficient for meeting broader environmental and development goals. They need to fit within broader policy goals for particular ecosystems, regions and countries (see Checklist 7). EbA initiatives may also need to align themselves with broader adaptation planning, such as the National Adaptation Plan process under the UNFCCC.

Checklist 7. Entry points for mainstreaming EbA

In order to mainstream EbA, synergies and entry points need to be identified in existing environment and development policies and plans to make the case (Hernández 2016). Integration of EbA into relevant policies, strategies and plans can be promoted by:

- Increasing awareness, knowledge and understanding of climate variability and climate change-induced threats through capacity building
- Enhancing capacities of stakeholders and institutions across sectors and at different levels to jointly formulate and implement policies that take climate change and EbA into consideration
- Ensuring that EbA interventions complement and contribute to other development initiatives and sectoral strategies, taking advantage of synergies and building common approaches
- Lobbying and advocacy led by high-level decision makers, strong institutions and EbA champions
- Demonstrating positive processes and results of EbA interventions and cost effectiveness
- Prioritising EbA strategies that deliver tangible and visible benefits in the short to medium term, such as vulnerability reduction and livelihood diversification
- Ensuring a multistakeholder process of continual learning and improvement in EbA outcomes

To promote mainstreaming of EbA at the local and national level, it is important to demonstrate the link between EbA and local or national economic development objectives. This should demonstrate EbA's contribution to targets for GDP, tax revenues, maintaining incomes and percentage of population above the poverty line, avoiding economic losses due to flood damage and loss of livestock or avoiding public expenditure on emergency water trucking, food distribution, or others. Decentralisation or devolution processes can offer one possible way to reorganise decision-making priorities and overcome the marginalisation of dryland, mountain or coastal EbA issues within selected decision-making processes. A strategy of this kind was formulated for the Arid Lands of Northern Kenya (Republic of Kenya 2011) (see Box 25).

Box 25. Devolution as a means to tailor policies to ecological and social realities in Kenya

A recent constitutional reform process (Republic of Kenya 2010) and vision strategy (Republic of Kenya 2011) have focused on devolution as a key means to overcome drought, flood and other development challenges faced in Northern Kenya.

Devolution will now bring services closer to people. In theory it will allow a greater degree of self-determination, as county governments plan and legislate in response to local needs and concerns. For an area such as Northern Kenya, which requires policy solutions tailored to its unique ecological and social realities, this is a major opportunity (Republic of Kenya 2011: 107).

Devolution measures were combined with an equalisation fund for the previously marginalised areas. However, challenges have been identified in the devolution process, including the need to:

- Facilitate the cross-boundary sharing of resources (including water)
- Include marginal groups and women (who have often been excluded from customary clan-based resource management institutions)
- Source local technical expertise and bureaucratic experience

Devolution in Kenya has been a slow process and the challenges are still numerous. In the largest and driest of the major catchments in Kenya, the Ewaso Ng'iro North Catchment Area, the experiences of water resources planners since 2011 have confirmed that the shift towards inclusive governance can be part of the solution to enable EbA. Although recent observations (described in King-Okumu *et al.* 2017) suggest that increasing local agency in water resource development helps to alleviate drought and flood emergencies, more concerted action is still needed. Since devolution has been introduced, competing claims to resources from upstream and downstream resource users have increased and there are major coordination challenges among the stakeholders.

Promoting mainstreaming as part of EbA interventions

EbA actions that have the potential to promote policy and institutional change should be prioritised in EbA strategies. For example, PPB in mountain ecosystems can change the mindsets of senior scientists who are also policymakers by directly involving them in fieldwork with farming communities. PPB has contributed to changes in national seed laws in China and Vietnam to support biodiverse local seed systems. CCAP's PPB programme in Guangxi also led to the institutionalisation of PPB in the Guangxi Maize Research Institute (provincial breeding institute).

Engaging local and national government officials from the start, including in the EbA planning process, is vital to promote mainstreaming (see Step 1). This may entail:

- Developing EbA initiatives with governments such as pilot projects to inform policy development or implementation of new policies, by demonstrating new approaches for natural resource management and climate adaptation
- Organising annual multistakeholder workshops to present the concrete impacts of EbA projects and emerging challenges, including those identified through meetings with communities (such as annual monitoring meetings)
- Taking policymakers to the field and enabling interaction with communities to raise awareness of policymakers and show concrete impacts (such as through field trips alongside multistakeholder workshops)
- Supporting the participation of vulnerable communities in multistakeholder workshops and policy dialogues, and the efforts of NGOs and researchers to promote policy change, including through EbA-related multistakeholder networks/platforms
- Supporting the scaling up of successful EbA initiatives to other communities and regions (such as through learning exchanges involving vulnerable communities and local governments) to create a strong evidence and political base
- Demonstrating effectiveness and cost effectiveness of EbA compared to other adaptation approaches through rigorous data collection and cost-benefit analysis

Formal VIAs have proved effective in promoting the integration of EbA in local and district-level planning, because they provide rigorous scientific data across large areas (such as across whole watersheds and catchments or several districts) which is useful for government planning. See for example the Global EbA in Mountains Programme VIAs in Uganda and Peru (Step 3). Time and resources should be built into project design to engage with policymakers and build new linkages after governments change, as well as flexibility to take advantage of opportunities for policy influence that may arise.

Choosing M&E indicators that can contribute to monitoring national adaptation plans or the SDGs, or which interest decision makers, can also promote mainstreaming (see Step 7). For example, in drylands it can be particularly interesting for public decision makers to consider whether EbA interventions may reduce public expenditure on social assistance or other services, or contribute to public revenues through taxes and permits for the use of natural resources. Reduced expenditure on drought and flood relief are an example of such indicators in dryland ecosystems.

Key outcomes for Step 8

→ **An action plan is developed to mainstream EbA into climate-sensitive sectors and policies, plans and strategies**

Tools and resources for Step 8

Case studies on mainstreaming tools
http://panorama.solutions/en/explorer/grid/1042

Climate proofing: a risk-based approach to adaptation
http://bit.ly/2EQVstb
ADB (2005)

EbA mainstreaming guidance
www.cbd.int/sbstta/sbstta-22-sbi-2/EbA-Eco-DRR-Guidelines-en.pdf
CBD (forthcoming 2018)

EbA solutions online portal
www.panorama.solutions/en/portal/ecosystem-based-adaptation
Panorama

Entry points for mainstreaming ecosystem-based adaptation
http://bit.ly/2trHXuz
GIZ (2018b)

Integrating climate change adaptation into development planning
www.adaptationcommunity.net/?wpfb_dl=191
Leiter *et al.* (2013)

Mainstreaming climate change adaptation into development planning
http://bit.ly/2CnFFAj
UNDP-UNEP (2011)

Scaling out the Potato Park through horizontal learning exchange
http://pubs.iied.org/14618IIED
Swiderska *et al.* (2012)

Mainstreaming ecosystem-based adaptation (EbA) and accessing EbA finance.
http://bit.ly/2CnY68f
EbA South (2014)

NDC adaptation toolbox
www.adaptationcommunity.net/nap-ndc/ndc-adaptation-toolbox
GIZ (2018a)

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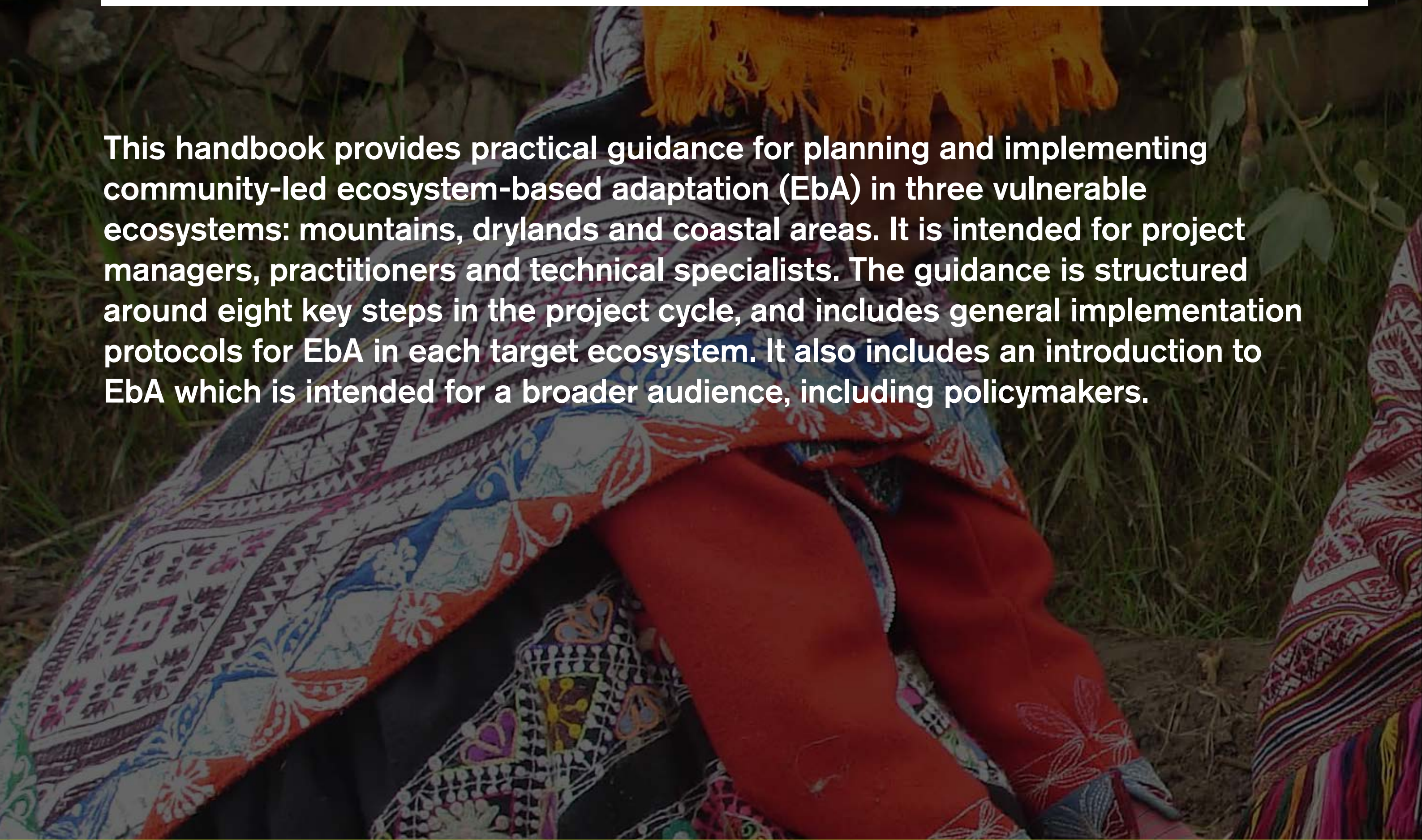
Knowledge Products

Toolkit

September 2018

Climate change, Natural resource management

Keywords:
Ecosystem-based approaches to adaptation (EbA), drylands, climate change adaptation, community-based adaptation (CBA)



This handbook provides practical guidance for planning and implementing community-led ecosystem-based adaptation (EbA) in three vulnerable ecosystems: mountains, drylands and coastal areas. It is intended for project managers, practitioners and technical specialists. The guidance is structured around eight key steps in the project cycle, and includes general implementation protocols for EbA in each target ecosystem. It also includes an introduction to EbA which is intended for a broader audience, including policymakers.

The handbook was developed under the Ecosystem-based Adaptation through South-South Cooperation (EbA South) Project and is a joint product between UNEP-IEMP and IIED.

IIED is a policy and action research organisation. We promote sustainable development to improve livelihoods and protect the environments on which these livelihoods are built. We specialise in linking local priorities to global challenges. IIED is based in London and works in Africa, Asia, Latin America, the Middle East and the Pacific, with some of the world's most vulnerable people. We work with them to strengthen their voice in the decision-making arenas that affect them — from village councils to international conventions.

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