Ecosystems protecting infrastructure and communities

Lessons learned and guidelines for implementation

Editors: Fabiola Monty, Radhika Murti, Sriyanie Miththapala and Camille Buyck

Global Ecosystem Management Programme

Supported by:
Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety
based on a decision of the German Bundestag
UNIL | Université de Lausanne

About IUCN

IUCN is a membership Union uniquely composed of both government and civil society organisations. It provides public, private and non-governmental organisations with the knowledge and tools that enable human progress, economic development and nature conservation to take place together.

Created in 1948, IUCN is now the world's largest and most diverse environmental network, harnessing the knowledge, resources and reach of more than 1,300 Member organisations and some 10,000 experts. It is a leading provider of conservation data, assessments and analysis. Its broad membership enables IUCN to fill the role of incubator and trusted repository of best practices, tools and international standards.

IUCN provides a neutral space in which diverse stakeholders including governments, NGOs, scientists, businesses, local communities, indigenous peoples organisations and others can work together to forge and implement solutions to environmental challenges and achieve sustainable development.

Working with many partners and supporters, IUCN implements a large and diverse portfolio of conservation projects worldwide. Combining the latest science with the traditional knowledge of local communities, these projects work to reverse habitat loss, restore ecosystems and improve people's well-being.

www.iucn.org

https://twitter.com/IUCN/

Ecosystems protecting infrastructure and communities

Lessons learned and guidelines for implementation

Editors: Fabiola Monty, Radhika Murti, Sriyanie Miththapala and Camille Buyck

This publication has been produced with funding from the German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) through the International Climate Initiative (IKI).

Published by: IUCN, Gland, Switzerland

Citation: Monty, F., Murti, R., Miththapala, S. and Buyck, C. (eds). 2017. *Ecosystems protecting infrastructure and communities: lessons learned and guidelines for implementation*. Gland, Switzerland: IUCN. x + 108pp.

Contributors: Sylvain Zabré, Karen Podvin, Alejandro Casteller, Erika Cortés, Alexia Stokes, Yan Zhang, Karen Sudmeier-Rieux, Anu Adhikari, Sanjaya Devkota, El H. Ballé Seye, Supranee Kampongsun and Jim Enright.

ISBN: 978-2-8317-1867-5 (print)
978-2-8317-1872-9 (PDF)

DOI: https://doi.org/10.2305/IUCN.CH..2017.14.en

Cover photos: Time-lapse of mangrove restoration site in Thailand in 2015 (Top) and 2017 (Bottom) © Mangrove Action Project

Back cover photo: Exchange visit in Senegal between project beneficiaries from Burkina Faso and Senegal © IUCN/ Camille Buyck

Designed by: Chadi Abi (www.chadiabi.com)

Printed by: ABP Global Printing Solutions (www.abp-project.ch)

Available from: IUCN (International Union for Conservation of Nature)
Rue Mauverney 28
1196 Gland
Switzerland
Tel +41 22 999 0000
Fax +41 22 999 0002
www.iucn.org/resources/publications

Acknowledgements: We would like to thank all the partners and actors involved in the EPIC project who contributed largely to its successful implementation. Our colleagues from the Global Ecosystem Management Programme have provided important technical input throughout the duration of this project particularly Edmund Barrow and Ali Raza Rizvi. Special thank you to Angela Andrade and Marisol Estrella for the peer reviews and feedback that contributed to improve this document. Thanks to Caroline Snow for proofreading the document. Any remaining errors are the sole responsibility of the authors.

Table of Contents

EXECUTIVE SUMMARY

Ecosystems Protecting Infrastructure and Communities (EPIC) is a global initiative implemented from 2012 to 2017 to promote the use of ecosystem-based approaches and protect communities from disasters and the negative impacts of climate change. It also aimed to have ecosystem-based disaster risk reduction recognised in key global frameworks such as the Convention on Biological Diversity (CBD) and the United Nations Framework Convention on Climate Change (UNFCCC). The project demonstrated the need to invest in ecosystem-based disaster risk reduction, to have more effective climate change adaptation in the targeted sites. This flagship project is funded by the German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) through the International Climate Initiative (IKI). It was implemented at global and national levels with pilot sites in six countries from three regions – China, Nepal and Thailand in Asia, Burkina Faso and Senegal in Africa as well as Chile in South America.

Ecosystem-based Disaster Risk Reduction (Eco-DRR) can be defined as the sustainable management, conservation and restoration of ecosystems to reduce disaster risk, with the aim of achieving sustainable and resilient development. While aiming to primarily address disaster risk reduction, it is recognised that Eco-DRR can contribute to climate change adaptation (CCA). Despite increasing recognition of the importance of ecosystem-based approaches for both disaster risk reduction and climate change adaptation, implementation remains mostly underdeveloped worldwide. With increasing disaster challenges and climate change threats, there is a sense of urgency to scale-up such approaches, given that ecosystem and the services that they provide can not only mitigate the impacts of natural hazards and climate change but they can also contribute to sustainable livelihoods and thus build resilience.

Recent global policy developments now provide important entry points to not only scale-up these approaches but also to ensure greater coherence through integrated approaches for conservation, disaster risk reduction and climate change adaptation. The theme of the 2017 Global Platform for Disaster Risk Reduction, “From commitment to action” sets the tone for the priorities in the Eco-DRR agenda. There are however several questions that act as barriers to the uptake of Eco-DRR actions on the ground: How do such initiatives look like? How are they implemented? Are they effective? What works or not? This publication presents details on *Ecosystems Protecting Infrastructure and Communities* (EPIC), a pioneer global initiative which promoted the implementation of ecosystem-based approaches for disaster risk reduction and climate change adaptation through five case studies in six countries. At the time that EPIC was developed, it responded to the need to build experiences and to address the knowledge gaps with regards to the implementation of ecosystem-based measures for disaster risk reduction and climate change adaptation. Following the major policy advances that support implementation of such approaches and the demand for technical guidance to support actions on the ground, the diversity of EPIC case studies- covering different types of ecosystems, hazards, countries, regions and ecosystem-based approaches-provide important lessons learned for further actions.

The publication provides a detailed description of the project’s operational approach and draws lessons from the case studies to inform and guide best practices to implement integrated ecosystem-based disaster risk reduction and ecosystem-based adaptation (EbA). It is intended for practitioners worldwide planning to initiate and/or scale-up ecosystem-based measures for long-term resilience. It is expected that these practitioners may range from NGOs and government bodies within the communities of practice of conservation, humanitarian aid and disaster risk reduction, sustainable development and climate change adaptation.

Chapter 1 introduces developments in the Eco-DRR agenda over the past decade and the relevance of EPIC in taking it forward by informing how action can be mobilised to do more such work. There have been major developments on the policy front that now provide opportunities to integrate Eco-DRR and EbA and also to scale up such work. EPIC’s overarching goal is to ensure that “ecosystem services are recognised, promoted and conserved as an integral part of disaster risk reduction policy, planning and programming in the six target countries and in key global processes such as implementation of The Hyogo Framework of Action of UNISDR, and climate change adaption framework of the UNFCCC”. With a secondary objective of showing the relevance of Eco-DRR for climate change adaptation, the project provides timely learning opportunities to support coherent actions.

The project used a strategy that simultaneously combines: 1) the generation of science-based knowledge, 2) implementation of ecosystem-based measures and 3) policy advocacy. It also used a multistakeholder approach engaging research institutions, government agencies and NGOS from different sectors and worked at different levels from grassroots to national levels.

Chapter 2 covers the implementation of EPIC in each targeted country. It discusses the individual approach used, achievements, challenges and lessons learned in implementing this flagship initiative on Eco-DRR/CCA:

Country	Project sites	Hazards addressed	Ecosystem-based approach	Key message
Burkina Faso	6 villages in Northern Region	Droughts and floods	Sustainable land management	Involvement of communities in identifying solutions to hazard risks, planning, implementation and monitoring leads to better community ownership of the interventions.
Chile	Biosphere Reserve Nevados de Chillán – Laguna del Laja (Ñuble and Biobío)	Avalanches, landslides, rock falls	Forest management	In the Valle de las Trancas, healthy forest ecosystems can play a crucial role in protecting infrastructure and communities from avalanche and landslide hazards.
China	Salween River Valley (Yunnan Province)	Landslides	Eco-engineering	An increase in plant diversity and proper mixtures of crop and tree species in ecological engineering projects could improve protection against shallow landslides and erosion, especially in southwest China.
Nepal	3 villages in Western Development Region of Nepal	Landslide and sediment runoff	Eco-engineering	EPIC Nepal has demonstrated successfully that eco-safe roads — an ecosystem-based approach to disaster risk reduction — are cost-effective and locally adapted, with great potential for reducing risk while increasing the resilience of communities living in landslide-prone areas.
Senegal	6 villages in Fatick Region	Droughts and salinisation	Sustainable land management	Participatory and iterative approaches ensure continued commitment from communities.
Thailand	2 villages in the Krabi River Estuary (Krabi province)	Storm surges and coastal floods	Mangrove restoration	Community-based Ecological Mangrove Restoration (CBEMR) is an effective method for successfully restoring abandoned aquaculture ponds back to a healthy, biodiverse mangrove bio-shield, which will help protect communities, infrastructure and agricultural lands from tropical storms and erosion hazards.

Chapter 3 analyses the successes and challenges of EPIC and articulates lessons learned from the project as well as recommendations to implement integrated Eco-DRR and EbA initiatives using a simultaneous science-practice-policy operational framework. EPIC's experience demonstrates that effective implementation requires working on three main aspects, namely science, policy and practice:

1. Science: Science has a key role to play in documenting Eco-DRR/CCA evidence, either as leverage points to influence policy as showcased in some of the case studies, particularly Nepal, or to inform evidence-based field interventions. It is therefore important to set up the basics for strong science from the early stages in an initiative, and to also engage with the scientific community to create interest in contributing to knowledge creation on scientific evidence and good practices.
2. Practice: An important component of Eco-DRR/CCA initiatives is their participatory nature. To ensure community mobilisation, adoption of and interest to continue the field-based interventions, these need to be relevant for the local communities. It is also important to empower local people through capacity building and to engage them in project design, implementation and monitoring.
3. Policy: Making the case for ecosystem-based approaches is probably the most important aspect to scale-up such work. They do not only need to be mainstreamed into different policies but also into different sectors. In the case of EPIC, there are lessons learned mainly with regards to mainstreaming ecosystem-based approaches into different policies including disaster risk reduction and climate change adaptation. Constant engagements through several meetings and training events with local and national policy-makers have been instrumental to influence policy. These close collaborations and exchanges during workshops and field visits can also facilitate policy influence even when the benefits from field-based interventions take time to manifest.

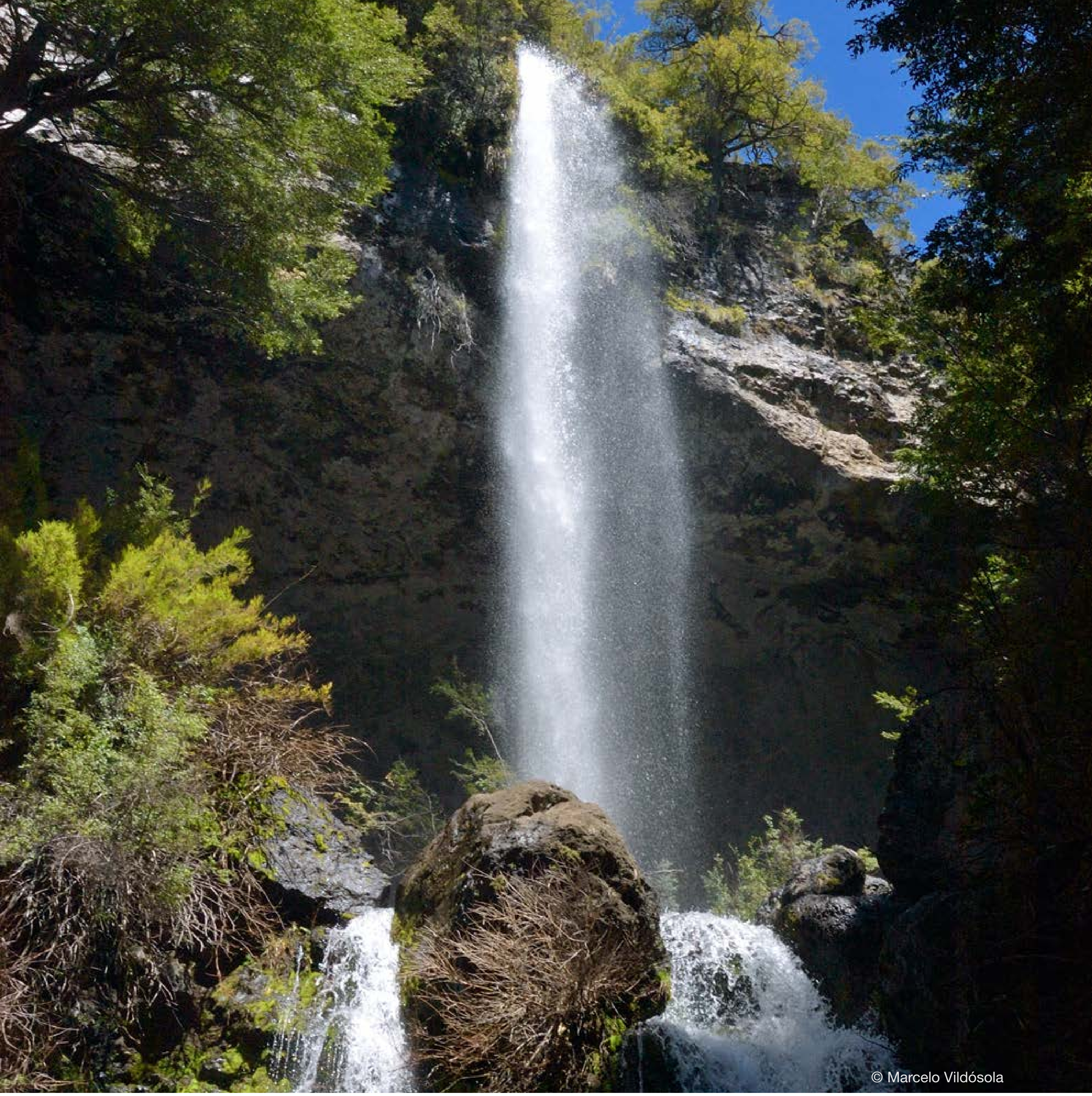
In summary important ingredients of success to build resilience, generate science-based knowledge, strengthen capacities of local people and institutions and influence policy include:

- Working at different levels from local to global level and engaging different stakeholders
- Implementation of a participatory approach and giving a voice to local people from the start of the project, by involving them in the design of the activities (through consultation meetings and Vulnerability and Capacity Assessment workshops) as well as implementation and monitoring
- Integrating livelihood improvement strategies with ecosystem-based interventions
- Including peer-to-peer learning opportunities between local people through exchange visits
- Early and constant collaboration with research institutions
- Building on existing relationships with local networks and institutions
- Organising frequent events training workshops and field visits to increase capacity
- Linking capacity building with policy advocacy

CHAPTER 4 compiles the lessons learned from EPIC and builds on existing guidelines for EbA implementation to propose a step-by-step guidance to implement integrated Eco-DRR and EbA initiatives:

While the fiver year-long EPIC initiative provides preliminary insights on policy development, research gaps and implementation of Eco-DRR, it is hoped that

the information contained in this publication can inform future such initiatives for scaling-up and promoting Eco-DRR. As we move forward with more coherent actions, the information exchange with the technical guidance can be two-way: 1) it can be used to develop and implement new projects and 2) It can be kept dynamic and relevant by being informed by other and new experiences. A mechanism that can be supported by global networks such as the Partnership for Environment and Disaster Risk Reduction (PEDRR) and the Friends of EbA (FEBA).



Chapter 1

The Ecosystem-based Disaster Risk Reduction Agenda and relevance of EPIC in taking it forward

Fabiola Monty and Radhika Murti

1.1 Setting the scene

The 2000s saw a growing interest in the importance of ecosystems for human wellbeing. The ecosystem approach defined as a “strategy for the integrated management of land, water and living resources that promote conservation and sustainable use in an equitable way” and its principles were endorsed during the fifth Conference of the Parties (COP) to the Convention on Biological Diversity (CBD) in 2000. However, it was not until 2004 that the attention started to be focused on the relationship between ecosystems and disaster risk reduction, catalysed by the tsunami in Southeast Asia. This growing interest however remained expressed in research and knowledge products. With the conservation, disaster risk reduction and adaptation communities operating separately, there were multiple gaps to be filled to start building synergies between these areas of work. At the time that the concept for the *Ecosystems Protecting Infrastructure and Communities* (EPIC) initiative was developed in 2010, there were few official linkages between the different global policy frameworks, namely the CBD, the United Nations Framework Convention on Climate Change (UNFCCC) and the Hyogo Framework for Action (HFA), the global blueprint for disaster risk reduction from 2005 to 2015. In practice, there were also few or no experiences in the implementation of ecosystem-based measures for disaster risk reduction and climate change adaptation and significant knowledge gaps on the effectiveness of such approaches. The need to build experiences and to address the knowledge gaps combined with new funding opportunities initiated several global field-based pilot projects worldwide such as EPIC. These initiatives started to build a knowledge base and lessons for the implementation of ecosystem-based approaches, and contributed to a shift in practice and on the policy scene.

Collaborative advocacy work between different organisations, for example through networks such as the Partnership for Environment and Disaster Risk Reduction (PEDRR), has contributed to several advances in global policies with opportunities for greater coherence. During the UNFCCC COP 19 in 2013, it was evident that Disaster Risk Reduction (DRR) including Ecosystem-based Disaster Risk Reduction (Eco-DRR) had attained a more prominent place in the climate change agenda with increasing effort to identify and capitalise on the links and commonalities between DRR and Climate Change Adaptation (CCA), with ecosystem management being a key one. This places EPIC as a timely initiative to serve as one of the first demonstrative pilots on how to operationalise ecosystem management for adaptation (long-term) and DRR (short- to medium-term).

In the past few years, there have been major policy advances (Figure 1) that not only provide opportunities to scale-up ecosystem-based approaches for disaster risk reduction but they also facilitate the uptake of integrated approaches for conservation, DRR, CCA and more recently climate change mitigation. A key milestone for the disaster risk reduction field was the adoption of the Sendai Framework for Disaster Risk Reduction 2015-2030, the successor to the Hyogo Framework for Action 2005-2015. The Sendai framework was the first agreement of the post-2015 development agenda and places a stronger emphasis on the importance of ecosystems. It also proposes a more rigorous monitoring framework that is aligned with the global monitoring framework of the Sustainable Development Goals (SDG).

As we now move towards the implementation of these key policies and the scaling-up of ecosystem-based measures for disaster risk reduction and climate change adaptation, it is particularly important to showcase and capture lessons learned from initiatives like EPIC to be included in broader and integrated strategies to build resilience. Drawing from EPIC’s case studies, this publication focuses on presenting

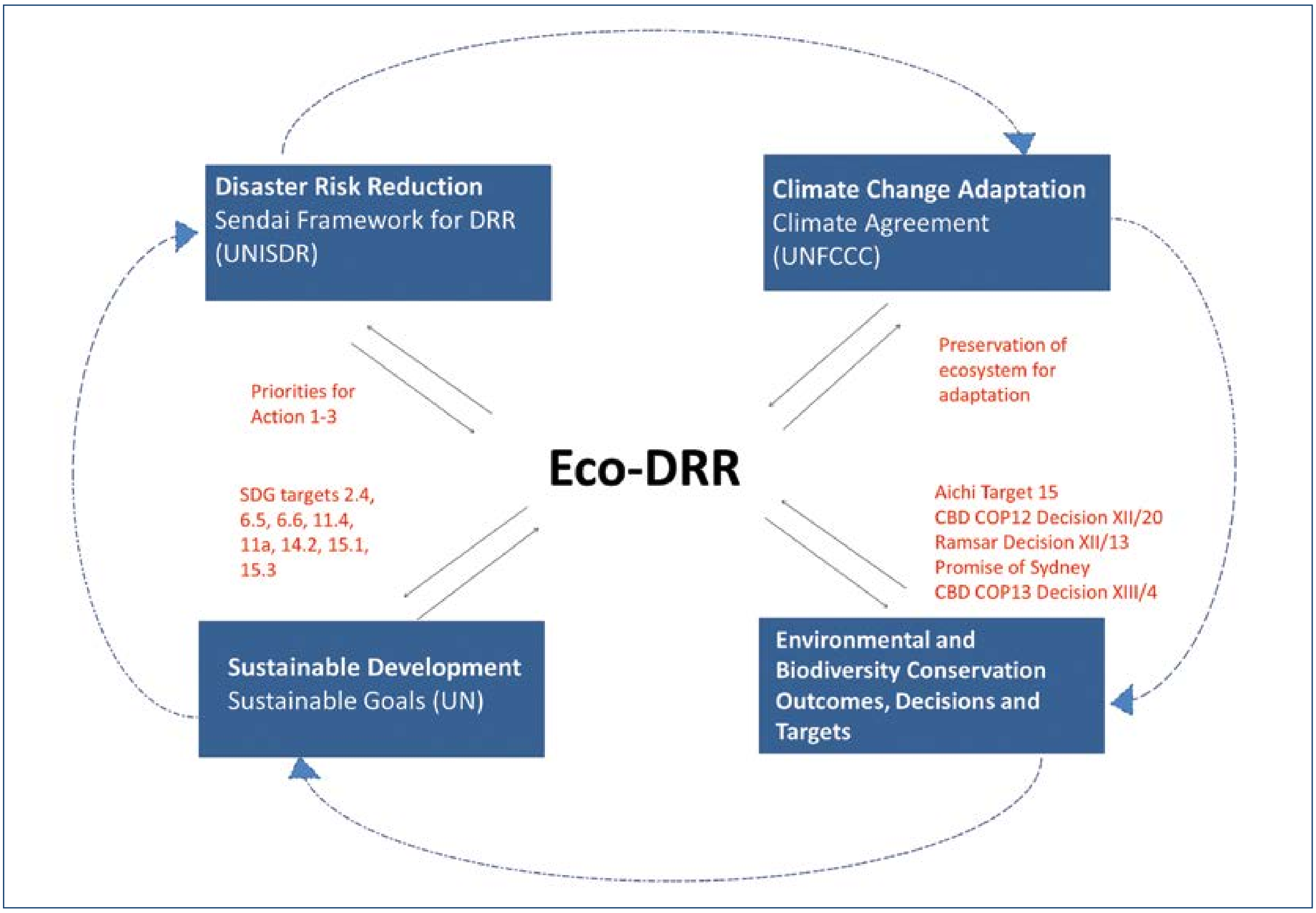


Figure 1. Major international agreements and policy developments of relevance to ecosystem-based disaster risk reduction (Adapted from Renaud et al., 2016)

©IUCN/Doris Cordero

preliminary lessons learned and guidance on how to implement ecosystem-based disaster risk reduction for long-term climate change adaptation. It is hoped that it will provide insights on how action can be mobilised to replicate and scale-up such work.

1.2 Disasters, climate change and ecosystem-based approaches

Increasing disaster risks and losses

The occurrence of disasters has been generally on the rise for the past three decades (Figure 2). While the number of reported disasters showed a slight drop from 2015 to 2016, economic losses due to disasters are almost twice as great in 2016 as compared to 2015 (Figure 3).

With climate change and the predictions that it will create new risks, disaster losses are likely to persist and increase. The 2017 global risk assessment is a clear reminder that environmental risks are a priority challenge worldwide with extreme weather events, 'natural' disasters and failure of mitigation and adaptation to climate change being among the top global risks to societies and economies in terms of likelihood and possible impacts (Figure 4; World Economic Forum, 2017).

While efforts to address disaster challenges have been primarily focused on disaster management, the recent global development on the policy scene is now calling for greater emphasis on disaster risk reduction, namely the prevention of disasters and new disaster risks (UNISDR, 2017).

Role of ecosystems in disaster risk reduction

It is now recognised that the state of the environment and the occurrence and extent of impacts of disasters are related. In an ideal situation where ecosystems are maintained in a healthy state, they are able to provide multiple benefits for human well-being, namely ecosystem services. Such services can be

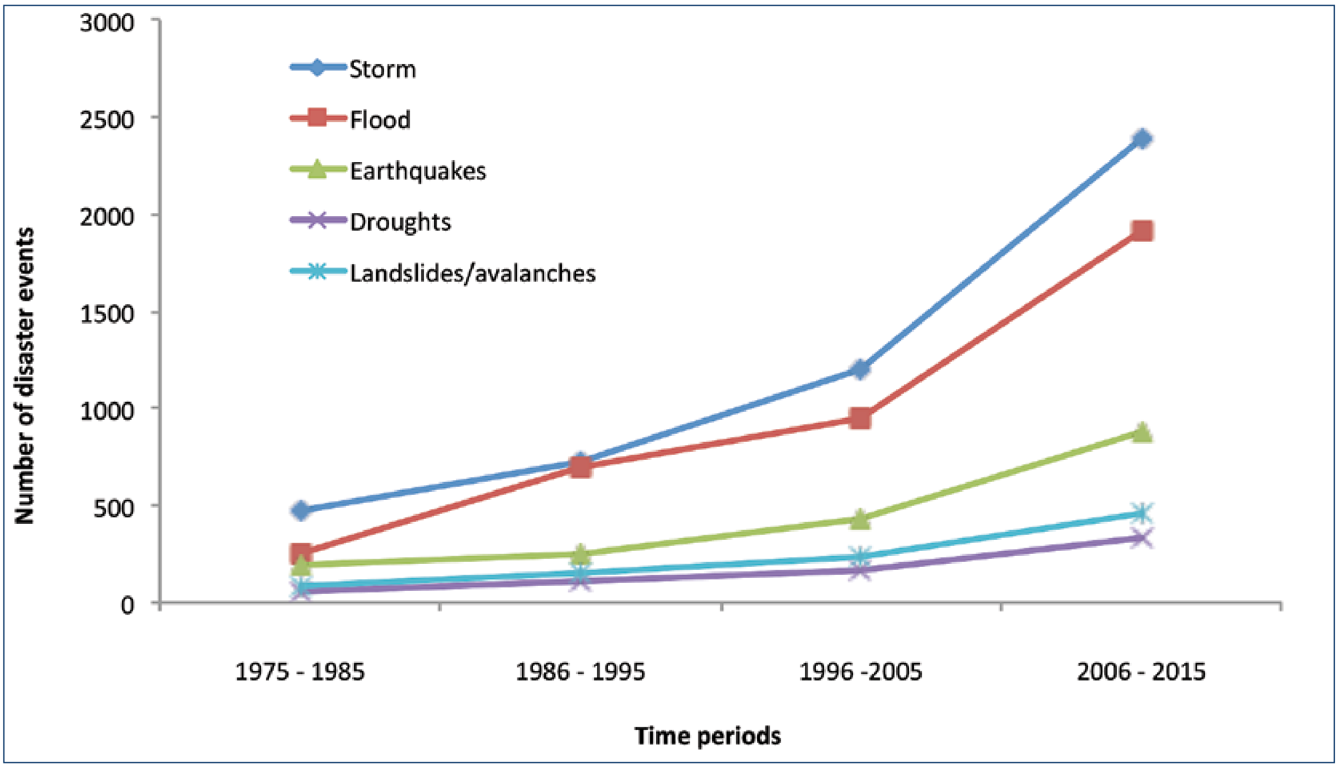


Figure 2. Trend in reported number of disaster events per natural hazard type worldwide, 1975-2015 (compiled from data from CRED EM-DAT-database, 2016)

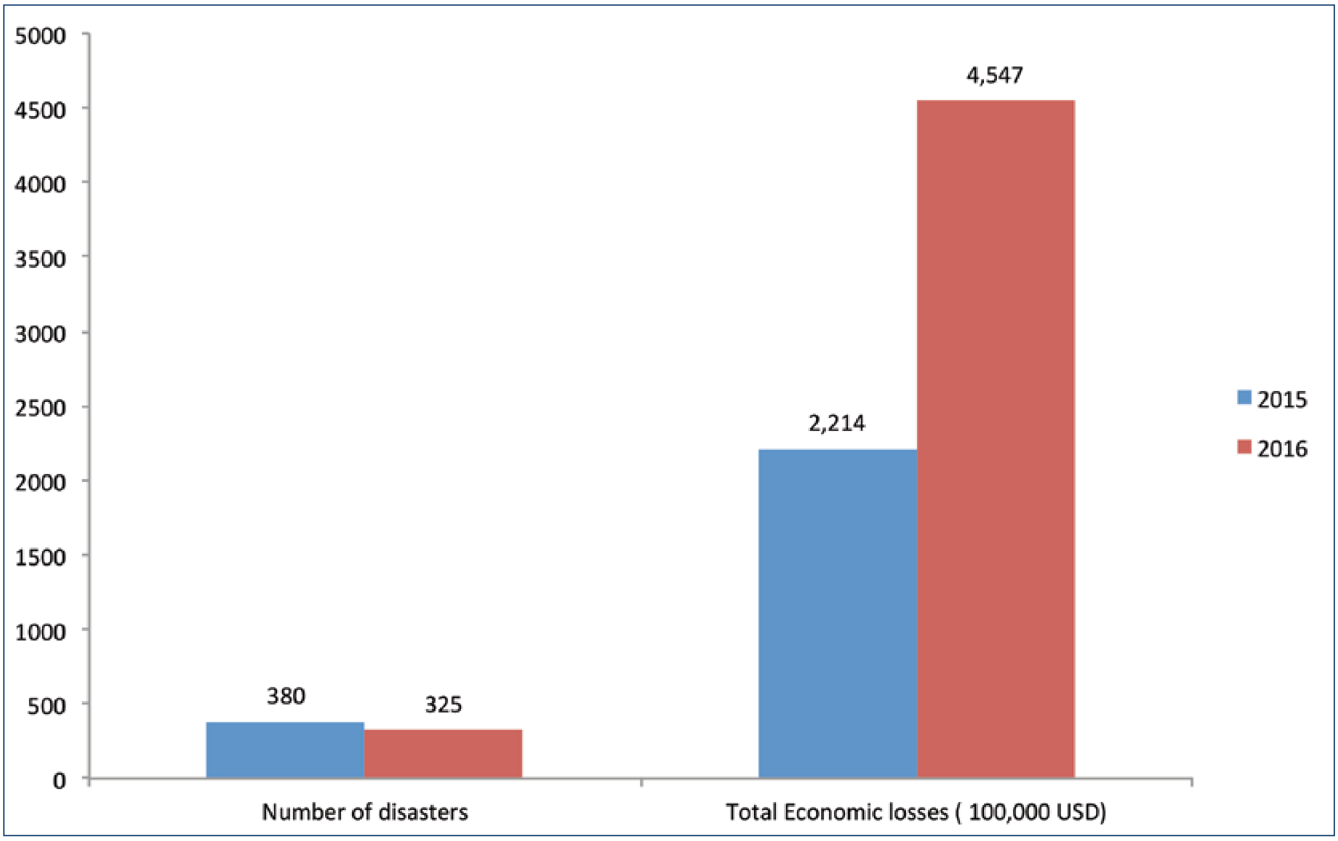


Figure 3. Number of reported disasters in 2015 and 2016 and total economic losses due to disasters in the same years (compiled from data from CRED EM-DAT-database, 2017)

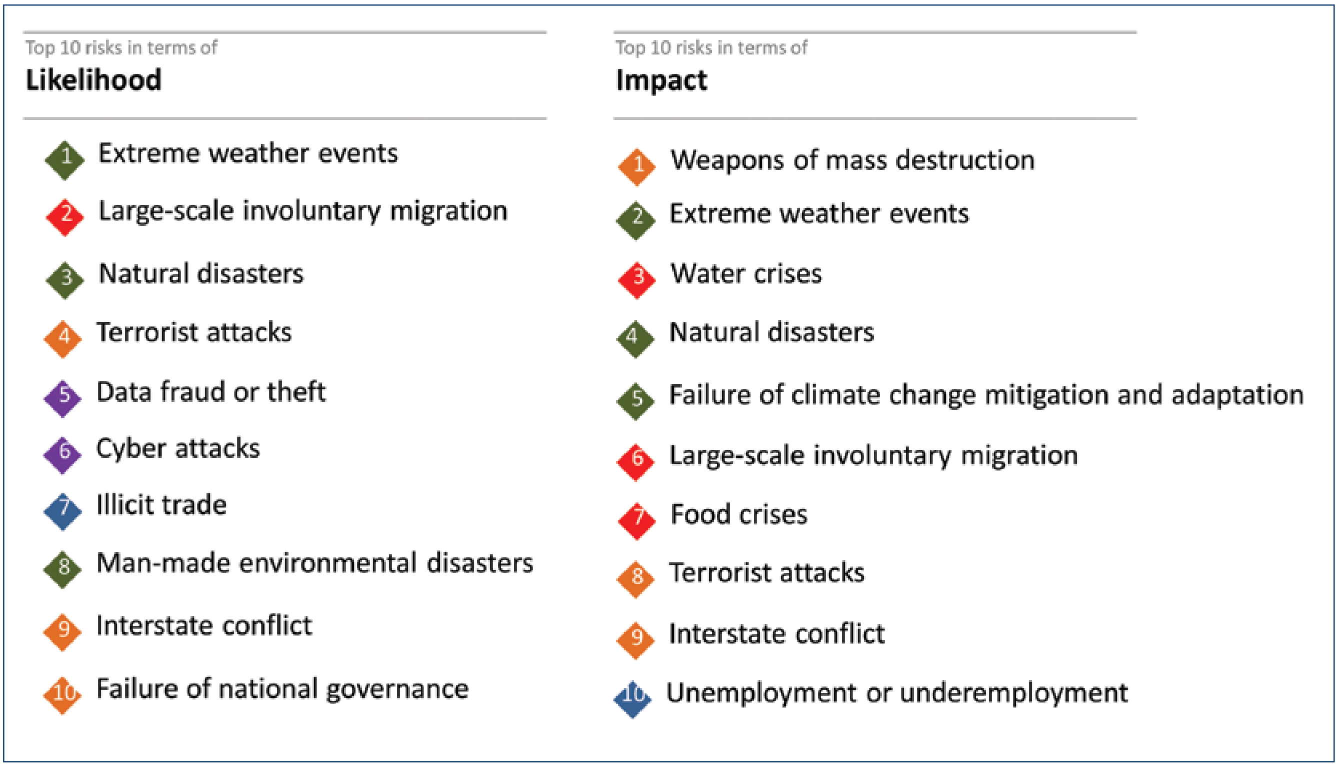


Figure 4. Top 10 identified global risks in terms of likelihood and impacts for 2017 (Source: World Economic Forum, 2017)

Box 1.1 Basic definitions

Hazard: A process, phenomenon or human activity that may cause loss of life, injury or other health impacts, property damage, social and economic disruption or environmental degradation.

Exposure: The situation of people, infrastructure, housing, production capacities and other tangible human assets located in hazard-prone areas

Vulnerability: The conditions determined by physical, social, economic and environmental factors or processes which increase the susceptibility of an individual, a community, assets or systems to the impacts of hazards.

Resilience: The ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions.

Underlying disaster risk drivers: Processes or conditions, often development-related that influence the level of disaster risk by increasing levels of exposure and vulnerability or reducing capacity.

Disaster Risk: The potential loss of life, injury, destroyed or damaged assets which could occur to a system, society or a community in a specific period of time, determined probabilistically as a function of hazards, exposure, vulnerability and capacity.

Disaster: A serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts which exceeds the ability of the affected community or society to cope using its own resources.

Disaster risk reduction: the concept of reducing disaster risks through systematic efforts to analyze and manage the causal factors of disasters, including through reduced exposure to hazards, lessened vulnerability of people and property, wise management of land and the environment, and improved preparedness for adverse events.

Source: UNISDR, 2009; United Nations, 2016

harnessed to help people prepare for, cope with and recover from disasters (Figure 5). For example, ecosystems such as mangroves, coral reefs and sand dunes can provide physical protection from the direct impacts of natural hazards and they can also reduce underlying vulnerabilities of communities through provision of subsistence, livelihood options and safety nets (Estrella and Saalismaa, 2013).

With ecosystem degradation, however, for example land clearing and vegetation loss, physical exposure to hazards, such as landslides, flooding, storm surges and drought, can be significantly increased thus aggravating their impacts on communities. Ecosystem degradation also contributes to disaster risk by increasing socio-economic vulnerability with reduced availability of goods and services that support livelihoods and other human needs (Sudmeier-Rieux, 2013). With ecosystem degradation proceeding at unprecedented and alarming rates worldwide (Steffen et al., 2015), there is a sense of urgency to address this major driver of disaster risk, and depending on how we manage ecosystems, we can be getting closer or farther away from the solutions for long-term resilience (Figure 6).

In the past decade, PEDRR has led the development of the concept of Ecosystem-based Disaster Risk Reduction (Eco-DRR)

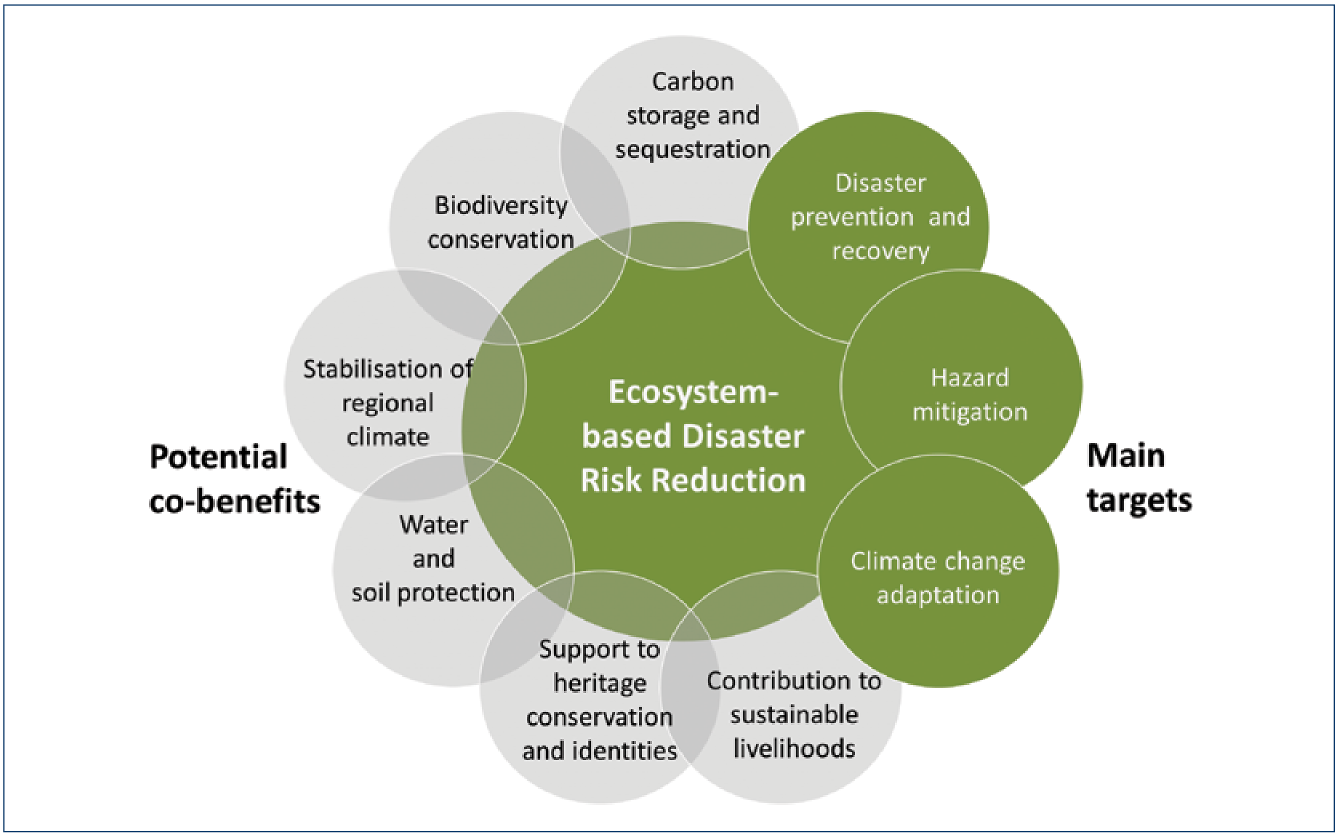


Figure 5. Multiple benefits provided by ecosystems (Adapted from PEDRR (2015) Training materials (unpublished))

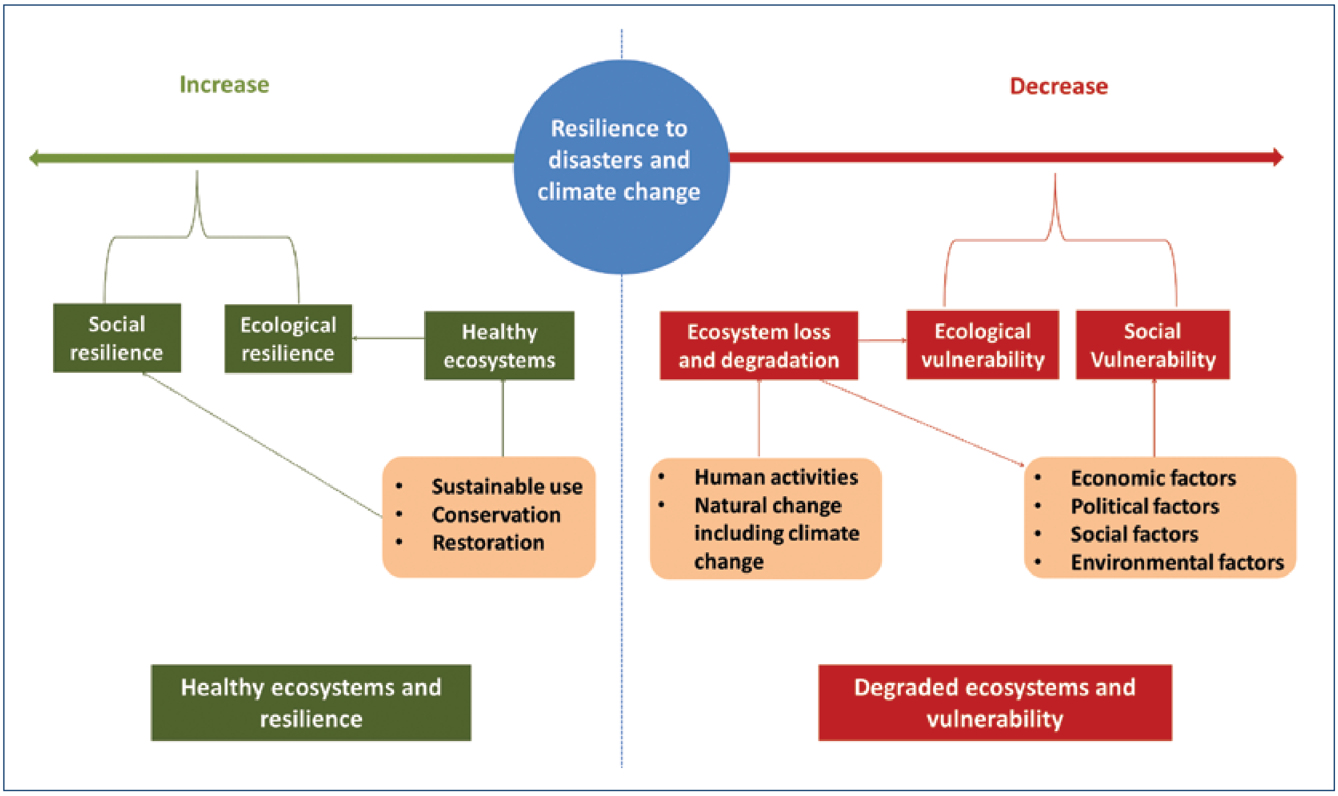


Figure 6. Theoretical model on linkages between state of ecosystems and either resilience or vulnerability (Adapted from Monty et al., 2016)

defined as "Sustainable management, conservation and restoration of ecosystems to reduce disaster risk, with the aim of achieving sustainable and resilient development" (Estrella and Saalismaa, 2013). The concept promotes the use of ecosystem management approaches such as integrated coastal zone management and area based conservation for reducing the physical exposure to a potential disaster faced by a community as well as underlying risks (such as poverty) that may exacerbate vulnerabilities of that community to a potential disaster.

Linkages between Eco-DRR and Ecosystem-based Adaptation

It is generally agreed that there is an overlap between Ecosystem-based Adaptation (EbA) and Eco-DRR initiatives. In terms of implementation, both approaches are based on the preservation, sustainable use and restoration of ecosystem services. EbA is defined as "the use of biodiversity and ecosystem services as part of an overall adaptation strategy to help people adapt to the adverse effects of climate change" (CBD, 2009) and "…may include sustainable management, conservation and restoration of ecosystems, as part of an overall adaptation strategy that takes into account the multiple social, economic and cultural co-benefits for local communities" (CBD, 2010). The pre-existing EbA definition provided the basis for the now widely accepted definition of Eco-DRR (Renaud et al., 2016) and thus it is not surprising that comparison of both approaches highlights more similarities than differences between the two concepts (Doswald and Estrella, 2015). The main differences between Eco-DRR and EbA are related to 1) their main goal and objectives, 2) the actors involved, 3) the policy fora involved and 4) the type of hazards that they address (Table 1) but there are now also increasing points of convergence in these different areas.

Table 1. Main differences between Eco-DRR and EbA (Source: Doswald and Estrella, 2015)

	Eco-DRR	EbA
1) Goal and objectives	• Addresses disaster risk reduction (DRR) • Aims to reduce disaster risk and increase protection and resilience against hazards	• Addresses climate change adaptation (CCA) • Aims to reduce vulnerability and increase resilience to climate change
2) Actors involved	• Environmental agencies/ ministries, conservation NGO but also humanitarian and disaster management actors at local and national levels, as well as climate change focal points	• Environmental agencies/ministries, conservation NGOs, climate change national focal points; usually does not engage with humanitarian or disaster management actors
3) Policy advocacy	• Targets climate change adaptation strategies, environmental policies, and other sectoral policies(e.g. water, agriculture)	• Engages with the environmental ministries/agencies and the conservation community, but still with a tendency to operate in separate policy tracks, depending on whether the project is more oriented towards DRR or CCA
4) Hazards	• Manages both climate and non-climate related hazards including earthquakes, volcanoes, avalanches, tsunamis	• Manages only climate-related natural hazards and long-term impacts of climate change.

While EbA strategies target only climate change adaptation (CCA), it is generally agreed that Eco-DRR can also support long-term adaptation given that climate change is also a driver of disaster risk (Estrella and Saalismaa, 2013; Renaud et al., 2016). In practice, several initiatives can be described interchangeably as either Eco-DRR or EbA. In a compilation of recent developments in the field of Eco-DRR and EbA, Renaud et al. (2016) highlighted that ecosystem-based approaches play a role in achieving both DRR and CCA and defined projects that cover both Eco-DRR and EbA (Eco-DRR/CCA) as: “the sustainable management, conservation, and restoration of ecosystems to reduce disaster risk and adapt to the consequences of climate change, with the aim of achieving sustainable and resilient development”.

While there are accepted definitions for both EbA and Eco-DRR and comparisons between the two concepts, it is useful to be able to identify what can be called EbA and Eco-DRR and how these can be implemented. The Friends of EbA network (FEBA) recently developed a framework for defining what qualifies as EbA (2017) and it identified three elements and five criteria to help identify EbA measures (Table 2).

This framework and particularly the criteria developed further showcase the similarities with Eco-DRR. It must also be noted that EbA and Eco-DRR both fall under the Nature-based solutions (NbS) umbrella concept. IUCN defines NbS as “actions to protect, sustainably manage and restore natural or modified ecosystems, which address societal challenges effectively and adaptively, while simultaneously providing human well-being and biodiversity benefits” (Cohen-Shacham et al., 2016).

This highlights two important converging aspects of EbA and Eco-DRR: 1) they differ from “business as usual” conservation in the sense that they are anthropocentric and focused on providing societal benefits and 2) while addressing societal challenges like climate change and disasters, they can also provide multiple benefits beyond risk reduction and adaptation (Renaud et al., 2016).

1.3 Ecosystems Protecting Infrastructure and Communities

EPIC promoted the implementation of Eco-DRR through five case studies in Burkina Faso and Senegal, Chile, China, Nepal and

Table 2. Elements and criteria that define EbA measures (Source: FEBA, 2017)

Element A	**EbA helps people adapt to climate change**
Criterion 1	Reduces social and environmental vulnerabilities
Criterion 2	Generates societal benefits in the context of climate change adaptation
Element B	**EbA makes active use of biodiversity and ecosystem services**
Criterion 3	Restores, maintains or improves ecosystem health
Element C	**EbA is part of an overall adaptation strategy**
Criterion 4	Is supported by policies at multiple levels
Criterion 5	Supports equitable governance and enhances capacities

Thailand (Figure 7; Table 3). The choice of these countries was guided by several factors: IUCN in-country presence; building on past work; and existing partnerships, particularly in Thailand, Burkina Faso, Nepal and Senegal. For Chile and China, they were priority sites for partners and stakeholders involved. Each case study focused on the use of at least one or a combination of ecosystem-based approaches to catalyse and promote improved management of ecosystems – and harness multiple ecosystem services – to protect vulnerable communities from risks associated with climate change and natural hazards. EPIC's overarching goal is to ensure that "ecosystem services are recognised, promoted and conserved as an integral part of disaster risk reduction policy, planning and programming in the six target countries and in key global processes such as implementation of The Hyogo Framework of Action of UNISDR, and climate change adaption framework of the UNFCCC". It is important to note that the EPIC funding was provided through the EbA window of the IKI funds. Therefore, a secondary objective of EPIC was to show the relevance of Eco-DRR to EbA. It is thus accurate to label EPIC more as a hybrid Eco-DRR/CCA project than just Eco-DRR.

The project was implemented by IUCN regional and country offices, together with key external partners (Table 3; See also chapter 2 and annex 2-7 for more details on different stakeholders involved).

Project implementation framework

In order to achieve its ambitious goal within five years, the project focused on three main aspects, namely science, policy and practices on the ground (Figure 8) by:

- Documenting scientific evidence and traditional knowledge – using a common research framework with research partners

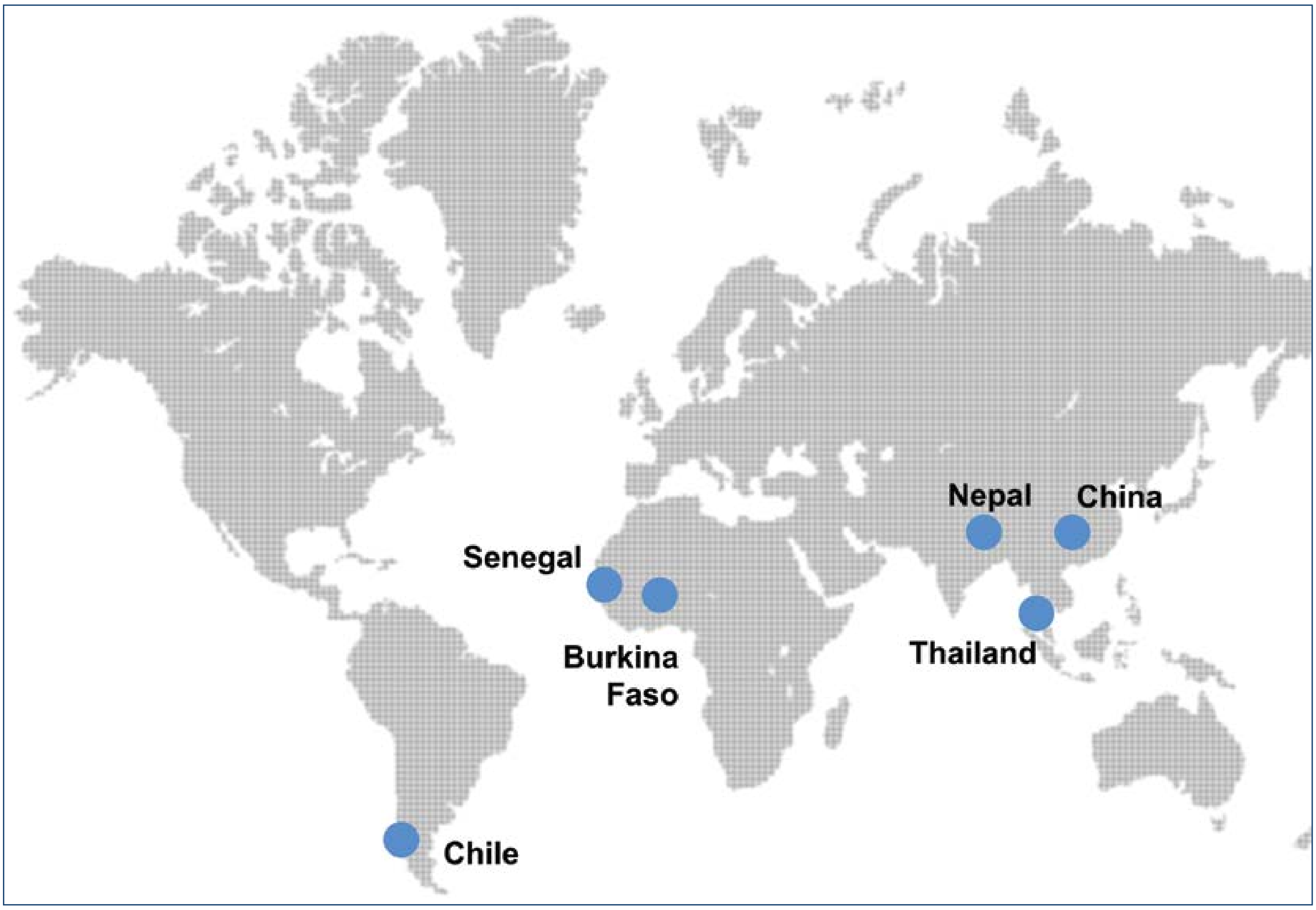


Figure 7. EPIC project sites

Table 3. EPIC case studies, focus and main partners in the six counties of implementation

Country	Focus	Main partner
Case study 1 : Strengthening Local Climate Change Adaptation Strategies in West Africa		
Senegal	Strengthening local resilience to floods and impacts of land salinisation	Regional Committee on Climate change (COMRECC)
Burkina Faso	Strengthening local resilience to floods and drought	Association pour la Promotion des Œuvres Sociales (APROS)
Case study 2 : Demonstrating Ecological Mangrove Restoration		
Thailand	Community-based ecological mangrove restoration against coastal hazards	Mangrove Action Project, Thailand
Case study 3 : Demonstrating the use of ecosystem services for landslide stabilisation and erosion reduction along rural roadsides, or “eco-safe roads”		
Nepal	Investigating the use of eco-engineering for the stabilisation of steep slopes	University of Lausanne, Switzerland
Case study 4 : Eco-engineering for stabilisation of steep slopes in Southern China		
China	Investigating the use of eco-engineering for the stabilisation of steep slopes	French National Institute for Agricultural Research (INRA)
Case study 5 : Quantifying and Improving the Protective Capacity of Forests against Snow Avalanches		
Chile	Promoting the use of forest for avalanche risk management	Snow and Avalanche Research Institute, Switzerland

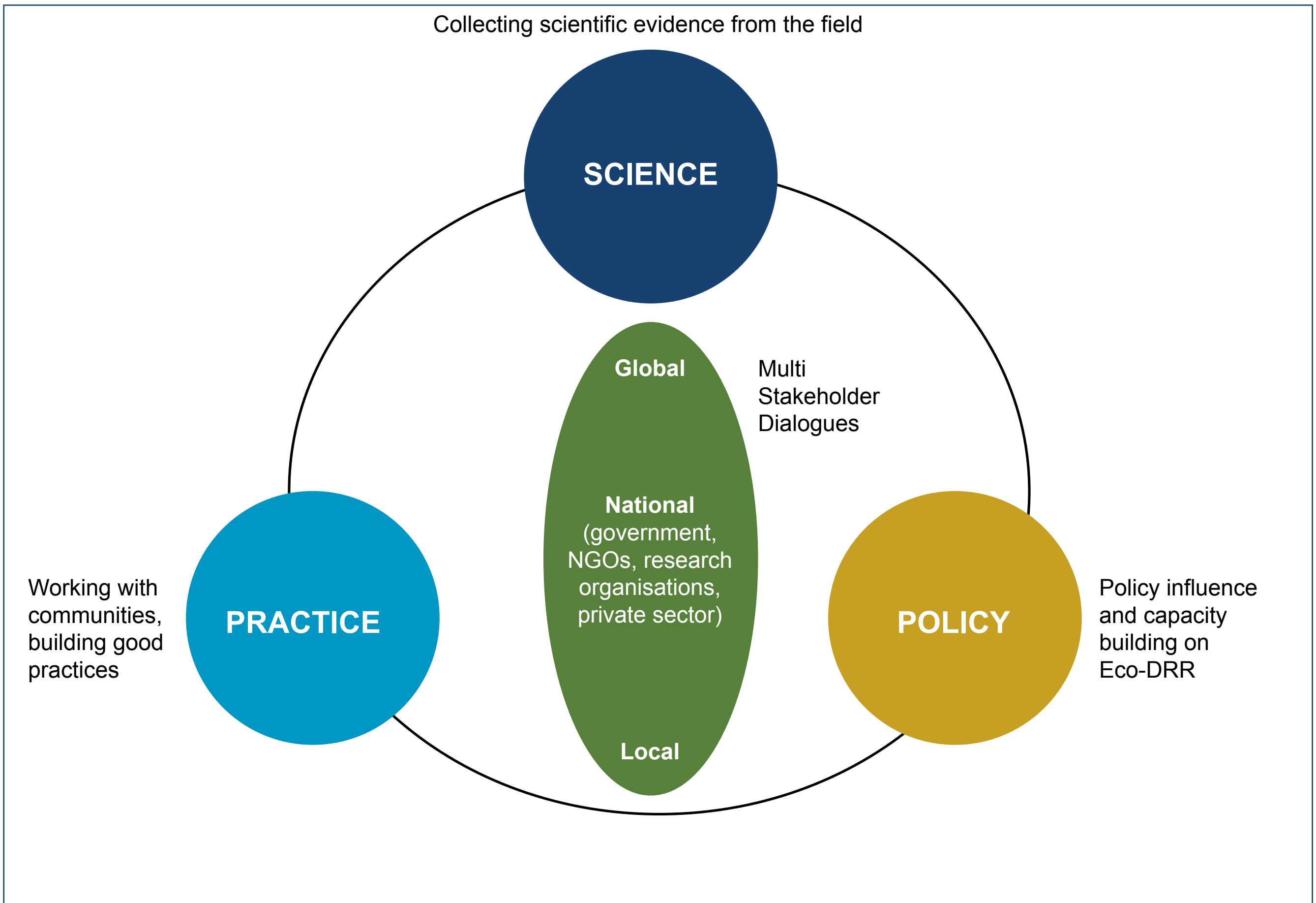


Figure 8. The strategy used by EPIC combining science, practice and policy

and ensuring that local solutions (mainly based on traditional and cultural practices) were prioritised as interventions.

- Building capacities to understand vulnerabilities and take action by using best practices – facilitating community led actions as well as leadership to explore, document and promote a systematic approach for using ecosystem management interventions for risk reduction from disasters.
- Promoting effective policies for integrated approaches to disaster risk reduction, climate change adaptation and environment management – identification of and actively targeting national and sub-national policy opportunities for mainstreaming Eco-DRR, as well as creating policies and acts to address gaps.

These three aspects are applied simultaneously bringing together a wide range of actors and stakeholders from the local, sub-national, national and global levels to establish a common agenda of reducing society's risks to disasters through different sets of activities (Table 4). It must be noted, however, that there were several variations in the implementation of activities across the countries with different levels of success in the implementation of the science-policy-practice interface but this is covered in more detail in the following chapters.

Table 4. Level of engagements and activities implemented as part of EPIC in the targeted countries

Engagement level	Science	Policy	Practice	Activities	Approach
Community	✓		✓	• Vulnerability capacity assessment	• Participatory tools; Multi-stakeholder interviews; Desk-based literature
				• Development and validation of action plans	• Consultation meetings
				• Training of communities	• Field-based demonstrations
				• Field interventions	• Ecosystem-based approaches; Livelihood diversification
				• Monitoring	• Action learning approach
				• Research	• Field data collection and modelling
Sub-national	✓	✓		• Risk profiling	• Desk-based literature review; Field data collection and mapping analysis
				• Capacity building and awareness-raising	• PEDRR training materials and workshops
				• Policy influence	• Advocacy and collaboration with local government officials
National		✓		• Capacity building and awareness-raising	• PEDRR training materials and workshops
				• Policy influence	• Advocacy and collaboration with national government officials

Global engagement

In parallel to implementation of the six cases on the ground, EPIC provided the opportunity to influence global policy mechanisms. As lessons learned started emerging from the process of implementation as well as from testing the concept of Eco-DRR, relevant global policy frameworks were informed of the potential of Eco-DRR in enhancing community resilience and in promoting environmentally friendly approaches to DRR and sustainable development. Through a combination of approaches – advocacy, capacity building and awareness-raising workshops, dissemination of knowledge products and publications, the project was able to support global policy coherence particularly from its second year of implementation. Key achievements include the following:

- 2012: Adoption of a resolution on the need for the conservation community to prioritise engagements in disaster risk reduction by way of Eco-DRR during the IUCN World Conservation Congress
- 2014: CBD COP 12 Decision XII/20 and *Promise of Sydney* document from the IUCN World Parks Congress in 2014 highlighted the critical need to actively employ conservation measures in DRR
- 2014-2015: Advocacy with EPIC countries' governments for inclusion of Eco-DRR principles in new global framework for disaster risk reduction
- 2015: Adoption of the Sendai framework that recognises sustainable management of ecosystems as a way to build disaster resilience

Monitoring, evaluation and learning

A DRR-EbA learning framework has been developed by IUCN as a mechanism to gather information on Eco-DRR and EbA as a part of a process to generate evidence-based knowledge for "nature-based solutions". Intended to help mainstream risk reduction elements and approaches in EbA related work – and vice versa – the overall purpose of this framework is to enable practitioners to document the value addition and effectiveness of Eco-DRR

© IUCN/ Fabiola Monty

initiatives for human resilience enhancement. This Framework builds on, and is related to IUCN's EbA Learning Framework, which has been developed to promote EbA approaches that result in sustainable management practices, and coherent scientific and policy messages. Developed under EPIC, the DRR-EbA framework unpacks core questions integrating DRR/CCA aspects as well as key questions for project implementation analysis (Annex 1). The framework was used in 2015, after 3 years of implementation to conduct a mid-term review of EPIC. This mid-term review focused on 1) assessing the main project's impacts on the three components, and 2) identifying factors of success and challenges in implementing such Eco-DRR/CCA project. Dedicated questionnaires were developed so as to gather partners' views on the project and lessons from the implementation of the case studies. In 2016 and 2017, a project evaluation was conducted and used a logical framework to assess progress, performance, achievements and lessons learned towards EPIC's overarching project goal.


© Claire Pedrot

Chapter 2

Implementation of EPIC: country case studies

Though EPIC case studies have common characteristics, they also show a high range of diversity (Table 5). They cover a wide range of ecosystems including mountainous ecosystems, coastal areas and drylands. They address a range of hazards from landslides in Nepal to droughts in Burkina Faso and avalanches in Chile and also have a multi-hazard approach, whereby one intervention addresses more than one hazard, such as in Chile. They also illustrate that Eco-DRR/CCA approaches can cover a range and combination of ecosystem-based approaches depending on the hazards that needs to be addressed. For all the case studies, the focus of the interventions with regards to disaster risk reduction is mitigation of hazards impacts and reduction of vulnerability.

Table 5. Summary of EPIC country case studies

Country	Project sites	Ecosystems	Livelihood (s)	Hazards addressed	Goal of country project	Ecosystem-based approach	Field interventions
Burkina Faso	6 villages in Northern Region	Dryland; Agro-ecosystems	Agriculture, livestock and trade	Droughts and floods	To diversify and strengthen the actors and their strategies involved in the prevention and adaptation to climate change impacts (drought and floods) on livelihoods and natural resources.	Sustainable land management	Restoration of vegetation cover through assisted natural regeneration and improvement of water tables using traditional techniques
Chile	Biosphere Reserve Nevados de Chillán – Laguna del Laja (Ñuble and Biobío)	Forests	Plantation forestry, agriculture and tourism	Avalanches, landslides, rock falls	To quantify and optimise the value of mountain ecosystems in the reduction of risk associated with snow avalanches and other natural disturbances, such as rockfalls and debris flows.	Forest management	Identification, protection and sustainable use of native forests as protective barriers in the Chilean Andes
China	Salween River Valley (Yunnan Province)	Mountain	Agriculture	Landslides	To identify native plant species playing a key role in stabilising and to establish relevant planting mixtures of these species in the target hillside landscapes (eco-engineering to combat landslides)	Eco-engineering	Stabilising slopes with native and mixed species vegetation to protect farming slopes and communities
Nepal	3 villages in Western Development Region of Nepal	Mountain	Agriculture and livestock	Landslide and sediment runoff	To build resilience to landslide risk through the demonstration of 'eco-safe' roads. This comprises up-scaling the use of ecosystem services along rural roads for landslide stabilisation.	Bio-engineering	Restoration of slopes and bio-engineering for land stabilisation
Senegal	6 villages in Fatick Region	Agro-ecosystems; Mangroves	Agriculture, livestock rearing and fisheries	Droughts and salinisation	To strengthen local adaptation strategies to climate change	Sustainable land management	Restoration of vegetation through assisted natural regeneration, soil stabilisation through traditional techniques
Thailand	2 villages in the Krabi River Estuary (Krabi province)	Mangrove	Fishing, aquaculture and subsistence harvesting of NTFP	Storm surges and coastal floods	To use the Community Based Ecological Mangrove Restoration (CBEMR) method to restore abandoned aquaculture ponds to productive mangroves, which will aid coastal protection and support resource based livelihoods, especially fisheries.	Mangrove restoration	Community based Ecological Mangrove Restoration

Burkina Faso

Sylvain Zabré and Fabiola Monty

Key Message

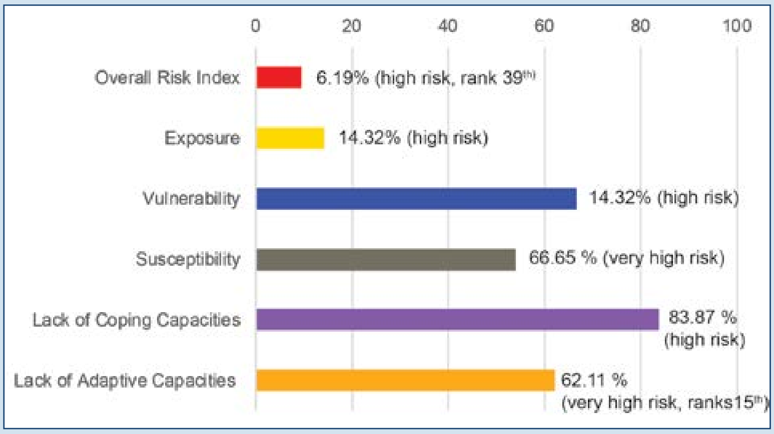
Involvement of communities in identifying solutions to hazard risks, planning, implementation and monitoring leads to better community ownership of the interventions.

Fast facts on Burkina Faso*

Population: 18.65 Million
Main Livelihood: 90% of the working population are subsistence farmers (Agriculture contributes 33% of GDP and employs 90% of the working population)
Gross domestic product based on purchasing-power-parity (PPP) per capita GDP (current international dollar): 1,884.364
Human Development Index: 0.402 (ranks 185th in the world)
Poverty headcount ratio at national poverty lines: 40.1%
Main drivers of ecosystem change:

- Loss of vegetation and biodiversity
- Loss of soil nutrients and organic carbon
- Water and wind erosion
- Loss of water availability, quality and reliability

World Risk Index:



*(Sources: World Bank, 2017; IMF, 2017a; UNDP, 2016; IUCN and ProAct, 2013a; United Nations University, 2016)

2.1.1 Background and context in Burkina Faso

Burkina Faso is a landlocked country, bordered by Mali in the north, Niger in the east, Benin in the southeast, Togo and Ghana in the south and Côte d'Ivoire in the southwest. It extends over 274,200 km2 and is largely flat (Barbier et al., 2009). It is one of the poorest countries in the world, with a GDP per capita of USD 725.2. An estimated 40.1% of the population lives below the national poverty line, comprising 16 million people (DANIDA, 2013; World Bank, 2017). Poverty in Burkina Faso has a distinctly 'rural face', and while 20.6% of urban dwellers fell below the poverty line in 2009, an equivalent figure of 48.8% was observed in rural areas (Kyendrebeogo et al., 2011). Regional disparities are also stark, with poverty rates of 68% and 17% in the northern and central regions respectively (IMF, 2012a).

Burkina Faso's economy revolves around activities dependent on environmental services and natural resources that are sensitive to climatic variability. Agro-pasture and forestry encompass 86% of livelihoods and account for 40% of national GDP, making them the country's main sources of economic growth (Kalame et al., 2011). Over 95% of Burkina Faso's rural inhabitants depend on forest resources to satisfy their energy needs, while non-timber forest products; wildlife, pastoral and fisheries resources generate income and play an integral role in the sustenance of cultural traditions and livelihoods (Yeye, 2010).

Climate change and disaster risk

Burkina Faso has one of the most extreme and variable climates in the world (González et al., 2011). It is prone to strong spatio-temporal variability and irregular rainfall patterns (Hagenlocher, 2013; WB, 2011). Burkina Faso ranks 15th in the world in lacking adaptive capacities to combat climate change, and although climate scenarios have yielded unclear results, the country has already experienced an increase in ambient temperature, a decrease in rainfall, along with a decrease in the average number of rainy days per year, and more frequent and intense weather events. The northern region of Burkina Faso is particularly prone to climatic extremes. The region is located in the Sahelian agro-climatic area, characterised by two alternating seasons: a long dry season of eight months (October to May); and a short rainy season of four months (from June to September) which brings about 650 mm and 1,000 mm. This precipitation is characterised by considerable seasonal and inter-annual variability (IUCN and ProAct, 2013a). During the dry season, the region experiences dry, cool, harmattan winds[1], usually from November to April (IUCN and ProAct, 2013a).

According to Burkina Faso's NAPA (2007), the northern region is prone to drought, floods, high winds and high temperatures. These recurrent climatic risks are occurring with increasing intensity, and their negative impacts are exacerbated by non-climatic drivers of vulnerability, including conflict, famine, deforestation and disease. From 2007 to 2012, the region experienced annual natural disasters such as floods, drought and strong winds (PDSANS, 2012).

Relevance of Eco-DRR interventions

Burkina Faso houses significant biological resources, however anthropogenic pressures (demographic growth, agriculture and energy demands) and climatic factors (climate change, hazard events and erosion) have fragmented and destroyed ecosystem components enhancing vulnerability (IUCN and ProAct, 2013a). Land degradation is a huge challenge in Burkina Faso, a phenomenon known to be exacerbated by conversion of natural habitats

1 A dry and dusty northeasterly trade wind, of the same name, which blows from the Sahara Desert over West Africa into the Gulf of Guinea.

into agricultural land and overexploitation of forest products (UNEP, 2015). Data from the UNEP-funded Global Assessment of Human-Induced Soil Degradation (GLASOD) classifies around 40% of national territory as having 'very severe' land degradation, rendering Burkina Faso the most affected country in West Africa (FAO, 2007). Land degradation and desertification contributes to loss of land fertility, reduced agricultural production, reduced income, and poverty and food insecurity. It is estimated that desertification costs the equivalent of 9% of national agricultural GDP per annum (Jorio, 2013).

Policy context

There are twelve policies and plans that are relevant to climate change and disaster risk reduction and among these, three are the most important. These are i) the National Adaptation Plan of 2015, which attempts to reduce vulnerability to the impacts of climate change by developing adaptation and resilience capabilities and facilitate the integration of climate change adaptation into policies, programmes, activities, development planning processes and strategies within relevant sectors and at different levels; ii) the National Strategy of Risk, Humanitarian Crises and Disasters Prevention and Management 2015-2017 to better manage disasters and humanitarian crises; and the National Action Plan to implement the Convention on Biodiversity 2011-2015 that will carry out realistic and achievable actions for the preservation and restoration of species and their environment, as well as engage in dynamic management and sustainable use of natural resources by empowering all the actors, particularly local communities.

EPIC sites in Burkina Faso

The case study was conducted in the provinces of Yatenga and Lorum in Burkina Faso's northern region. These two provinces extend over 16,130 km^2 and represent 6.5% of the national territory (RDP, 2010). The study sites include six villages within four municipalities (marked in red and green respectively in Figure 9: Namissiguima (villages of Basnéré, Birdininga and Tougou), Koumbri (Tibtenga village), Barga (Ramdolla village) and Titao (Sillia village).

EPIC's project area is one of the most vulnerable to climatic risks and natural disasters in West Africa. Using existing national and regional assessments on vulnerability to climate change, food insecurity and poverty, three criteria were used to identify the northern region based on:

1. The level of vulnerability to climate change
2. The level of food insecurity
3. Poverty level

Final choice of the villages within the region was done following consultations with government technicians and sites visits. As the area comprises of 52 villages, the geographic distance between each were considered to ensure a representative geographic coverage.

Objectives of EPIC in Burkina Faso

The overall goal of the project was to diversify and strengthen the actors and their strategies involved in the prevention and adaptation to climate change impacts on livelihoods and natural resources in two countries of West Africa.

Its specific objectives are:

1. To document and assess the risks and/or effects of climate change on poor people, on poverty efforts to the benefit of local decision-makers of the rural development, water resources and environment sectors;
2. To demonstrate economic benefits of integrated ecosystem-based adaptation strategies on the reduction of rural poor communities' vulnerability.

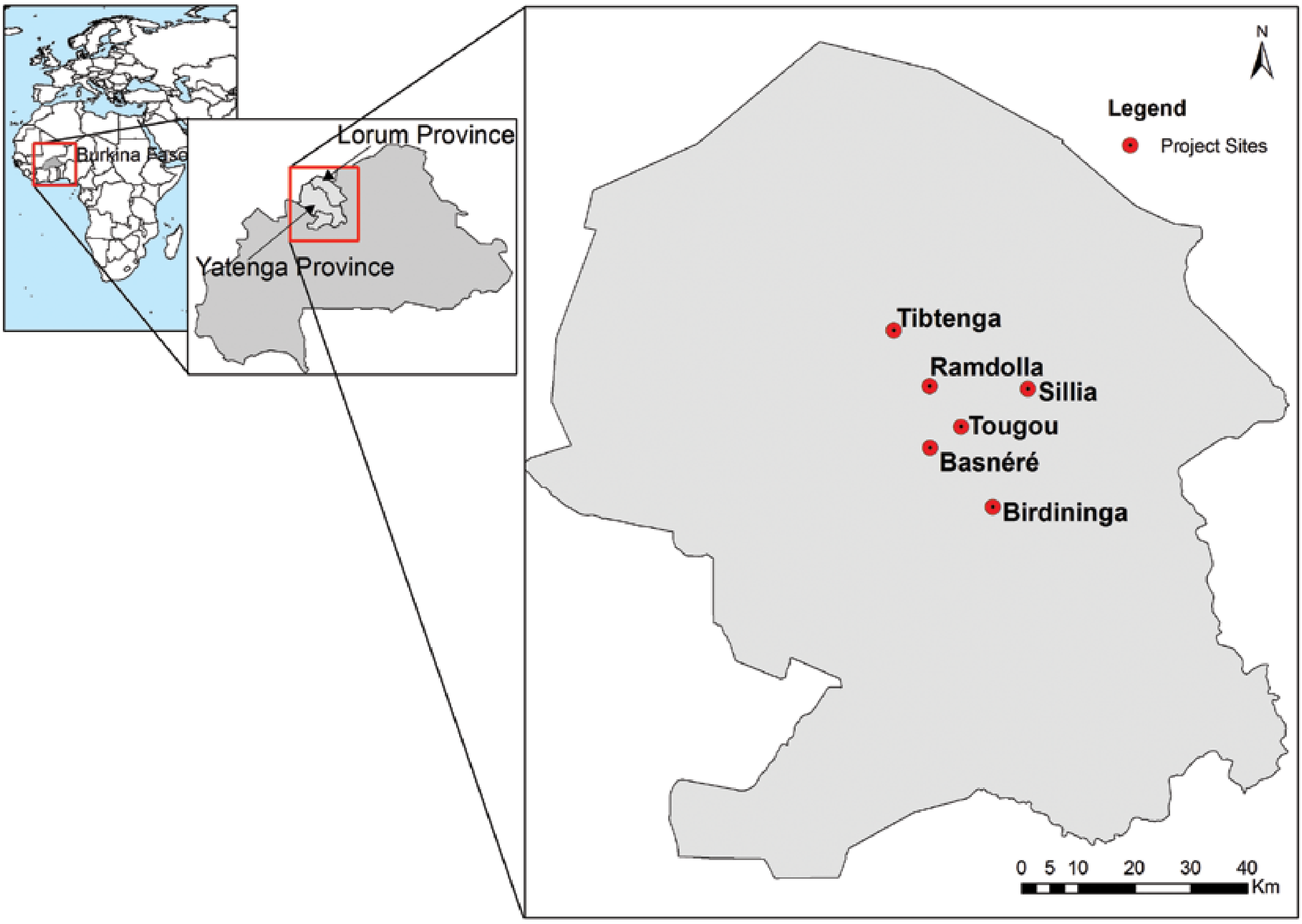


Figure 9. Map of the EPIC sites in Burkina Faso

2.1.2 Operational approach in Burkina Faso

EPIC implementation in Burkina Faso consisted of 7 main steps: 1) baseline assessment on the northern region of Burkina Faso, 2) selection of villages, 3) vulnerability capacity assessment and identification of local innovations to address identified risks, 4) development of action plan, 5) validation of the action plan and production of annual work plan of activities in each village, 6) training of communities for the implementation of activities and 7) implementation of activities.

Vulnerability and capacity assessment

The design and implementation of ecosystem-based approaches for community resilience in Burkina Faso was shaped by a vulnerability capacity assessment (VCA) conducted in July 2013 in the northern region. The VCA was conducted during a five-day participatory workshop convening 52 participants including mostly community representatives from the six targeted villages as well as representatives from local NGOs, local government agencies and a national research institution. The Climate Resilience Evaluation for Adaptation through Empowerment (CREATE) participatory tool was used to guide community members to identify, analyse and document their vulnerabilities. Using a conceptual framework that breaks down vulnerability and capacity into simple matrices, CREATE can be used to qualitatively assess social vulnerability and capacity.

In the context of EPIC, the CREATE tool namely its vulnerability assessment matrices were combined with the toolkit Promoting Local Innovation (PLI) which uses “creative exercises and discussions and lead participants into a process of mutual learning and knowledge exchange aimed at identifying and promoting local adaptation capacities in the form of innovations" (Marthez-Stiefiel and Murti, 2014). The combination of these two tools allows to: 1) document the problems by identifying priority factors that contribute to vulnerabilities and 2) to identify and prioritise locally-relevant solutions or *local innovations* to respond to risks and climate change impacts. A summary of the integrated approach is summarised in Table 6 below.

Outcomes of the VCA workshop in Burkina Faso

The VCA workshop in Burkina Faso revealed that the most important climatic factors impacting the villages were mostly droughts, floods, strong winds and high temperature and these are mostly having negative impacts on agriculture, livestock, vegetable gardening, grassland, water bodies, tree vegetation etc. Based on the assessment of factors contributing to vulnerability, the participants identified the innovations in Table 7. During implementation, additional activities to diversify and improve livelihoods for example vegetable gardening were also included.

Following the identification of the innovations, six individual village action plans were developed to implement these. The action plans contained the following information: 1) Actors involved and their roles, 2) list of activities for example collection of stones and construction of stone bunds, 3) Strategy to be used for example training and exchange visits, 4) timeline and 5) the expected results such as ownership of the innovations by the communities.

Table 6. Summary of integrated CREATE/PLI approach to assess social vulnerability and identify local innovations

Step	Goal	Description
1	Establishing joint teamwork values and climate change problem diagnosis	Getting to know each other through introductions, establishing a sense of teamwork and common values through role plays focused on conflict resolution and past experiences. Using vulnerability assessment matrices, defining the climate change problem. Establishing non-climatic sensitivities and external factors beyond the community's control.
2	Joint visioning for the future	Visioning for the future through 2-D or 3-D models of the geographical landscape and discussions on the desired socio-economic and socio-ecological condition.
3	Identifying adaptation responses (termed innovations)	Communities identify solutions with inputs from external actors, as needed. Mapping of information gaps on the solutions. Using peer-to-peer learning in a marketplace setting to appraise all responses according to ecological (including CC and disasters) concerns, socio-political/ economic considerations and cultural, ethical, health related concerns
4	Field visit to analyse an existing example of an innovation	Nominee of a particular innovation (that can be visited in the vicinity of the workshop) coordinates a field trip
5	Joint action planning	Identifying resource needs, defining roles and responsibilities, agreeing on a workplan
6	Fair (optional)	An opportunity to communicate and share the workshop journey and its outcomes with the wider community and stakeholders beyond the workshop participants

Action and social learning

In Burkina Faso, implementation and monitoring of the activities followed an action learning process. Following the development of the action plans during the VCA workshop, individual meetings were held in each of the villages to validate the action plans for implementation in 2014. Monitoring and planning workshops were then organized yearly at the end of 2014, 2015 and 2016 to evaluate the implementation of activities in that year and to plan activities for the following year. These workshops convened representatives from the six villages as well as government technicians. An assessment of each activities implemented per villages were conducted including identification of the constraints and proposed solutions to address these.

Besides these meetings, exchange visits were regularly implemented in Burkina Faso between the villages of interventions for peer-peer learning. Exchange visits were also organised for the project beneficiaries to visit other neighbouring villages, providing an opportunity to share their experiences with EPIC as well as to learn from the villages visited. Such an exchange initiated a demand and eventual implementation of bio-digesters in the EPIC villages. These use cattle dung to produce combustible gas as an alternative to firewood for cooking. Two exchange visits were also organised between project beneficiaries in Senegal and Burkina Faso to explore the relevance and potential to export the different local innovations in the two countries. The exchange visit in Senegal included a community representative from each of the target village in Burkina Faso and consisted of: 1) initial meeting and introductions between community representatives and local government officers, 2) field visits to all of the target villages in Senegal and 3) a one-day workshop including presentations on all activities implemented in both countries and discussions.

Table 7. Main innovations identified during the VCA workshop in Burkina Faso

Innovations	Description
Soil restoration through endogenous techniques	
Zaï	Consists of digging holes where organic manure is deposited. It contributes to CCA through its ability to reduce the effects of drought by improving water infiltration into the soil. It also helps recovering degraded lands and increases crop yields, thus improving food security.
Stone bunds	These are mechanical constructions built with stones aligned along the contour of a parcel of land. Bunds offer an adaptation strategy to rainfall variability by reducing water erosion and increasing water infiltration. As a consequence, crop water stress is reduced during drought.
Half-moons	These are shallow basins (depth of (15 – 25 cm) of the shape of a semicircle (about 4 m in diameter) that is dug using axes and shovels. Crops are then grown within the open basin. They are meant to increase water infiltration and storage in the soil and improve soil fertility.
Increasing vegetation cover	
Reforestation	Replanting locally adapted trees
Assisted natural regeneration	It is a simple, low-cost restoration method that can effectively convert degraded lands into more productive areas, by the retention of naturally regenerating seedlings, particularly those of the legume family, that then enhance soil productivity and and eventually provide shade and protection to crops (Shono et al., 2007)

Capacity building and awareness-raising on Eco-DRR

Besides the VCA workshop, several training events were organised to strengthen the capacities of communities and government officials to facilitate EPIC implementation as well as to promote scaling up of the approach. These include:

1. Three community training programmes on seed production (involving 30 people), zaï and stone bunds (300) and composting (30) were held;
2. Six practitioners were taken to the EPIC study sites in Senegal for a study tour to exchange experiences.
3. Thirty partners (including 10 NGO's, 10 local government, 10 technical partners and one research institution) were provided training on Eco-DRR using Partnership for Environment and Disaster Risk Reduction (PEDRR) techniques.
4. One hundred and six participants of Climate Change Adaptation Day in 2014 were introduced to the concept of Eco-DRR.

2.1.3 Results and challenges in Burkina Faso

EPIC implementation in Burkina Faso involved multiple stakeholders (Annex 2) to implement the Science-Practice and Policy approach. Research activities in Burkina Faso were limited and conducted mostly at the beginning of the project including the VCA rural appraisals as well as a study on the impact of climate change on the livelihoods of communities in the EPIC project area finalised in 2015. In 2016 a study of the impact of the endogenous interventions (Figure 10) on millet and sorghum yields were conducted. Though it produced interesting results and inform practice, the scope of the study and sampling size remained small. Developing a stronger scientific base particularly quantitative socio-economic assessments and cost-benefit analyses was mostly limited by the capacity. Policy influence at local and national level was also minimal in Burkina Faso during the project duration due to political instability. In September 2015, a coup d'état was launched in the country which brought civil unrest for several months and eventually major changes in government at local and national level. There were also changes in management staff of several EPIC partner institutions. Five municipal authorities that were partners on the project were replaced with temporary special delegations in 2015. During these different transitions, the local IUCN office has had to re-establish networks and build new collaborations. However, a strong component of the policy engagement in Burkina Faso is the maintenance of a close collaboration with the National Council for Emergency Relief and Rehabilitation (CONASUR) which provides a good entry-point to leverage policy commitments, continued efforts and more actions on the ground.

Field interventions

- Six village development committees were established to implement the activities
- Two thousand one hundred and twenty-two hectares of zaï and 1,045 hectares of stone bunds, were constructed to strengthen the productive capacity of the land.
- Some 42,022 plants maintained in five nurseries were introduced into home gardens and fields
- 264 hectares were restored using Assisted Natural Regeneration, improving the availability of fodder and strengthening forest resources.
- The above innovations benefitted all 10,181 community members in the six villages.
- 32 biodigesters were provided to turn domestic waste into biogas. These benefitted about 600 community members.
- The promotion of organic gardening was further enhanced by the establishment of 56 manure pits that benefitted over a thousand community members.

Effectiveness of the innovations implemented

There are several examples in the scientific literature on the effectiveness of the endogenous practices implemented as part of EPIC in Burkina Faso. Regarding zaï, previous

Figure 10. Pictures of endogenous practices implemented in Burkina Faso (A: Early stages of stone bund installation, B: appearance of grasses as land recover with stone bunds, C: Half-moon structures following harvest, D: Digging of zaï holes; © IUCN/Sylvain Zabré)

studies and comparisons with untreated farms has shown that they are effective in increasing cereal yields particularly when implemented on degraded soil (Maatman et al., 1998; Somé et al., 2004). Constructions of stone bunds are documented to reduce run off and soil loss by about 12 % and 45 % respectively (Zougmoré et al., 2003). Maatman et al. (1998) found that the combinations of Zaï and stone bunds were mutually reinforcing technologies to conserve water and land. A small study conducted at the EPIC sites showed similar results, noting for example that sorghum yield with zaï alone was 1290 Kg/ha while it was 1330 Kg/ha for stone bunds that was used in combination with zaï by several farmers (APROS, 2016). However, it is important to acknowledge that there is a lack of robust and quantitative data on effectiveness for the EPIC villages. Qualitative information through focus groups (6 focus groups; 36 men and 38 women) conducted in 2017 provided anecdotal evidence that the practices implemented were increasing crop yields. The approach used by EPIC in Burkina Faso remains worthy of detailed scientific probing. The innovations were not implemented in isolation and how the different sets of combinations of practices fare relative to one another constitute important knowledge. The integration of reforestation, assisted natural regeneration and endogenous land restoration practices and their combined role in reducing social vulnerability are particularly relevant. In terms of conservation practice, there are also opportunities for learning as assisted natural regeneration (ANR) was also combined with Zaï pits in Burkina Faso. An important barrier here is possible mismatch between project set-ups and scientific research needs. Effective scientific monitoring of the crop yields requires long-term temporal data collection and would also require a strong presence on site.

South-South learning and gender issues

Several exchange visits between communities have been organised: between villages benefiting from EPIC; between EPIC beneficiaries and neighbouring villages and between project beneficiaries in Burkina Faso and Senegal. These exchanges provide a good example of the importance of such south-south learning and the simplicity of how to implement them. Community testimonies have highlighted that there is stronger social cohesion within and between villages. In terms of learning, beneficiary communities have adopted and expressed great interests in practices they have observed in other communities in both Burkina Faso and Senegal. Even though EPIC was implemented in only six villages, the two-way exchanges provided an opportunity to export the project's approaches to other communities.

In that aspect, one important contribution of the project is the promotion of gender equity. During the implementation of the project, EPIC has also been used to increase awareness on gender issues by including women in the activities including meetings, trainings and implementation of innovations. The exchange visit in Senegal provided an opportunity to promote this. The choice of community representatives to make the trip to Senegal was done through internal community consultations and it was decided that the delegation team should include three men and three women. This experience was shared with the communities in Senegal.

Policy influence

- There has been recognition of the relevance of the Eco-DRR approach by the local authorities as indicated by interviews with government officers and discussions during the final EPIC workshop in 2017.
- The governor of the region has communicated with IUCN committing support for any initiative for an up-scaling of the project achievements.
- EPIC Burkina Faso has been engaged with CONASUR in the process of changing policy through the implementation of a national action plan for the strengthening of capacities for risk reduction and preparedness to response to emergency in Burkina Faso.

2.1.4 Lessons learned in Burkina Faso

- Inclusive and participatory project design through the VCA ensure that technologies put in place to build resilience are locally relevant
- Involving communities in different stages of the project has resulted in strengthening community capacities and cohesion and ultimately achieved community empowerment.
- • Involvement of communities in identifying solutions to hazard risks, planning, implementation and monitoring leads to better community ownership of the interventions.
- Eco-DRR/CCA projects should not exclude non-ecosystem-based approaches and objectives from its intervention. These can be integrated with livelihood development activities which help to provide incentives.
- Successful participatory approaches can provide means to address gender issues
- The above two points highlight that Eco-DRR/CCA projects have the potential to go beyond disaster risk reduction and climate change. It is important to explore how these co-benefits can be better integrated and enhanced in such initiatives.
- Exchanges between local actors within and between countries can be useful learning experiences for different communities ensuring they are active leaders of change in their land.

Chile

Karen Podvin, Alejandro Casteller and Erika Cortés

Key Message

In the Valle de las Trancas, healthy forest ecosystems can play a crucial role in protecting infrastructure and communities from avalanche and landslide hazards.

Fast facts on Chile*

Population: 17.91 Million

Main Livelihood: Mining (especially for copper), fishing, forestry, wine and fruits.

Gross domestic product based on purchasing-power-parity (PPP) per capita GDP (current international dollar): 16,660.21

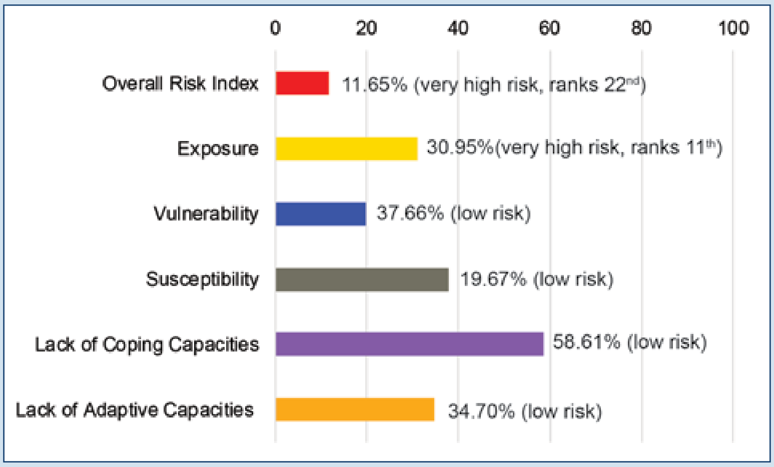
Human Development Index: 0.700, ranks 38th in the world.

Poverty headcount ratio at national poverty lines: 14.4 %

Main drivers of ecosystem change:

- Deforestation and land degradation caused by forestry and agriculture;
- Overfishing;
- Environmental impacts of mining and hydroelectric development;
- Air pollution caused by transport and manufacturing sectors;
- Water pollution because of the lack of proper wastewater treatment and unsustainable agricultural and mining practices;
- Climate change impacts and natural disturbances.

World Risk Index:



*(Sources: World Bank, 2017; ECLAC, 2017; IMF, 2017b; UNDP, 2016; United Nations University, 2016; Garschagen et al., 2016)

2.2.1 Background and context in Chile

Chile has a surface area of 756,096.3 km^2 and extends along 4,270 km^2 as a long, narrow strip of land, west of the Andes, bordering Argentina on the east, Peru on the north, Bolivia on the northeast, the Drake Passage on the south and the Pacific Ocean on the west. The country has four main north-south morphological features: the Andes Mountains in the east, the Coastal Mountains in the west, and the Intermediate Depression, and the Coastal plains (IUCN and ProAct, 2013b).

Climate change and disaster risk

Chile fulfils seven out of nine characteristics of vulnerability defined by the UNFCCC (MMA, 2016). Climate change predictions indicate a decrease in rainfall (mainly in the central region) and an increase in temperature (especially in the mid-northern region) (Government of Chile, 2015). The fifth Report to the Intergovernmental Panel on Climate Change (IPCC) highlights the severe impacts on the country's livelihoods and its ecosystems, particularly the sectors of fishing, aquaculture, forestry, livestock and farming (Government of Chile, 2015). These vulnerabilities and impacts have also been documented in the national communications to the UNFCCC Secretariat and are being incorporated into the National Plan of Action for Climate Change (MMA, 2016).

Chile is also a country that is prone to multiple natural hazards — ranked 11th among the most exposed countries worldwide to natural hazards (Garschagen, et al., 2016). The frequency and intensity of climate-related events such as strong winds, droughts and forest fires are also expected to increase (IPCC, 2014). The main risks from hazards include flooding, extreme temperatures, wildfires, earthquakes, volcanic activity, storms and landslides (McBreen, 2016). In recent years, prolonged droughts have also influenced the frequency of large-scale fires (González, et al., 2014) affecting crops, native forests, availability of water for consumption and the welfare of thousands of people.

Relevance of Eco-DRR interventions

The expansion of farming and forestry activities and the exploitation of resources for energy have led to the fragmentation of ecosystems within the selected site for EPIC work (see section below). Increasing urbanisation, given the ever-growing tourism in the study site called Valle de las Trancas has resulted in the expansion of infrastructure and housing, exerting even more pressure on the local landscape and its biodiversity. All year, the site receives a significant number of tourists attracted by winter sports and thermal waters in this volcanic area. Because of this, in the recent decades, the Valle de las Trancas has experienced fast growth in economic development. In addition, the valley is often affected by gravitational processes including snow avalanches. Additionally, the selected study area is exposed to a variety of natural hazards including snow avalanches and debris flows.

Policy context

Currently in Chile, there are a few policy instruments that incorporate Eco-DRR elements into their plans, namely the sectoral Climate Change Adaptation Plan in Biodiversity that aims to strengthen environmental institutions, public organisations, private entities and civil society to adapt to the impacts of climate change on biodiversity and ecosystem services. The National Policy of Urban Development presents a more holistic vision of the need for considering ecosystems in disaster risk management and reduction. Other policies that mention ecosystem-based adaptation are, for example, the National Plan of Action for Climate Change, which emphasises the role of ecosystems for climate change adaptation, while the Climate Change Adaptation Plan mentions the need for training on these topics. Finally, the National Policy for Disaster Risk Management acknowledges that, in the future, disaster risk reduction should incorporate other kinds of units for territorial planning, such as the ecosystems, basins or macrozones of biodiversity (ONEMI, 2014).

EPIC sites in Chile

The EPIC project site in Chile is the Biosphere Reserve Corredor Biológico Nevados de Chillán-Laguna del Laja (referred to henceforth as BR), declared by UNESCO in 2011 (San Martín, 2014), within the central Chilean zone, in the Biobío Region (Figure 11). The BR extends over an area of 565,807 hectares and is divided into three main areas: core, buffer and transition (17%, 70% and 13% of the BR's area respectively). It seeks to reconcile the conservation of biological and cultural diversity with economic and social development (íbid., 2014). The BR has eight communes with a population of around 7,728 inhabitants (San Martín, 2014). Around 78% of the BR is owned privately.

Objectives of EPIC in Chile

The goal of EPIC in Chile was to recognise and promote the conservation of ecosystem services within the national policies and programmes for disaster risk reduction and climate change adaptation, and as an integral part of various global agreements and strategies.

Its specific objectives were to

- demonstrate the importance of sustainable management of ecosystems as an alternative to reduce the risks of disasters and to adapt to climate change;
- strengthen capacities, create awareness and improve communication about ecosystem-based disaster risk reduction and climate change adaptation; and
- disseminate, through multi-stakeholder platforms, lessons learned and practical solutions that can be replicated or included into programmes and public policies.

2.2.2 Operational approach in Chile

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), and with support from the

Figure 11. Map of the EPIC site in Chile

Regional Government of Biobío. In 2013, a vulnerability assessment using the same method and tools as described in section 2.1.2 earlier was carried out to help local and external stakeholders understand the current and potential impacts of disasters and climate change and identify risks. Scientific research followed, while in parallel, the EPIC team engaged in intensive policy advocacy.

Outcomes of the vulnerability and capacity assessment

The VCA workshop in Chile was implemented over five days and convened 24 participants. The top three priorities identified to be addressed by the EPIC project were: 1) drought and tourism, 2) forest fires and biodiversity and 3) drought and energy infrastructure. 16 innovations were proposed and prioritised into the following:

1. Create a water committee to regulate the sustainable use of water, including water use in the tourism sector
2. Promote the sustainable management and conservation of native forests
3. Establish an agency to promote eco-tourism and conservation of the Biosphere Reserve
4. Promote sustainable energy consumption by designing lighting solutions, building architectural designs, and encouraging sustainable firewood use, among others

Action plans were then developed for each innovation. These included information on actors and roles, activities to be implemented, means required for implementation and expected changes.

Scientific research

A literature review of more than 200 documents, of scientific knowledge about the ecosystems services of forests and their role in reducing disaster risk, revealed that the link between disaster risk reduction and ecosystem services was not yet established in Chile. In parallel, a study on avalanches assessed the main hazards locally and analysed their processes and their interactions with forest ecosystems. The general goal of the case study is to quantify and optimise the value of mountain ecosystems in the reduction of risk associated with snow avalanches and other natural disturbances, such as rock falls and debris flows. Dendrochronological[2] methods allowed for the reconstruction, in time and space, of the patterns of snow avalanches for the past decades. Simulation models were used to determine different avalanche patterns such as maximum runouts and maximum impact pressures for the current state of the forest structure and for other forest (or non-forest) scenarios. In addition, a study about the local perceptions of ecosystem services of the forest, climate change and local risks of natural hazards was conducted at Valle de las Trancas, with the objective of assessing how the local community perceived the importance of the native forest and its ecosystem services, including their knowledge and awareness about the relationship between native forest and natural hazards of the area. This study also generated new information to feed local decisions regarding territorial planning, natural hazards, regional tourism, management of the BR and adaptation to climate change.

Capacity building and awareness-raising on Eco-DRR

Multi-stakeholder meeting supported the networking of key local stakeholders of the BR and raised awareness about the need for adopting the approaches of Eco-DRR and EbA in Chile. Around 270 stakeholders at the local level (BR) and around 150 actors from the national level have been engaged in eight workshops organised by EPIC partners.

2 The science or technique of dating events, environmental change, and archaeological artefacts by using the characteristic patterns of annual growth rings in timber and tree trunks' (English Oxford Living Dictionaries, 2017).

Knowledge and capacities related to Eco-DRR (and EbA) within these diverse stakeholders from civil society, government and academia have been exchanged and fostered since 2013.The scientific results of EPIC have been disseminated in five international events.

The EPIC experience has also been disseminated through diverse communication products and means. One scientific publication is currently under peer-review.

Policy advocacy

A literature review and analysis of the current legal and policy framework identified opportunities for the inclusion of Eco-DRR, and concluded that it is imperative to enhance and modify instruments and laws related to territorial planning at different scales. For policy advocacy, EPIC used participatory processes through multi-stakeholder dialogues, meetings and continuing coordination with political partners throughout the project's implementation.

2.2.3 Results and challenges in Chile

EPIC implementation in Chile involved multiple stakeholders (Annex 3) to implement the Science-Practice and Policy approach. Though the VCA workshop proposed several local innovations to be implemented in the project area, EPIC in Chile eventually did not focus on the practice component. This is mostly because of a lack of financial resources as well as the lack of presence in the country to implement field-based interventions. Currently IUCN does not have a presence in Chile and partners involved in the project were from the scientific and policy fields. Implementations of the innovations were expected to be implemented by local stakeholders but did not progress as expected. Yet the project had strong scientific and policy components.

Increased awareness within communities

Although EPIC in Chile did not include field-based interventions, the VCA process contributed to increase knowledge on the risks to climate change and disasters among local stakeholders, and assessing which are some of the main solutions that could be implemented. In addition, according to the results of the EbA effectiveness research methodology[3] it was assessed that the EPIC project has built a foundation for local human resilience, mainly because of the awareness generated by the project on climate change vulnerabilities and risks to disasters, as well as the role that (forest) ecosystems play in mitigating these risks.

Science-based knowledge and evidence on the protective role of forests

The combination of the applied methods provided the basis for hazards mapping of the most exposed sectors of the valley (Casteller et al., *In prep.*). Dendrochronological studies showed that the Nevados de Chillán has a rich history of natural disturbances. In the past, many avalanches and debris flow events occurred. In the years 1995 and 2000, avalanches occurred in many tracks (Figure 12). Results of the simulation models show that native broad-leaved forests shorten runout distances and reduce impact pressures for small to medium avalanches. While it is evident that grey measures (for example sheds) could be locally constructed to reduce exposure to snow avalanches in the valley, greener alternatives such as the avoidance of large openings in forest management or even afforestation could improve the protective capacity of the forests without altering the landscape in such a pristine environment.

Policy influence

Through its policy advocacy approach, EPIC in Chile has been able to mainstream the Eco-DRR concept into the Chilean government lexicon,

3 Part of a BMUB-funded, IIED led project, in which IUCN is one of the implementers, along with the UNEP-WCMC

Figure 12. In the years 1995 and 2000 avalanches occurred in many tracks (shown in pink) (© Alejandro Casteller)

and there are now multiple opportunities for its future integration into various policies and planning instruments (Table 8).

2.2.4 Lessons learned in Chile

- While in most case the consultative workshops confirmed that EPIC's focus was appropriately responding to people's needs in terms of climate change adaptation and disaster risk reduction, in the case of Chile, local people highlighted other risks that could have been included in EPIC concept. Indeed, floods and landslides are recurrent hazards frequently occurring in the study area, while the project currently focuses on avalanches that are rarely occurring.
- Using rigorous, pioneering science (combination of dendrological studies with simulation models to generate knowledge on avalanche patterns and the protective role of forests) and multi-stakeholder dialogues, EPIC has been able to position the Eco-DRR approach among a diverse range of stakeholders from local to national levels.
- The engagement of the diversity of stakeholders at both local (BR) and national levels to promote inter-institutional and multi-disciplinary coordination is useful for maximising impacts at policy levels.
- When disseminating scientific knowledge, it should be tailored in a way that science is made accessible to the range of different stakeholders — such as decision-makers, civil society, and academics.
- Although the capacities of the range of stakeholders about the Eco-DRR concepts were strengthened through EPIC, there is a continuing need (as a cross-cutting and strategic component) to ensure that Eco-DRR and EbA are institutionalised to obtain enduring influence. Therefore, more multi-level spaces for cross-learning will be useful for integrating perspectives and maximising impacts in policy from the local to national levels.
- For future initiatives, it should be essential that a component of implementation (the practice of Eco-DRR) is included to

Table 8. Summary of policy influence and opportunities in Chile

Policy document/ government body	Outcome
National Plan for Adaptation to Climate Change in Biodiversity	EPIC has been included as a measure of adaptation to climate change to disseminate and promote the value of ecosystem-based adaptation solutions, such as ecosystem restoration, reforestation, as a mechanism of reduction of natural hazards exacerbated by climate change.
Regional Ministerial Secretary of Environment (SEREMI MA)	Sent recommendations to Biobío in the Regional Government of the same region suggest including the results of EPIC's avalanche study in the Biobío Regional Land-Use Plan (currently under formulation).
National Climate Change Adaptation Plan	EPIC has contributed to the aim: 'to develop a training programme for public institutions and other stakeholders at national, regional and local levels on adaptation to climate change within the framework of disaster risk reduction, including, among others, issues related to impacts of climate change, adaptation and focus and non-traditional adaptation alternatives'. These experiences and lessons can be further institutionalised.
Ministry of Public Infrastructure	There has been growing interest about the EPIC results from the Valle de las Trancas, to assess potential sustainable alternatives (such as green-grey measures) to reduce the risks of avalanches in the road that connects the valley with the upper part of Nevados del Chillán. In addition, they have shown interest in learning more about nature-based solutions.
National Emergency Office (ONEMI)	The National Platform on Disaster Risk Reduction from the National Emergency Office (ONEMI) has shown an initial interest in integrating the Eco-DRR approach into its multi-sectorial platform.

complete the comprehensive approach of science, practice and policy.

- Land-use planning in Chile is a sector that must be focussed on, from a multi-sectorial and territorial perspective, for the integration of Eco-DRR into the country's planning and policy.
- Economic valuation of Eco-DRR, that includes the value not only about reduction of risk but also about the protective services of forests ecosystems (and all other ecosystem services) will be critically necessary in the portfolio of results used to convince decision-makers about the benefits of eco-DRR over hard engineering solutions.

China

Alexia Stokes and Yan Zhang

Key Message

An increase in plant diversity and proper mixtures of crop and tree species in ecological engineering projects could improve protection against shallow landslides and erosion, especially in Southwest China.

Fast facts on China*

Population: 1,378.67 Million

Main Livelihood: Services (51.63%), industry (39.81%) and agriculture (8.56 %)

Gross domestic product based on purchasing-power-parity (PPP) per capita GDP (current international dollar): 16,660.21

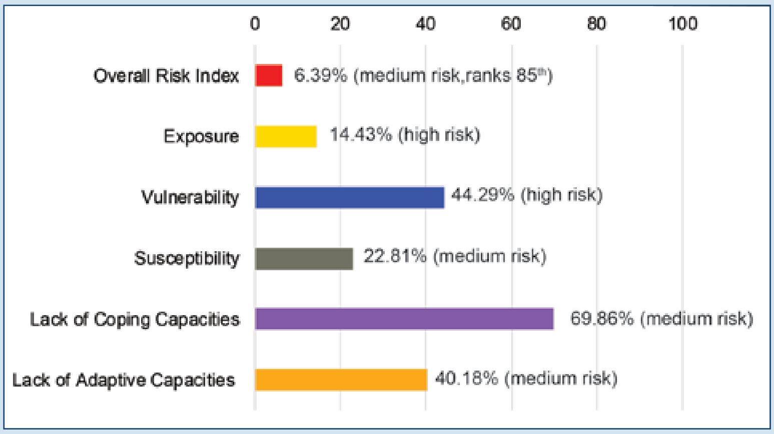
Human Development Index: 0.738 (ranks 90th in the world)

Poverty headcount ratio at national poverty lines: 3.14%

Main drivers of ecosystem change:

- Erosion
- Accelerated urbanisation and industrialisation
- Overexploitation and unsustainable use of biological resources
- Environment pollution
- Climate change

World Risk Index:



* (Sources: World Bank, 2017; IMF, 2017c; UNDP, 2016;; United Nations University, 2016)

2.3.1 Background and context in China

China is the world's most populous country with 1,378 million people, home to about 18.4% of the world's population (World Bank, 2017). Across its extensive landscape of 9.597 million km^2, is found a range of extensive ecosystems, both tropical and temperate, and a coastline of 14,000 km of coastline (IUCN and ProAct, 2013c).

Climate change and disaster risk

The effects of climate change are already being felt in China. Annual average air temperature has risen faster than the average rate of global warming, increasing by 0.5-0.8°C in the past century. This change is variable over the extent of the country, with the largest warming of 0.36°C per decade in northeast China, and the smallest of 0.15 °C in southwest (Piao et al, 2010).

Annual precipitation trends between 1960 and 2006 show a decrease in the northeastern area, but increases in northwestern and southeastern China. There are also seasonal changes in rainfall, with most areas (except the Qinghai–Xizang Plateau) showing a decrease in Autumn precipitation, while winter precipitation has increased (Piao et al, 2010). In addition, there has been a decrease in the annual number of rainy days across China (Piao et al, 2010).

Within much of western China is a triangle-shaped tectonic area, the convergence zone of the Eurasian, Pacific and Indian Plates, where 'tectonism is intense' (Gao, 2010). China is, therefore, affected by frequent earthquakes — in fact, in this century, there have been 89 events where there was ground movement (CRED, 2017). Given that 69% of the land is mountainous and given China's geological history, geological disasters are also common (NPR, 2012 in litt. IUCN and ProAct, 2013c).

In addition, meteorological disasters such as floods have increased in frequency and affect two-thirds of the country (IUCN and ProAct, 2013c).

Reported since 2000, are i) 174 floods affecting nearly 889 million people and costing 147.5 million USD; ii) 89 earthquakes, affecting 62.3 million people and costing 103.3 billion USD; and iii) 47 landslides affecting 2.4 million people and costing 1.7 billion USD; (CRED, 2017).

Relevance of Eco-DRR interventions

In the last fifty years, there has been a significant increase in the construction of roads in rural China (Sidle and Ziegler, 2012). When such roads are not designed well, and constructed on steep mountain slopes, the frequency of landslides increases (Sidle and Ziegler, 2012), as exemplified in China, where, as a consequence of deforestation, road and infrastructure construction, landslides have increased significantly in the last five decades (Ghestem et al, 2014), increasing soil erosion and river sedimentation (EPIC final report, 2017).

The Chinese government has through several policies and programmes sought to address this issue (EPIC final report, 2017). Although disaster-risk reduction and climate change adaptation are now included in environmental policies, approaches used to address this issue remain focused on hard engineering (EPIC final report, 2017), lacking the suite of ecosystem services that ecosystem-based approaches restore.

The Yunnan Province, where the EPIC project sites were located (see next section), has been identified as containing 10% of China's geological disaster-prone sites (EPIC final report, 2017). Sixty percent of the towns in the Salween watershed within this province are reported to be affected by mountain disasters while 52% of its land area is subject to soil erosion (EPIC final report, 2017).

Policy context

China has a rather complex policy system, including different policy instruments for different purposes. There are no specific laws about Eco-DRR, but many relevant ecological and disaster policies. Of the many hundred environment-related policies, the following are the most relevant: i) the Grain for Green Programme of 1999 in its current phase of 2014-2020, which restores vegetation on existing sloped agricultural land, by providing compensation in form of grain and cash to communities (Ministry of Finance, 2015); ii) The 13th Five Year Plan on Forestry Development (2016-2020), specifying extensive priorities and numerous tasks for the State Forestry Administration to better manage forestry in China, including disaster risk reduction, in many proposed/ongoing programmes (State Forestry Administration, 2016); iii) The 13th Five Year Plan on Integrated Disaster Prevention and Reduction published in 2017 for 2016-2020, specifying priorities and tasks to better manage disasters, through improving policies and systems, integrating disaster management to other sector plans and policies, establishing information systems, undertaking projects, promoting awareness raising, civil society participation and international cooperation. Ecological management is included as an ecological engineering approach to disasters (Ministry of Civil Affairs, 2017).

EPIC sites in China

In China, the focus of EPIC is on the Upper Salween River valley (Figure 13). A UNESCO World Heritage Site, the upper Salween River valley is one of the world's richest areas in terms of plant biodiversity. However, it is also a mountainous area where degraded steep slopes are prone to landslides/erosion. The natural wealth together with the safety and livelihoods of people living in the valley are under threat from the massive soil runoff and landslides (EPIC final report, 2017). The government has implemented the Grain for Green in the Upper Salween River valley. Two field sites were selected: Lukuidi (Salween River Valley) and Jinghong (Xishuangbanna).

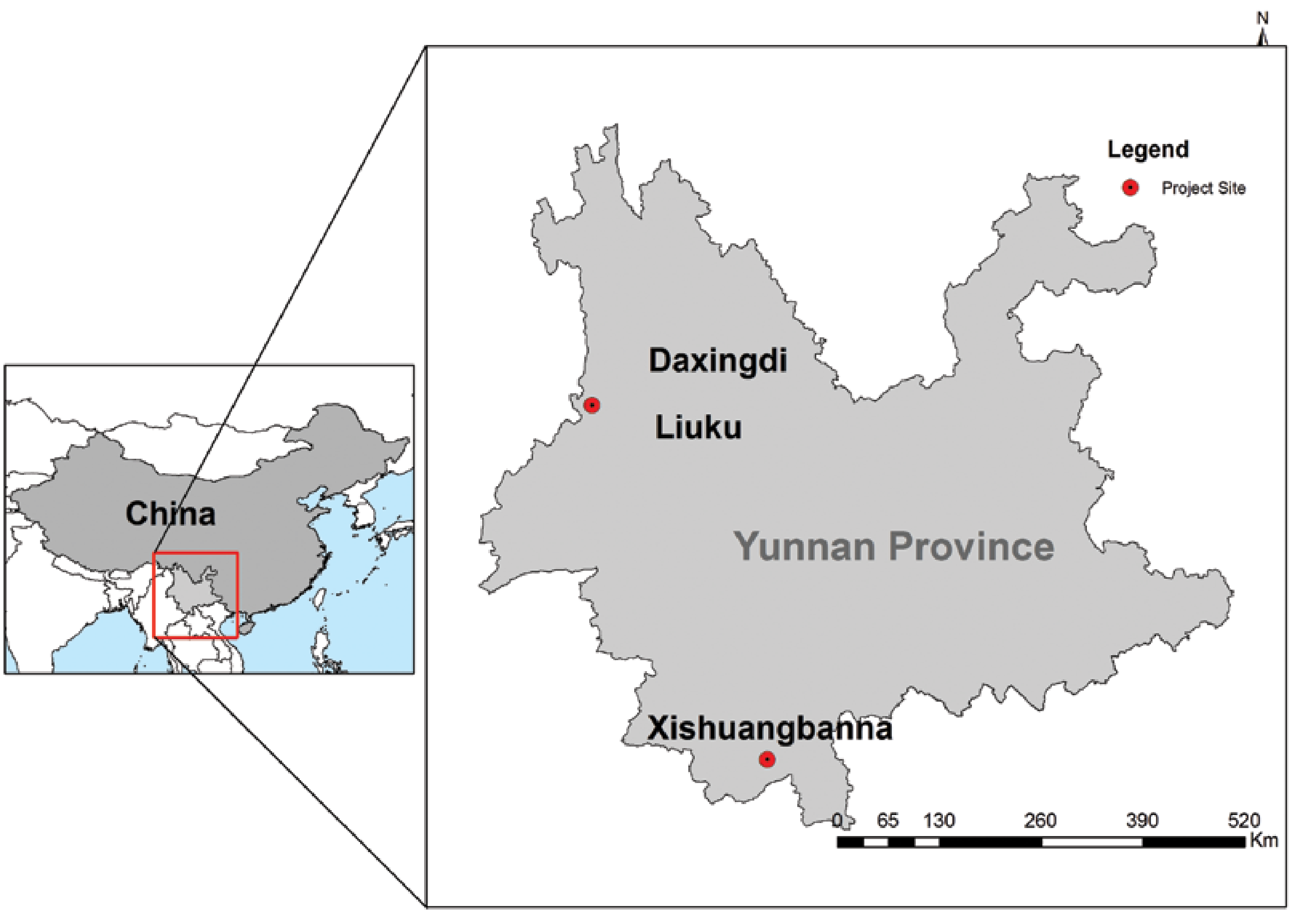


Figure 13. Map of the EPIC site in China

Objectives of EPIC in China

The goal of EPIC in China was to investigate the use of eco-engineering for the stabilisation of steep slopes.

Its specific objectives were to

- Analyse the spatial occupation and root structures of relevant plant species on steep slopes that can potentially alleviate the risk of shallow landslides and reduce soil particle runoff caused by water runoff due to floods and heavy rain.
- Calculate the influence of vegetation on slope stability through the use of geotechnical engineering models, with the aim of developing a tool to aid engineers choose plant species suitable for fixing soil on slopes with regard to shallow landslides.

2.3.2 Operational approach in China

EPIC in China was jointly implemented by the Institut National de la Recherche Agronomique (INRA) and IUCN China, the former conducting scientific research in the Yunnan Province and the latter addressing policy issues, respectively. The implementation of a socio-economic VCA on site proved to be difficult at the beginning of the project. Alternatively, a landslide risk assessment was conducted and the social vulnerability context was documented based on existing literature. A second social vulnerability assessment was conducted in 2014 which built on existing literature through interviews and discussions with local governments and communities. Road-related landslides and associated riverine sedimentation were documented as being important challenges in the Salween River basin and are affecting or expect to affect site productivity, decrease water quality downstream, increase flood potential and impacts livelihoods of water users in communities downstream (IUCN and ProAct, 2013c). Field visits to Upper Salween were undertaken from 2013 to 2016 by IUCN China and INRA. INRA then performed field experiments and numerical modelling to demonstrate the mechanical role of vegetation for improving slope stability and the impact of different plant species on hydrological processes.

Scientific research

The comprehensive landslide vulnerability assessment in the Salween River valley involved the measurement of landslide erosion along seven unpaved road segments in the upper

Figure 14. Measuring landslide size and intensity along recently constructed roads in the Salween River Valley Yunnan Province China © Alexia Stokes

drainage basin and calculated sediment delivery rates into the Salween River (Figure 14). Rates of landslide erosion measured were extremely high and at one site, the rate of erosion of 48,235 megagrams per hectare per year is the highest ever reported along a mountain road corridor (EPIC final report, 2017).

In Lukuidi, two sites — one, an active landslide slope, and the second, a slope where a landslide had occurred in 2000 but which has no recent activity — were selected. Sixty species from the Salween River Valley had been previously shortlisted to nine species based on various ecological, economical and ethnobotanical criteria. Characteristics of these nine species were examined regarding their desirability for fixing soil on slopes.

A study using Google Earth Pro to detect locations of landslides showed that Google Earth Pro was also conducted and showed that it was not an adequate tool for precise landslide detection and that detection rates changed with the experience of users. It was concluded that Google Earth Pro was suitable for identifying zones of landslides, but was not sufficiently accurate to detect small, shallow landslides (EPIC final report, 2017).

Capacity building and awareness-raising on Eco-DRR

Several training events were organised to strengthen the capacities of communities and government officials to facilitate EPIC implementation as well as to promote scaling up of the approach:

- The concepts and approaches of Eco-DRR and the plan for EPIC China were introduced at an Inception Workshop in Kunming, targeting ten provincial stakeholders, including technical institutions such as the Kunming Institute of Botany and Xishuangbanna Tropical Botanical Garden of Chinese Academy Sciences;
- A similar training for 70 national stakeholders, namely central ministries (NDPR SFA, MWR and Ministry of Environmental Protection) technical institutions and NGOs.
- Another provincial workshop held in Kunming used the EbA Learning Framework to facilitate discussions and the potential and priorities to integrate the EPIC approach and Eco-DDR into forest and land use policies and projects. This workshop had over 20 participants including some from the Yunnan Forestry Department, Yunnan Forestry Academy, Nujiang Forestry Bureau.
- The EPIC experience in China and dissemination of the scientific results, to discuss the future areas for focused study and priorities for Eco-DRR were the foci of another national workshop in March 2017. Over 40 people, including officials and experts from five ministries including Ministry of Environmental Protection and the Ministry of Communications provided their insights and suggestions.
- Four training sessions in China and Hong Kong were carried out, for 50 and 100 people respectively, to demonstrate that to reduce surface erosion, a high density of roots and increased soil occupation is required. In both cases, soil protection is improved by a diversity of plant species.

Policy influence

EPIC in China used the following processes to commence policy influence:

- It conducted policy analyses to identify existing policies related to climate change, adaptation, as well as related sectors/ institutions. This analysis identified the following as key policy players for Eco-DRR in China: i) the National Disaster Reduction Center (NDRC) under the Ministry of Civil Affairs (MFA), which is the secretariat to the China National Commission for Disaster Reduction (CNCDR), the overall decision-making and cross-sectoral body in China; ii) the State Forestry Administration (SFA), which is the ministry managing the forests, wetlands and biodiversity; and iii) the Ministry of Water Resources (MWR), dealing with major water induced disasters, especially floods and droughts.

- EPIC then proceeded to build relationships with the NDRC, as well as related officials of SFA and MWR, who have participated actively in national workshops and events and are now willing to partner with IUCN for the next steps.
- EPIC sought engagement with key technical experts on the Board of Experts to CNCDR (which helps ministries formulate policies), so that the results and knowledge generated by EPIC China could be incorporated into such policies.
- EPIC has established collaborations with key technical institutions including the Chinese Academy of Sciences, Chinese Academy of Forestry, Chinese Society of Forestry, China Water and Soil Conservation Society.
- • EPIC China results and other IUCN nature-based solutions experiences are now being used by a key expert to develop a technical guideline for the China Water and Soil Conservation Society.

2.3.3 Results and challenges in China

EPIC implementation in China involved multiple stakeholders (Annex 4) to implement the Science-Practice and Policy approach. However, in China, the practice component was eventually not implemented. Community engagement was an important challenge due to several factors including distrust of strangers and the uninhabited nature of the study site. The local social and political contexts have restricted several investigations and activities of EPIC.

Science-based knowledge and evidence on the effectiveness of eco-engineering

The stronger component of the case study is the scientific knowledge generated. The EPIC scientific results have been published in peer-reviewed journals in seven papers. These results have also been presented at 15 conferences and meetings. The study on mechanical effects of vegetation on slope stability revealed that deeper rooting species, than those currently present on the slope monitored are required for improved slope stability. Rainfall simulations carried out in mixed, natural forest and rubber tree plantations showed that most infiltration into soil occurred in natural forests compared to rubber plantations, indicating that conversion from natural forest to plantations could increase erosion. In cultivated soils, mixtures of tree and shrubs and herbaceous plants — such as the practice of alley cropping — will benefit the soil. Through the different studies a Stability Database[4] has been developed to aid site managers choose the most suitable species fields when replicating eco-engineering work.

Policy influence

Eco-DRR related policy development is constrained by the fact that there are some 30 relevant sector agencies and ministries whose functions are disparate. In addition, thousands of technical institutions also play critical roles in policy making. However, the approach used by EPIC achieved several results in terms of policy influence:

- A NDRC delegation participated in the IUCN World Conservation Congress in 2016 in Hawaii and spoke at a side event on Eco-DRR event, indicating their growing interest in Eco-DRR as a consequence of the efforts of EPIC in China. A report by the delegation, suggesting greater collaboration with IUCN on Eco-DRR, has been accepted by the NDRC.
- The SFA has agreed to work with IUCN on a GEF funded project, that aims to integrate ecosystem service considerations, including water and soil conservation and disaster reduction, to the reform process of some 5,000 State Forest Farms), a land

4 http://publish.plantnet-project.org/project/stability

management unit in China that in total, comprise about 25% of all China's forests or five % of terrestrial territory. The project is expected to be established in 2017.

- A wider reach to a greater range of relevant stakeholders has been established through i) the Water Salon, a joint mechanism facilitated by World Resource Institute, IUCN China, WWF, Global Water Partnership, trying to promote good water management in China; ii) the China Megacities Watershed Partnership, a joint mechanism promoted by IUCN China, China Water and Soil Conservation Association and the Beijing Forestry Society to ensure water security for Chinese major cities through addressing the ecosystem management issues, such as erosion control; and iii) Mangroves for Future China Advisory Panel, a stakeholder group established by IUCN China to promote mangroves conservation and restoration in China.

2.3.4 Lessons learned in China

- Sites selected for research purposes might not be the most suitable for getting communities' involvement and demonstrating impacts. Hence, a trade-off needs to be found between research requirements and the project's vision and objectives and site selection need to be strategic.
- The combination of 1) producing clear scientific results that show that soil conservation can be improved and erosion can be reduced to mitigate the impacts of landslides and 2) networking with national authorities and experts to build trust, building their capacities and disseminating the scientific results, has proven to be a successful approach to promote eco-DRR.
- Working with Chinese partners is not only essential for international projects like EPIC to work smoothly in China, but is also a good approach to mobilise stakeholders and ensure the involvement of the key people.
- Understanding how to work on policy in China and integrating it in the project design is critical for policy influence. China has its own ways of policy development, which is different from many other countries, where advocacy and lobby may work. An effective approach for policy influence requires building trust with policy makers, understanding how other players fit into the policy arena, forging relationships and conducting joint projects and research.
- It is important to build local capacity of Chinese institutions and transfer technical knowledge for the continuation of Eco-DRR-related research on Eco-DRR and to convert research to practices and policies.
- As Eco-DRR in China is related to many ministries, targeted messaging relevant to policy makers is needed. For example, the NDRC-MCA is the focal agency on DRR but has no mandate for ecosystems, while, in contrast, the SFA manages ecosystems but has little input into DRR. Thus, highlighting the Sendai Framework to make Eco-DRR relevant to NDRC, and referring to ecosystem services when engaging with SFA makes Eco-DRR relevant to both organisations.
- EPIC China's research site only represents a specific example in China, which is too limited for policy makers, even for provincial level policy makers. Further studies on other sites and more capacity building events are needed for various stakeholder groups.

Nepal

Karen Sudmeier-Rieux, Anu Adhikari and Sanjaya Devkota

Key Message

EPIC Nepal has successfully demonstrated that eco-safe roads — an ecosystem-based approach to disaster risk reduction —is cost-effective and locally adapted, with great potential for reducing risk while increasing the resilience of communities living in landslide-prone areas.

Fast facts on Nepal*

Population: 28.98 Million

Main Livelihood: Agriculture, which amounted to 1/3rd or 31.37% of GDP

Gross domestic product based on purchasing-power-parity (PPP) per capita GDP (current international dollar): 2,606.066

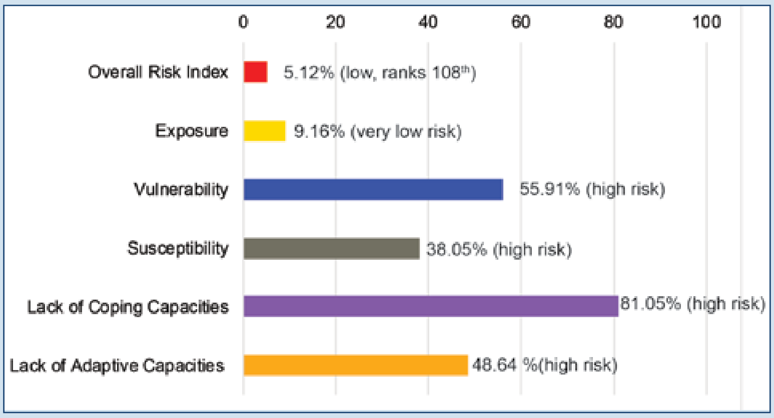
Human Development Index: 0.548 (145th place)

Poverty headcount ratio at national poverty lines: 25.2 %

Main drivers of ecosystem change:

- Climate change
- Unplanned rural road construction
- Migration
- Land abandonment

World Risk Index:



*(Sources: World Bank, 2017; IMF, 2017d; UNDP, 2016; IUCN and ProAct, 2013d; United Nations University, 2016)

2.4.1 Background and context in Nepal

Nepal is a landlocked, largely mountainous country (over 80% is mountainous), divided into five physiographic units that run east to west: the high Himalaya (4,877 to 8,848 meters), high mountains, the middle hills region, the Churia or Siwalik range and the Terai region in the plains (lower than 200 m and the agriculture region of Nepal) (Sudmeier-Rieux et al. 2014).

Climate change and disaster risk

Nepal's has an annual rainfall varying from 1,000 to 5,000mm. Around 80% of this precipitation occurs during the monsoon season, which lasts from June to September. Cloud bursts can bring more than 300 mm of rainfall in 24 hours and create severe flash flooding and landslides (MoHA, 2009). Over the last three decades, winter rainfall has decreased from 30 mm to 17 mm per day, and total rainfall days has decreased from 135 to 120 days (Shah et al.,2012). In contrast, temperature in Nepal has increased in the range of 0.06-0.120°C per year in the mountains and hills and by about 0.030°C in the Siwalik and Terai regions during the period of 1971-94 (Shrestha et al, 1999).

In addition, the Himalayan range is one of the geologically youngest in the world, making these mountains seismically active (Geological Society, undated). Therefore, the rate of natural erosion and the transport and deposition of sediments is high and landslides are a natural feature in the Himalayas (Sthapit and Tennyson, 1991). Climate change in the Himalayas is predicted to exacerbate such natural hazards, resulting in more frequent extreme events, such as global lake outburst flood, floods, drought and landslides, which have caused major damage in the past. Many of these hazards have, indeed, intensified during the past two decades, especially flooding and landslides. Between 1996-2015 there have been 235 fatalities, on annual average, mainly because of flooding and landslides (Germanwatch, 2017).

Relevance of Eco-DRR interventions

A major trend in Nepal's rural development is the exponential pace of rural road construction. Because of the 2008 Decentralisation Act, significant authority and budgets have been transferred to local governments. Consequently, rural road construction has become the main priority of the Village Development Committees (VDCs) and District Development Committees (DDCs), the main village and district authorities. Following the boom in rural road construction, many communities are collecting their own funds to rent bulldozers and building rural roads, in landslide-prone areas, without proper technical guidance, surveying, drainage or structural protection measures (Sudmeier-Rieux et al., 2017, submitted). The number of rural roads in the Phewa watershed has increased from 26 km in 1979 to 340 in 2016 (Vulliez et al., submitted). The result is that many of these rural roads collapse during the first monsoon rains, triggering landslides and accelerating erosion rates, directly affecting economic development and increasing vulnerability (Leibundgut et al., 2016; Sudmeier-Rieux et al , submitted).

Nepal's steep topography and geological history combined with changes in temperature and rainfall, will have profound negative impacts on the agricultural sector, on ecosystems and livelihoods (MoHA, 2016). Such changes are particularly acute for poor communities, who are highly vulnerable and have little capacity to cope with such change.

Policy context

There are some 30 policies, acts and regulations that are related to disaster risk reduction, climate change and environmental conservation. Of these the three most important policies in relation to disaster risk reduction and climate change are i) the Water Induced Disaster Management Policy (2006), which focuses on water-induced disasters such as floods, landslides, erosion and mentions bio-engineering as a means to mitigating their impacts; ii) National Strategy for Disaster Risk Management (NSDRM) (2009), based on the Hyogo Framework for Action (HFA) of 2005, whose long-term vision is to develop Nepal as a disaster-resilient community; and iii) the National Adaptation Programme of Action (2010) which mentions community-based disaster management as a means for combatting climate change.

EPIC sites in Nepal

The Panchase region (Kaski, Parbat and Syangja districts) in Western Nepal (Figure 15) was selected for piloting the EPIC project as it lies in the IUCN Ecosystem-based Adaptation (EbA) Mountain project area, selected by the EbA project for its vulnerability to climate change, which is already having negative impacts on water resources, agriculture and biodiversity. The three districts consist of 17 village development committees (VDCs) and cover an area of more than 284 km^2. Within this area, there are 15,964 households with a population of 62,001 (CBS, 2011).

The area is in sub-tropical climatic region in the central-western region of Nepal, with hot and humid summers (30-35°C) and cold (3-5°C) and mostly dry winters. The altitude of the location is between 700 and 2,517 AMSL and rainfall is among the highest in the country, with annual precipitation levels close to 4,000 mm (CBS, 2009). The entire area is severely affected by annual landslides and flooding, which occur during the monsoon season (Leibundgut et al., 2016; Vulliez et al, submitted). These events usually cause casualties and are very destructive for local livelihoods. Landslides block roads and destroy houses and sediment flows frequently cover productive agricultural lands, hampering economic development in the area.

Objectives of EPIC in Nepal

The main goal of the EPIC project was to catalyze and quantify the role of ecosystems in protecting vulnerable communities against the risks associated with climate change and natural hazards.

Its objectives were to:

1. Establish demonstration sites for reducing landslide instabilities along road sides using

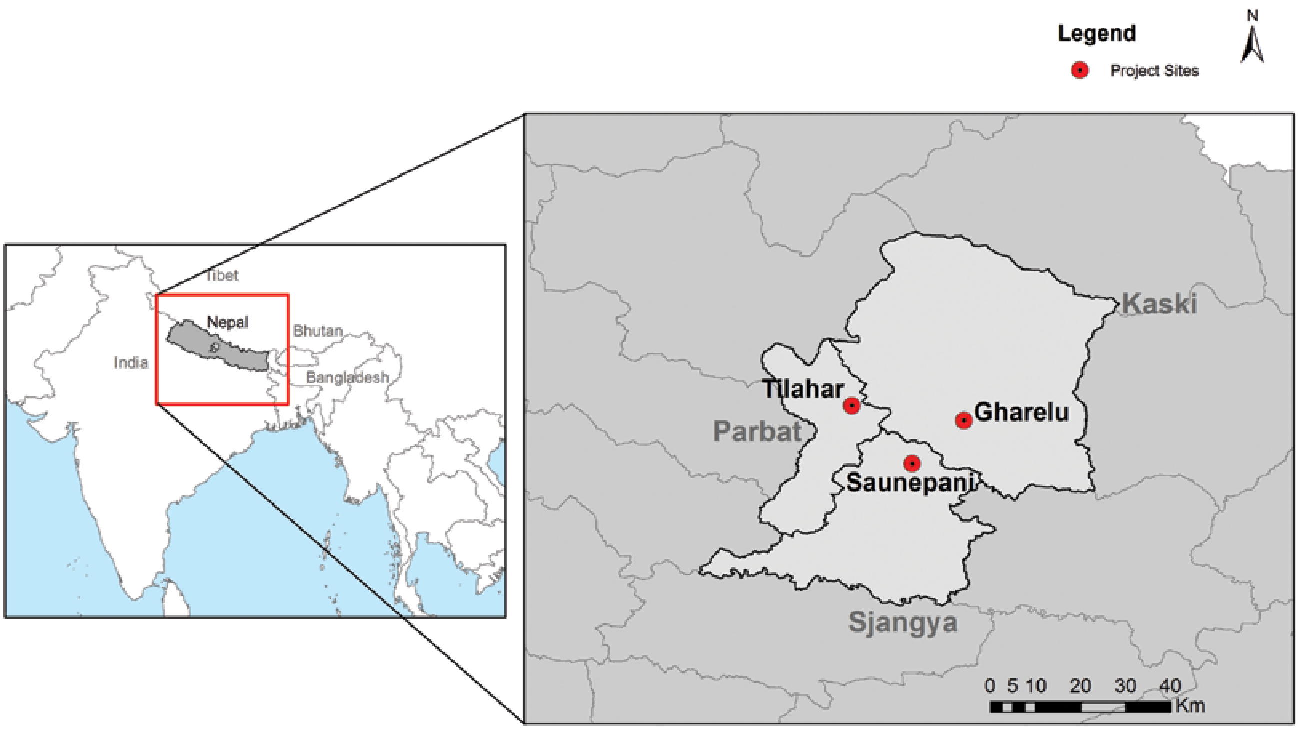


Figure 15. Map of the EPIC site in Nepal

ecosystem-based, locally adapted bio-engineering methods;
2. Develop capacity building through national and district level workshops that bring together stakeholders from the environmental sector, disaster management, land use planning, development and civil society;
3. Advocate ecosystem-based disaster risk reduction at global, national and local levels by influencing policy processes at these various levels.

2.4.2 Operational approach in Nepal

The EPIC project in Nepal was developed jointly between the University of Lausanne (UNIL) and IUCN Nepal. The EPIC team conducted preliminary field and scoping visits, consultations and meetings from a range of government officers, university personnel and communities to identify stakeholders and sites for implementation. An inception workshop was then held to carry out participatory vulnerability analyses, community risk maps and participatory bio-engineering maps.

Memoranda of Understanding were formalised both at the national and district level with the Ministry of Forests and Soil Conservation to ensure involvement from the Department of Soil Conservation and Watershed Management (DSCWM). Partnerships were launched with the EbA Mountain project and research institutions such as the Tribhuvan University and the University of Agriculture and Forestry University. Baseline studies of the selected sites were carried out, activities identified in a participatory manner, and demonstration sites were established in three villages. Intensive capacity building (See later section) also buttressed the project.

Vulnerability and capacity assessment

The VCA in Nepal was conducted using a combination of qualitative and quantitative data collection methods including geological assessments, remote sensing and semi-structured interviews with 'key informants'. The study was conducted at the community and household level. Five villages were surveyed through 48 semi-structured household surveys. The studies provided information on the main sources of income, land management and use trends, population concerns forexample unemployment, flooding, etc.

Scientific research

Through the EPIC project, support was provided for research on Eco-DRR to eight master's degree students and two PhD students, all of whom were Nepalese citizens. Biophysical research was carried out establishing rhizotrons — underground areas constructed to study the soil and its interactions with plants — as well as automated weather stations. Drone imagery, remote sensing and Laser-based Terrestrial (LiDAR) scans were used to capture and measure, with high precision, changes in erosion rates.

Socio-economic research (using cost-benefit analysis) was also carried out at the EPIC sites by Dr. M. Vicarelli, (Department of Economics, University of Massachusetts, Amherst, USA). This study compared conventional bulldozed, or grey roads with bio-engineered or 'eco-safe roads' over a 40-year time horizon (Sudmeier et al., submitted).

Capacity building and awareness-raising on Eco-DRR

Through the EPIC project, there have been extensive efforts to increase awareness about Eco-DDR at both local and national levels:

- For communities, bio-engineering training was provided to 66 community members.
- A booklet on bio-engineering techniques has been distributed to all 56 District Soil Conservation Offices officers of Nepal.
- Community cross-learning field visits were organized to foster community exchange.
- Five national and regional workshops, totaling participation of over 300 people, were held.

- A workshop creating awareness about Eco-DRR specifically for 20 journalists was held.
- Four cross-learning visits to demonstration sites, for about 110 people, were carried out for research institutions, academics as well as INGOs.
- EPIC results have been disseminated thorough mass media in local and national newspapers, presentations, national and international television.
- More than a dozen field visits/ study tours organized for different stakeholders with 96 participants
- Four cross-project learning visits were carried between China and Nepal, as well as a visit to Chile

2.4.3 Results and challenges in Nepal

EPIC implementation in Nepal involved multiple stakeholders (Annex 5) to implement the Science-Practice and Policy approach. The case study generated strong science, practice and policy influence despite encountering several challenges. These include variations in the level of community participation across the EPIC sites and establishing trust and relations with local and national government.

Bio-engineering activities and community involvement

Three demonstration sites (Figure 16) and three bio-engineering committees were established successfully and all three are actively seeking funding to extend bio-engineering works. One site — Gharelu —has already extended the EPIC interventions. About 450 community members benefitted from EPIC activities. Over 90 focus group meetings and discussions were held to discuss issues and provide support to communities. Nurseries in two District Soil Conservation Offices (Kaski and Syangja) were supported to produce bio-engineering species (previously not a common practice), enabling distribution of species to communities. To date, more than 5,000 seedlings have been distributed. Plant survival rates were monitored by communities, encouraging citizen science. In Gharelu, communities are now harvesting Broom grass used for road stabilisation during the dry season, for use as fodder and for sale and are earning 20,000 NPR per year, per kilometre.

Science-based knowledge and evidence on the effectiveness of bio-engineering

The rhizotron-led studies showed that Broom grass (*Thysanolaena maxima*) had the highest overall survival rate, but this varied between the demonstration sites, likely because of differences in soil types and community participation in ensuring survival. It also had the deepest roots (up to one meter below the soil), however Scented grass (*Chrysopogon gryllus*) had the strongest roots. These preliminary results provide guidance for bio-engineering best practices, especially as intense rainfall and longer drought periods are predicted. Both historical and the recently recorded data

Figure 16. Demonstration site Gharelu before interventions (left) after interventions (right) (© Sanjaya Devkota)

demonstrate that the rainfall in the region should be considered intensive with the potential for high soil loss (Devkota *et al.*, submitted).

The role of rural earthen roads in contributing to increased erosion and landslides was documented and 179 erosion events along 129 km of roads surveyed in 2014-2015 amounting to an estimated 100 m^3 of soil per km per year released into the Phewa watershed along earthen rural roadsides in Phewa Lake watershed (at the heart of the Panchase area) were recorded (Leibundgut et al,. 2016).

Vulliez et al. (submitted) documented that nearly half (44%) of 174 landslides were due to a large rainfall event in Phewa Watershed crossed by a road, of which, 84% were located within a buffer of 40 m from a road. These results show a trend shift in erosion zones from riverways and open grazing areas to roadsides, as a consequence of improved grazing management and exponential road construction, respectively. Results in 2016 of LIDAR scans demonstrate that soil loss was reduced by 95% at the Tilahar demonstration site (Sudmeier-Rieux et al, 2017, submitted).

The cost-benefit study developed five different scenarios using various levels of assumptions, from very conservative to moderate estimates of future soil losses as a consequence of road construction (Figure 17). Scenario 1 assumes a 'normal' monsoon season (based on historical rainfall records) with conservative yield losses as a result of damaged agricultural land adjacent to rural roads. In this scenario, the 'eco-safe road' becomes more cost-effective after 12 years as repair costs are significantly lower. Scenario 5 estimated that in with high agriculture losses along grey roads, the cost of grey roads may be significantly higher than eco-safe roads from the very first year of construction and the costs of eco-safe roads actually decrease over time while benefits accrue as a consequence of income generated from grasses in bio-engineering sites. Both scenarios give values per kilometre of road construction, assuming a discount rate of 0.1 (which translates the stream of costs and benefits into a single monetary value, or the net present value (NPV)). These losses and repair costs are often not accounted for by policy makers and communities, when decisions are made to use funds for constructing roads.

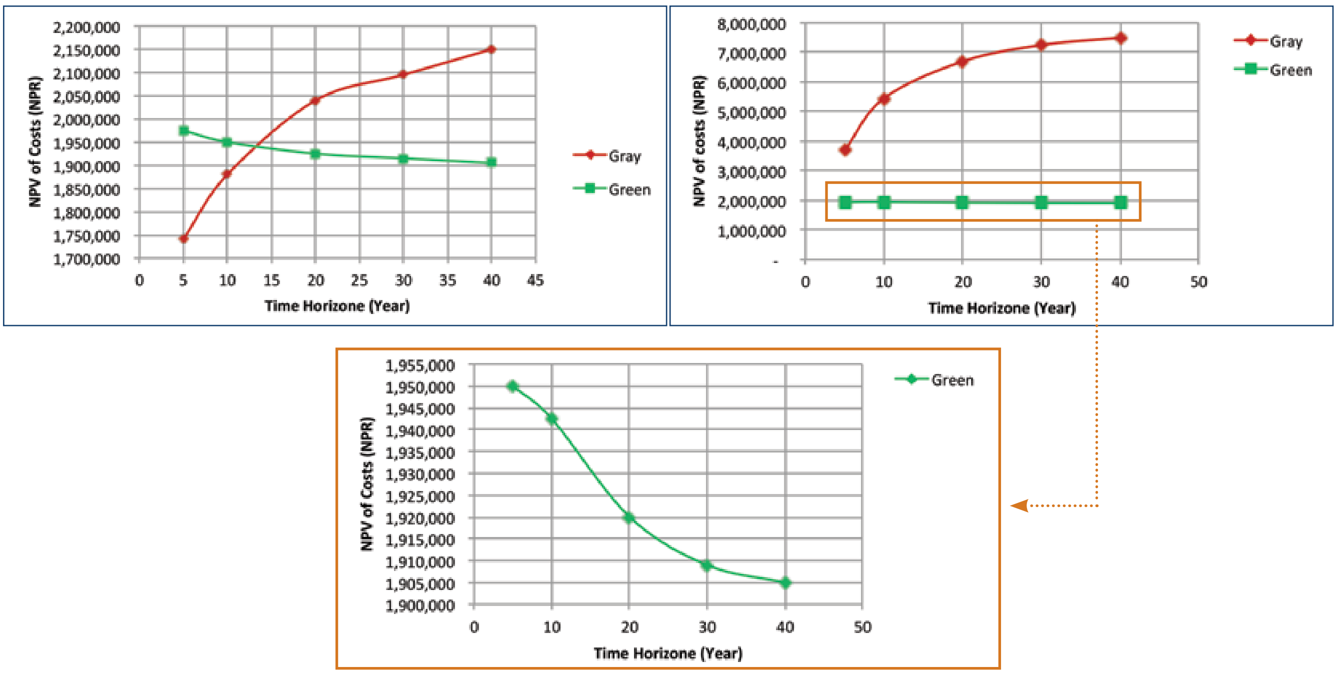


Figure 17. Left: Scenario 1: a conservative comparison of initial costs and very low estimated losses over time. Right: Scenario 5: the worst-case scenario of high losses as a consequence of repair costs and agricultural losses due to grey roads. The small inserted figure on right shows the eco-safe road in more detail for this scenario. Credit: Vicarelli, U Mass Amherst.

For research on resilience and indicators of resilience that would contribute toward establishing decision-support systems for increasing resilience (Sudmeier, Devkota and Adhikari, unpublished data), five focus group sessions were undertaken to obtain feedback on indicators of resilience using two groups. The top five indicators were found to be: employment (32.2%); education (29.5%); soil productivity (22.2%); vocational skills (19.9%); and safe houses and schools (19.8%).

The above scientific research has generated five peer-reviewed scientific publications (published, submitted for publication or in preparation); 11 scientific presentations and posters; one book (with parallel funding) on migration and DRR and a video documentary as well as eight presentations at international fora.

Policy influence

The above scientific results have been fed into many policy-related events including those listed below:

- A policy brief developed, widely distributed and now uploaded online.
- A workshop targeting policy issues was held with 50 participants from relevant government ministries (including concerned Ministries, Departments, and other relevant institutions etc.), national and international non-governmental organisations, consultants, and other stakeholders.
- Twenty-five participants from seven different government ministries, including the National Planning Commission member responsible for the environment and the Forest policy implementation working group from the Ministry of Forests and Soil Conservation, were taken on five site visits.
- Eco-DRR has now been integrated into the National Strategic Framework for Nature Conservation (2015-2030)
- The EPIC has provided inputs into the draft Forest Sector Strategy, as well as the Forest Sector Climate Change Policy both of which are being currently formulated.
- At the national level, ecosystem-based approaches are being mainstreamed into targeted policies related to road construction, land management (Integrated Watershed Management) and DRR.

2.4.4 Lessons learned in Nepal

- Policy arguments were strengthened significantly when based on rigorous scientific findings.
- Community participation in vulnerability assessments, field trips, on-site training, and cross-community and project exchanges, and community science (monitoring interventions) all have contributed to community ownership.
- It is important to integrate livelihood enhancement benefits with DRR/CCA benefits: the selection of bio-engineering plants in consultation with community members is critical and will have a higher success rate when combined with species that bring direct livelihood benefits, such as broom grass which is a species with both deep roots for slope stabilisation and for making brooms which can be sold for profit. Alternatively, mixing deep-rooted species with fodder species also provides communities with livelihood benefits.
- Media training and taking policy makers on visits to demonstration sites were very beneficial for raising awareness about the issues and EPIC interventions and for policy advocacy.
- Both the above lessons exemplify the adage ‘convincing by demonstrating’
- Sound, strong analytical science and economic valuation are essential as evidence to convince decision makers.
- IUCN-Nepal’s long-term policy support to key ministries on environmental legislation enabled effective influence and mainstreaming of Eco-DRR into policy advocacy.

Senegal

El H. Ballé Seye

Key Message

Participatory and iterative approaches ensure involvement and continued commitment from communities.

Fast facts on Senegal*

Population: 15.41 Million

Main Livelihood: Agriculture, livestock and fishing are the main livelihoods in the country.

Gross domestic product based on purchasing-power-parity (PPP) per capita GDP (current international dollar): 2,733.47

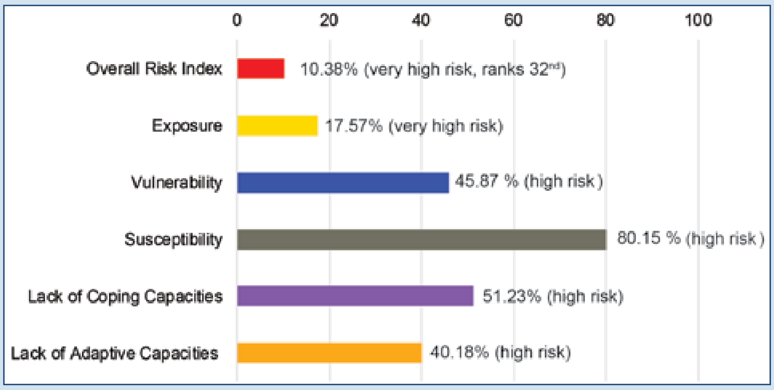
Human Development Index: 0.367 (ranks 163rd in the world)

Poverty headcount ratio at national poverty lines: 46.7%

Main drivers of ecosystem change:

- Salinisation and acidification of land
- Coastal erosion
- Destruction and fragmentation of ecosystem due to construction of roads, dams and human settlements

World Risk Index:



* (Sources: World Bank, 2017; IMF, 2017c; UNDP, 2016;; United Nations University, 2016)

2.5.1 Background and context in Senegal

Senegal is in the westernmost part of Africa's Sahel region, extending over 196,722 km², and bordered to the north by the Islamic Republic of Mauritania, east by Mali, south by Guinea Bissau and Guinea and the west by the Atlantic Ocean. The Republic of Gambia is almost entirely surrounded by Senegal (IUCN and ProAct, 2013e).

Climate change and disaster risk

Climate change in Senegal is characterised by erratic rainfall in time and space, resulting in a rainfall deficit and the disruption of the annual rainfall calendar. In addition, mean annual temperatures have increased by 0.9°C since 1960 (IUCN and ProAct, 2013e).

This variability in rainfall, combined with sea-level rise and inland freshwater and resource extraction, is driving soil salinisation and degradation, which has reduced agricultural productivity and hampered growth in all key economic sectors. Nearly three decades ago, research revealed that soil salinisation had affected an estimated 90,000 hectares in the Saloum estuary (NAPA, 2006).

Unsustainable agricultural practices, coupled with drought, have also resulted in desertification which affects soil fertility and again, reduces agricultural productivity (IUCN and ProAct, 2013e).

In addition, the frequency and intensity of extreme weather events are increasing. For example, reported between 2000 and 2017 are three droughts, affecting 17,73702 people in total and 13 floods affecting 868,357 people (CRED, 2017).

Relevance of Eco-DRR interventions

Agriculture contributes 18% to the GDP and employs 46.1% of the population (World Bank, 2017). Senegal's land degradation (salinisation and desertification) combined with the uncertainty and unevenness of rainfall, has resulted in a decrease in agricultural productivity in a country where nearly 50% of the population is categorised as poor (IUCN and ProAct, 2013e).

In the Fatick region selected by EPIC for its interventions (see below), poverty is overwhelming — about 20% higher than the national average (68.1%) (FAO, 2011) — and almost 90% of population is engaged in agriculture (IUCN and ProAct, 2013e). There are frequent bush fires highlighted by violent winds, creating forage deficits. In addition, high temperatures accelerate the drying of grass. Traditional poultry farming is also heavily affected, as the high heat causes massive mortalities.

Salinisation of water and land is another risk attributed to climate change and change in land cover. Because of low freshwater inputs during periods of drought and deforestation and inland fresh water extraction, salt affected areas have become more frequent and have expanded over the regions and particularly in the lowland and valleys.

Policy context

There are seven main policies that relate to climate change, disaster risk reduction and the mitigation of environmental destruction. Of these the most relevant policies are i) The Emergent Plan for Senegal 2014-2035 which promotes, *inter alia*, prevention and reduction of major disaster risks through the development of contingency plans at national and regional levels, promotion of a culture of disaster risk prevention and management; ii) The plan for national organisation of relief by the 'Organisation de la Réponse de Securité Civile' (ORSEC) of 2013 that facilitates the rapid mobilisation and engagement of exceptional means when public emergency services are overstretched because of the extent of the disaster; and iii) Contribution Nationale Déterminée au Niveau National (2015-2020) which falls within the framework of the Emergent Plan for Senegal, as well as its sectoral management programmes. This plan tracks Senegal's progress on climate change adaptation and mitigation (MoE&SD, 2015b).

EPIC sites in Senegal

The Djilor district is in the department of Foundiougne, Fatick region. It is about 40 km from the sea in the protected area of the Saloum Delta Biosphere Reserve. Extending over an area of 576 km², it has 28,606 inhabitants distributed in 44 villages and eight hamlets (Municipal Council for Djilor, 2009). Six villages within the district — Djilor, Gagué Cherif, Goudème Sidy, Kamatane Bambara, Péthie and Sadioga — totalling about 6,700 people, were selected for EPIC interventions (Figure 18).

Objectives of EPIC in Senegal

The overall goal of EPIC in Senegal was to reinforce local adaptation strategies to climate change.

The specific objectives were to:

- assess the risks and effects of climate change on poor people;
- demonstrate the economic benefits of adaptation strategies based on ecosystems (EbA).

2.5.2 Operational approach in Senegal

Site selection in Senegal was based on i) vulnerability to climate change; ii) richness of biodiversity; iii) commitment of communities and local authorities; and iv) the presence of IUCN Senegal. An inception workshop was held to carry out vulnerability and capacity assessments to identify risks and the Promoting Local Innovations (PLI) tool used to elicit traditional solutions (innovations) to these risks. These innovations were prioritised and scientific research to provide baselines regarding these topics was obtained through partnerships with research institutions — the School of

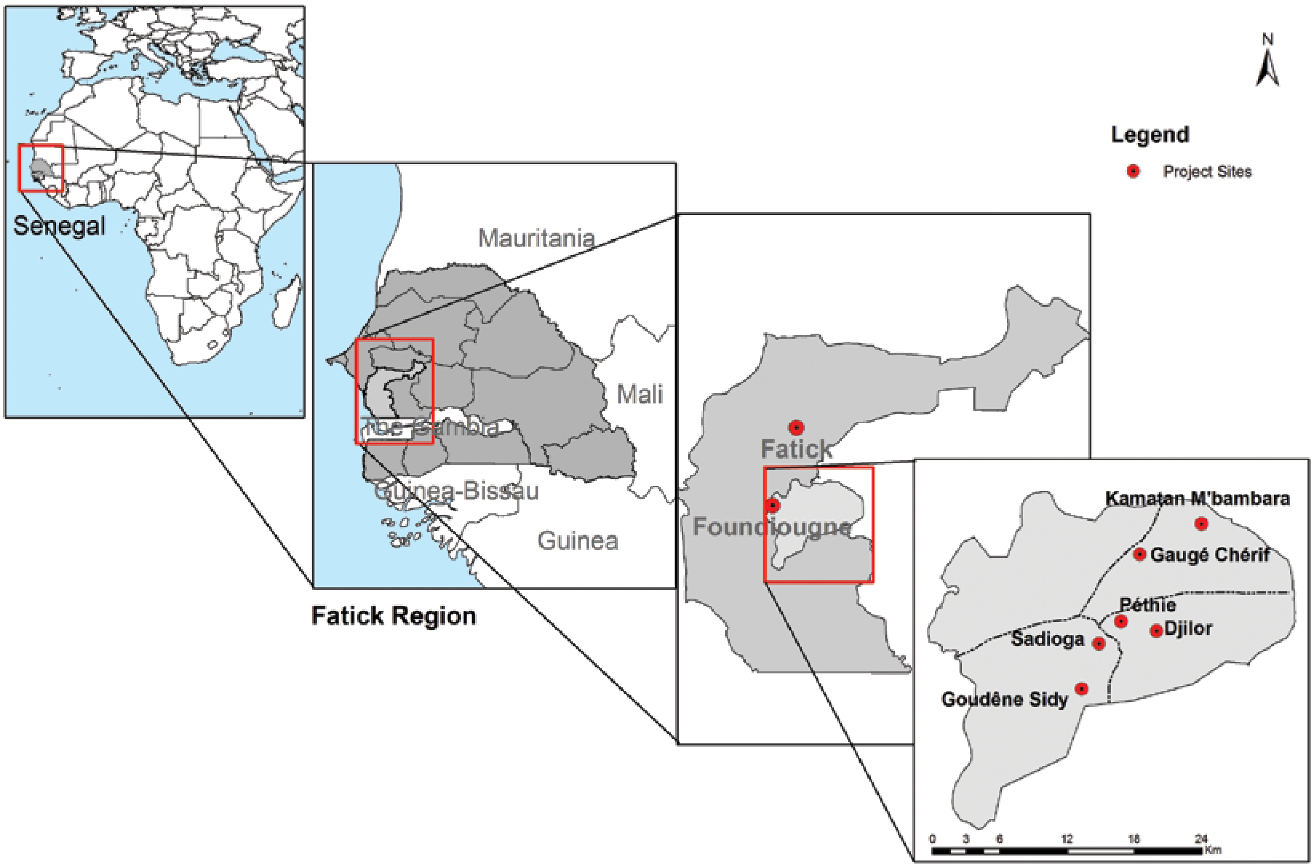


Figure 18. Map of the EPIC site in Senegal

International Agro-development (ISTOM) and the Institute of Environmental Sciences (ISE). Training was provided to community members for successful implementation.

A commission — comprising a range of regional officers from various technical services (the Commission of Prevention and Disaster Risk Management and Humanitarian Affairs) — was established for the prevention and disaster risk management in the department of Foundiougne. This commission served as EPIC's steering committee.

Outcomes of the vulnerability and capacity assessment

The VCA in Senegal used the same method as that implemented in Burkina Faso. It was conducted over four days convening representatives of the concerned communities, government technical officers in charge of rural development, local NGOs and technical partners and IUCN staff. The VCA results indicated that vulnerability factors include drought, floods following heavy rainfall and soil salinisation. These hazards, largely exacerbated by human activities, are of major concern for the socio-economic development of the region. For example, land salinisation, which has reached an unprecedented scale in the area, has significantly reduced the quality of soil and vegetation cover, thus leading to water and wind erosion. One of the direct consequences of this situation is the accentuation of the cereal shortfall with its corollary food insecurity mainly because of the reduction of arable land.

Based on existing vulnerabilities of the region, three innovations were selected based on their relevance, but also in relation to the project objectives:

1. Using the 'Assisted Natural Regeneration' (ANR) for conserving forest resources
2. Construction of 'fascines' or anti-salt bunds with local materials. These are small structures made of bundles of sticks (deadwood) and built into the earth along the contours of a slope to reduce salt intrusion and soil erosion and increase water infiltration (Figure 19)
3. Establishment of a mechanism for regulating the exploitation of natural resources for sustainable use

Actions plans were also developed following the VCA and contained the following information: 1) actors involved and their roles, 2) list of activities for example collection of stones and construction of stone bunds, 3) strategy to be used for example training and exchange visits, 4) timeline and 5) the expected results.

During implementation, additional activities to diversify and improve livelihoods were also included. These include vegetable gardening and establishment and improvement of poultry activities. Exchange visits were also organised with beneficiaries from Burkina Faso. The first exchange visit was conducted in Senegal in 2016 and the second one was conducted in 2017 with community representatives from Senegal visiting the villages of interventions in Burkina Faso.

Baseline scientific studies

In Senegal, the socio-economic vulnerability assessment was complemented with scientific baseline risk assessment in the project area, through the partnership with the School of International Agro-development (ISTOM) and the Institute of Environmental Sciences (ISE). The following studies combined with results from the VCA helped to guide the project implementations:

- Mapping risks of disasters in the Djilor district, analysing climatic hazards in the municipal territory by degree of exposure, intensity and frequency;
- Assessing the impacts of climate risks on the sectors of agriculture, livestock and fisheries, in relation to agricultural production (such as variation of yields, quality, fertility, soil structure, extent of water-induced erosion, extent of

salinisation and crop-specific diseases); as well as economic impacts (such as changes in working time, loss of stocks, price changes);
- Characterising the potential for Assisted Natural Regeneration (such as assessment of floristic composition; frequency of natural regeneration by species; parameters for assessing ANR such as number, abundance, regeneration rate, density per species);
- Characterising soil salinity in the region

Capacity building and awareness-raising on Eco-DRR

Besides the VCA workshop, several training events were organised to strengthen the capacities of communities and government officials to facilitate EPIC implementation as well as to promote scaling up of the approach. These include:

- Eighty-two community members comprising village development committees for the six villages were trained to strengthen their capacities in organisational dynamics, project management and project monitoring.
- Two training sessions covering three modules (ANR, establishing a nursery for salt-tolerant and drought-tolerant species; and the recovery of salinised soils) were conducted and followed by a practical hands-on learning sessions for 90 people (community members, rural council officers, women's groups, youth groups, farmers, fishers and farmers, and government officers from the Department of Water and Forests, the Regional Division for the Environment and Classified Establishments and the Centre for Support to Local Development).
- A training workshop on Eco-DRR was conducted and attended by 40 stakeholders involved in risk management, including civil society, NGOs, international institutions and projects and programmes in the field of climate change as well as local decision-makers including 15 heads of regional services and local elected representatives.
- An exchange visit to Kaffrine, for sharing experiences on and understanding of the economic benefits of ANR was held for five local decision-makers, ten representatives from technical departments and 20 cultivators.
- In addition, six Senegalese cultivators visited the department of Ouahigouya in Burkina Faso to observe and learn from EPIC interventions.
- EPIC Senegal has been showcased on the German television channel DW-TV (Deutsche Welle TV) and at other international for a, such as the World Conservation Congress.

2.5.3 Results and challenges in Senegal

EPIC implementation in Senegal involved multiple stakeholders (Annex 6) to implement the Science-Practice and Policy approach. Research activities in Senegal were mostly conducted at the beginning of the project but contributed to shape the local policy scene. The results of the different baseline scientific studies including mapping of risks in the Djilor district were shared during different workshops which increased awareness on the disaster challenges that the area was facing. This provided incentives and a demand for improved institutional support allowing the project to contribute to the establishment of new local committees for risk reduction. Unfortunately the Senegal case study also lacks strong scientific assessments of its impacts, partly limited by capacity. Another challenge was the lack of constant presence within the area of intervention with IUCN main office being far from the villages. However with close collaboration and strengthening of capacities of both the local government and communities, the project was able to implement strong practice on the ground.

Field interventions

- Nearly half the population of the six villages — about 3,200 people — were involved in EPIC interventions.
- Seventy-six anti-salt bunds or fascines were constructed, benefitting the whole population of about 6,700 people.
- Two nurseries were established in the villages of Gagué Cherif and Péthie and through the EPIC project, 1,766 plants have been produced and planted in degraded lands.
- After practising Assisted Natural Regeneration[5], there are now 7,192 saplings growing in 232 hectares of cultivated land. A training handbook for commencement and maintenance of nurseries to produce seedlings of forest and fruit plants for planting in degraded land, was also produced.
- In the villages of Kamatane Bambara and Péthie reforestation on one hectare each has been commenced.
- One hundred and twenty roosters of the Blue Holland variety (a stronger, better variety) have been introduced as an income-generating livelihood for women, so that they may use this income to purchase gas for cooking instead of collecting fuelwood from forested areas and further degrading them. This has resulted in the production of 450 cross-breeds in two months. The value of these cross-breeds is five times higher than the cost for a local chicken.

Effectiveness of the innovations implemented

Similarly, to the case study from Burkina Faso, it is important to acknowledge that there is a lack of quantitative data on effectiveness for the EPIC villages. Qualitative information through focus groups (6 focus groups; 85 men and 76 women) conducted in 2017 as well as opportunistic observations and collection of information during three field visits in 2016 and 2017, provided anecdotal evidence that the practices implemented were improving soil quality and increasing crop yields. Community testimonies linked assisted natural regeneration and fascines with an increase in amount of land that can be cultivated as well as re-appearance of grasses in degraded land. However, it is difficult to isolate the cause-and-effect relationships and to attribute 'documented' changes with project interventions. Here also, an important barrier is possible mismatch between project set-ups and scientific research needs. Effective scientific monitoring can be implemented over long-term but would require a strong presence on site. One potentially important area of study in the project site is comparisons between fascines

Figure 19. left: Fascine (© IUCN/Ballé Seye); Right: Saplings growing in an ANR field (© Sriyanie Miththapala).

5 Assisted natural regeneration (ANR) is a simple, low-cost land restoration method that can effectively convert degraded lands into more productive areas, by the retention of naturally regenerating seedlings, particularly those of the legume family, that then enhance soil productivity and eventually provide shade and protection to crops (Shono et al., 2007).

and hard infrastructures (concrete dams) that have been previously implemented in the area to address land degradation by comparing for example, their effectiveness in mitigating land degradation and their cost-effectiveness. Discussions with the communities and field visits have highlighted that these concrete dams have been unsuccessful in restoring the land. Indeed, communities in the area have had to abandon traditional rice cultivation due to land degradation despite establishment of the dams in several areas. While it would be easy to generalise that these infrastructures are not as effective as nature-based ones, this context in Senegal provide a very good opportunity for innovative studies that can inform practice. Besides comparative studies, it will be useful to assess the factors that did not work for the concrete dams. Fascines are small structures implemented within villages and even if effective, they probably need to be combined with other structures that address the local issues at landscape level.

Policy influence:

- EPIC in Senegal has provided capacity building, particularly on ecosystem-based adaptation to the local committee (Commission of Prevention and Disaster Risk Management and Humanitarian Affairs) in charge of prevention and disaster risk management in the Fatick region.
- Also at the local level, a Departmental Committee for Prevention and Management of Natural Disaster Risk and Humanitarian Affairs has been established to ensure horizontal linkages among departments and the development of an operational plan, the first of its kind in Senegal.
- At the national level, ecosystem-based approaches for DRR and CCA have been included in the National Wetland Policy (2015), integrating wetland conservation into disaster risk reduction.
- Also at the national level, a national platform to promote ANR has been established as collaboration among IUCN, Word Vision, Environment and Development Action (ENDA) and Innovation Environnement Dévéloppement (IED) Africa.

2.5.4 Lessons learned in Senegal

- Keeping communities at the heart of solutions to adapt to climate change impacts is essential for the success of such programmes.
- The approach of working at grassroots, local and national levels has been very successful in ensuring the creation of awareness about ecosystem-based approaches to adapt to climate change.
- Investing in capacity building and sensitising a range of stakeholders to ecosystem-based approaches to deal with natural hazards and climate change is essential for project success.
- Eco-DRR/CCA projects can be integrated with livelihood development activities which help to provide incentives.
- Exchanges between local actors between countries can be useful learning experiences for different communities ensuring they are active leaders of change in their land.
- Eco-DRR/CCA can be a combination of “natural” and “built” infrastructures. In West Africa, some of the infrastructures built for example to reduce soil erosion and store water, involve the construction of man-made structures such as fascines and stone lines. In contrast to conventional hard engineering solutions, these are constructed using available natural resources such as plant debris, woody materials and stones and thus nature-based. But they illustrate that protection of ecosystems may not exclude built structures and that they can be complementary.
- Research can be leveraged to strengthen local institutional support and provide opportunities for continued actions
- Involving communities in decision-making, project management and implementation, strengthened through capacity building, leads to community ownership.

Thailand

Supranee Kampongsun and Jim Enright

Key Message

Community-based Ecological Mangrove Restoration (CBEMR) is an effective method for successfully restoring abandoned aquaculture ponds back to a healthy, biodiverse mangrove bio-shield, which will help protect communities, infrastructure and agricultural lands from tropical storms and erosion hazards.

Fast facts on Thailand*

Population: 68.86 Million

Main Livelihood: Industry sector (40.5%), Agriculture, forestry and fisheries (38.1%), Services and business (16.9 %)

Gross domestic product based on purchasing-power-parity (PPP) per capita GDP (current international dollar): 17,730.54

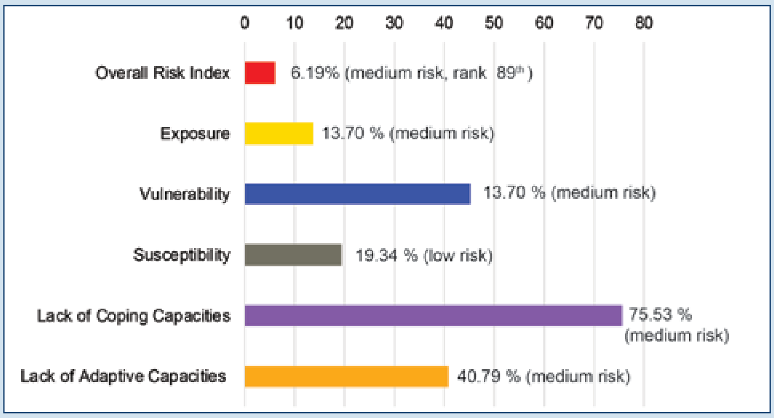
Human Development Index: 0.740 (ranks 87th in the world)

Poverty headcount ratio at national poverty lines: 10.6 %

Main drivers of ecosystem change:

- Destruction and degradation of natural habitats from urbanisation, development projects, conversion to agriculture and over fishing.
- Overexploitation of natural resources (poaching, hunting and wild trafficking)

World Risk Index:



*(Sources: World Bank, 2017; National Statistical Office, 2016; IMF, 2017f; UNDP, 2016; MoE, 2014; United Nations University, 2016)

2.6.1 Background and context in Thailand

Thailand extends over 513,115 km^2 in the northern part of the Malay peninsula of Southeast Asia and is bordered by Myanmar, Laos P.D.R, Cambodia and Malaysia Asia (IUCN and ProAct, 2013f). It has a coastline that stretches for 3,219 km along the Gulf of Thailand and Andaman Sea (IUCN and ProAct, 2013f).

Climate change and disaster risk

During the past 55 years, the average temperature in Thailand has increased significantly (ONEP, 2015). Every decade, average temperature has increased by 0.174°C, which is higher than the average global temperature increase of 0.126°C, for the same period of time (ONEP, 2015). It is predicted that average temperature both during the day and night time will slightly increase, and the number of hot days during the year will also increase, affecting all of Thailand (Setthasirot et al, 2015). This increased temperature is predicted to cause a longer dry season for 2-3 months by the end of the century (ONEP, 2015).

Regional diverging trends in rainfall have been observed, with decreases in central and eastern Thailand, and increases in the northeast, the Gulf of Thailand and the Bangkok metropolitan area (TransRe, 2016). In addition, there have been seasonal shifts in the volume of rain with a significant increase between November and April and a decrease May and October. Climate variability in the form of intense rainfall days is increasing, while rainfall patterns are changing (TransRe, 2016). This rainfall variability has the potential to cause flash floods.

From 1993-2008, the sea level in the Gulf of Thailand has risen about 3-5 mm per year when compared to the global average of 1.7 (±0.5) mm per year (TransRe, 2016).

In addition, the frequency and intensity of extreme weather event has increased. Since 2000, there have been 41 floods (riverine and flash), affecting 35 million people, and costing 42.7 billion USD; 10 storms and cyclones affecting 1 million people and costing 22 million USD; and eight droughts affecting 21.5 million people and costing 3.7 billion USD (CRED, 2017).

Climate change will have overarching impacts on Thailand's agriculture, coastal tourism, and the capital city. "One degree of warming will destroy the rice crops that are central to the economy, and a few centimetres of sea level rise will submerge the capital city and devastate coastal tourism" (Kisner, 2008).

Relevance of Eco-DRR interventions

During the period from 1985-2000, land conversion into shrimp ponds for aquaculture led to massive mangrove deforestation, exacerbating the vulnerability of coastal local populations against natural hazards such as storms surges, strong winds or sea level rise. The coastal landscape of Thailand, as in many other countries in Asia, is blanketed by a jigsaw puzzle of abandoned shrimp ponds in areas of former mangrove forest (Enright, person. comm).

Within the Krabi River Estuary in the southwest of Thailand is Klang Island, which is where EPIC carried out its interventions. This island is only about one metre above sea level and high sea tides that occur annually between October and December have become higher and cause flooding (Raks Thai, 2014). Storms and winds during monsoon seasons adversely affect communities living on this island. Coastal erosion driven by mangrove destruction and water extraction inland is also very detrimental. Since 2003, this erosion has become very severe with one coastal community losing three to four metres of beach every year (Raks Thai, 2014). During the dry season, there are water shortages, and seawater intrusion (Raks Thai, 2014).

There have been many mangrove restoration campaigns following major disasters. However,

in many cases there were high levels of failures, attributed *inter alia* to implementation techniques (Thavanayagam and Thangmuthu, 2014). Therefore, it is important to use scientifically rigorous knowledge to effectively restore mangrove ecosystems that not only act as bio-shields, but also provide multiple economic, social and ecological benefits (Lewis, 2005).

Policy context

The key act for disaster risk reduction is the Disaster Prevention and Mitigation Act of 2007, implemented by the Department for Prevention and Mitigation of National Disasters under the Ministry of Interior as the principal focal point for coordination, policy and planning for disaster prevention and mitigation.

Climate Change Master Plan 2015-2050 focuses on the 6 areas for adaptation and mitigation. It includes 1) Water, flood and drought management, 2) Agriculture and Food security, 3) Tourism, 4) Public Health, 5) Natural resource management, and 6) Settlement and human security. A draft of the National Action Plan on Climate Change 2017-2021 (Phase 1 of implementation) will prioritise agriculture, public health and tourism in the 2017 implementation plan. The principal instruments for adaptation and mitigation in these fields will be implemented by different government agencies; for instance, Ministry of Finance, Ministry of Interior, Ministry of Agriculture and Cooperatives, Ministry of Tourism and Sports, Ministry of Natural Resources and Environment, Ministry of Transport and Ministry of Energy.

The Marine and Coastal Resource Management Act of 2015, implemented by the Department of Marine and Coastal Resource, also promote community engagement in the sustainable management of marine and coastal resource management.

EPIC sites in Thailand

Ban Klongkam (EPIC site one) village is located on Klang Island, and faces the Andaman Sea, approximately 100 metres from the coast (Figure 20). A large part of the community is located close to mangroves and a beach which are low-lying areas that consist of small canals

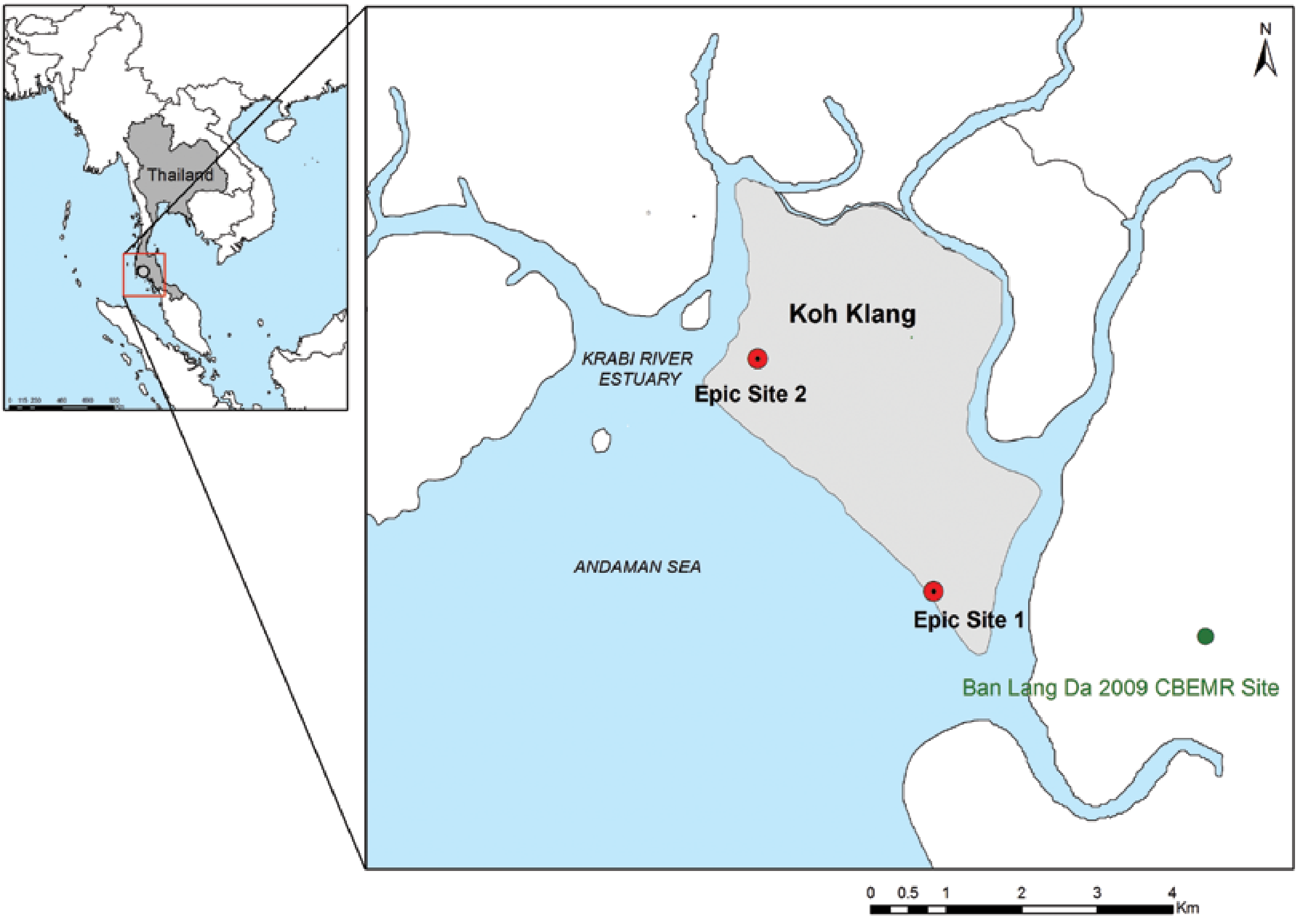


Figure 20. Map of the EPIC site in Thailand

connecting to the community. There are 177 households with a population of 799 people in this village. EPIC site two is Ban Koh Klang is one metre above sea level, and approximately 300 metres the Andaman coast. There are 468 households and a total population of 2,098 in this village.

Shrimp aquaculture — the most important cause of mangrove loss — developed rapidly on the island from the late 1980s to the mid-2000s and then declined.

Objectives of EPIC in Thailand

The overall goal of the EPIC project in Thailand was to use the Community based Ecological Mangrove Restoration (CBEMR) method to restore abandoned aquaculture ponds to productive mangrove habitats, which will aid coastal protection and support resource-based livelihoods, especially fisheries.

The specific objectives were to:

- create two CBEMR demonstration sites for future CBEMR trainings in Thailand and build awareness of the hydrological factors in restoring areas degraded by man- made changes to the hydrology;
- use a multi-stakeholder approach during the entire process involving government, local people, and NGOs;
- empower and build capacity of local communities as central stakeholders in coastal resource management so that they become examples of agents of change in a bottom-up approach to neighbouring communities and hopefully leading to the establishment of a local community network;
- restore the biodiversity of mangrove habitat, which a number of community members depend on as a supplementary livelihood such as producing thatch for income and mud crab collection;

- develop and deliver tailored policy messages for target government agencies; and
- establish a stakeholder dialogue platform, comprised of government, NGOs, civil society established in Thailand, which will use and promote nationally and provide input to the findings of the project.

2.6.2 Operational approach in Thailand

EPIC in Thailand was implemented jointly by the Mangrove Action Project (MAP) and IUCN Thailand, the former carrying on-the-ground interventions and the latter addressing policy issues, respectively.

Under the EPIC project, the Mangrove Action Project (MAP) utilised two abandoned shrimp ponds on Klang Island, in the Krabi River Estuary Ramsar Site as demonstration sites to showcase the Community based Ecological Mangrove Restoration (CBEMR) methodology. CBEMR is a methodology for mangrove restoration which is based on science, using nature as the model for mangrove restoration. It is grounded in the principle that restoring mangroves requires initial restoration of natural ecological processes that once supported healthy mangroves. Thus, CBEMR places a strong emphasis on correcting hydrological problems and dealing with natural or man-made stressors to facilitate natural mangrove regeneration. It reaches beyond the mere planting of seedlings, as is typical of most mangrove restoration projects, and increases the effectiveness of restoration of degraded mangrove forests by embracing and understanding the mangrove ecosystem as a whole, using nature as a model for restoration (MAP 2017). CBEMR is also a participatory, community-led process that involves communities from the planning stage through to implementation, empowerment, ownership and monitoring.

A local EPIC Advisory Committee (of 11 members) was established and met for half a day on average three times per year. This committee comprised government officers from district and provincial level; officers of the local mangrove management unit and regional office from the Department of Marine and Coastal Resources (DMCR); community representatives and NGOs. The role of the committee was to keep stakeholders informed of project progress, provide feedback and solutions as needed, as well as to disseminate information on CBEMR.

Policy advocacy was conducted through discussions and awareness workshops.

Vulnerability and capacity assessment

In Thailand, the VCA analysis was conducted based on a manual developed by CARE International on community's climate change adaptation framework. This framework comprised a set of questions for the data analysis for local organisations and at the community level. The data derived were qualitative data, which later used to analyse, compile, and write the conclusions. The overall process followed these guidelines. The study also gathered background information on future trends in climate change and risks within the project site based on a previous study conducted by Southeast Asia START Regional Center (SEA START RC).

Science and monitoring

Two systems of monitoring were used to monitor the restoration sites: 1) Quadrat analysis and 2) time-lapse photography. Nine fixed quadrats measuring 3m X 3m were established on each site and monitored regularly with data collection on mangrove species, height and health condition percent of ground cover, and number of crab holes plus any other observations, especially hydrology, and volunteer seedlings appearing on site. Time-lapse photography were taken every three months and proved to be a simple, cost-effective method of monitoring regeneration.

Although not directly supported by EPIC, one post-doctoral student, two PhD students and three master's degree students, used the EPIC sites to collect data for their research. A third PhD student will commence work soon. The work of the post-doctoral students has been published in two peer-reviewed journals/book. One of these students has developed a multiple linear regression model to predict levels of biomass and carbon in mangrove ecosystems. Once published, this research may provide an inexpensive and reliable way of estimating carbon stock in mangroves.

Capacity building and awareness-raising on Eco-DRR

Several training events were organised to strengthen the capacities of communities and government officials to facilitate EPIC implementation as well as to promote scaling up of the approach. These include:

- Two CBEMR training workshops and a study tour were carried out to build local capacity on mangrove restoration for 57 participants from local communities and local government. Many of these members are now part of the CBEMR community network organised by MAP. The network has three main objectives: to build capacity on CBEMR; transfer CBEMR knowledge to other communities through meetings, workshops, study tours and trainings; and to have CBEMR spokespersons and supporters who will communicate with the DMCR, as a mechanism to help change their approach to mangrove restoration. Community members involved in these trainings now understand the CBEMR method, know how to implement it, and are aware of the approach's strengths and weaknesses.
- As much as the positive impacts of CBEMR were promoted, the EPIC project also served to raise awareness of the negative impacts (both biological and socioeconomic) of mangrove monocultures to a very wide range of people.
- Two training workshops for both local people and local authorities in Krabi introducing Eco-DRR was held for 80 participants.
- In total, there were five local workshops held with 176 participants.
- Nationally, there were three workshops held with a total of 198 participants.
- EPIC results have been disseminated widely within Thailand and also at 16 international conferences. In addition, a blog, handbooks, flyers on CBEMR and videos have been produced and disseminated.

2.6.3 Results and challenges in Thailand

EPIC implementation in Thailand involved multiple stakeholders (Annex 7) to implement the Science-Practice and Policy approach. The participatory approach used from the beginning of the project and during implementation helped to ensure the inclusion local knowledge. In terms of challenges, mangrove restoration activities were slowed down by free grazing goats in the second EPIC site. Different types of fencing methods had to be tested depending on their effectiveness to protect the mangrove seedlings. An attempt to incorporate silvofisheries into the CBEMR sites also proved be unsuccessful due to difficulty to control the high energy tidal conditions at the sites such that it is suitable for both mangrove restoration and silvofisheries.

Field interventions

- Two mangrove demonstration sites, totalling two hectares have been established successfully using the CBEMR method, and involving 25 community members in physical work. This process included developing a baseline report of location and stakeholders; consultation with communities; surveying and selecting two abandoned ponds; negotiating with holders of ponds to secure their consent to proceed with restoration; carrying out climate vulnerability and capacity of communities; collecting baseline biophysical data of the sites; developing

Figure 21. Top: EPIC Site # 1 in June 2015; Bottom: the same site in August 2017 (© MAP)

and implementing mangrove restoration with hydrological plans, using hand-digging and a backhoe to restore hydrology; monitoring the sites with fixed quadrats to assess the diversity of flora and fauna as well as using time-lapse photos (Figure 21)

- The CBEMR method has restored mangrove species biodiversity to the restoration sites. One the main goals of CBEMR is to bring back the full range of mangrove species diversity which existed previously on the site. Most mangrove restoration projects plant even-aged monoculture plantations, often in areas not suitable for mangroves. CBEMR ensures that each species will be in the correct zone as determined by nature. There are now eight mangrove species in the EPIC sites, as well as fauna such as mud crabs and fish.
- Raks Thai Foundation (CARE Thailand) has commenced implementation of CBEMR principles at their restoration sites on Klang Island in Klong Prasong village and Klong Yang village in Krabi. Raks Thai learned about CBEMR from the training carried out under the EPIC project and from its field projects and is now implementing its elements.
- Even though the EPIC sites are in their early stages of natural recovery already 580 people have from 25 countries have visited these sites to learn about the CBEMR process, including local government

officials, DMCR officers from Bangkok, study groups, students, master's degree and, PhD researchers, media personnel, MAP Interns, and hundreds of international volunteers.
- Local communities have provided traditional knowledge to trap seeds in the demonstration sites. Namely salt tolerant grasses were found to provide not only a physical trap for seeds but may also act as nurseries protecting and shading mangrove seedlings. In areas of barren soil, local communities have also recommended that brush piles be staked down on the pond bottom and used to trap seeds.

Policy influence
- IUCN established a working group consisting of local NGOs, MAP, DMCR and IUCN to work together on for policy of marine and coastal resource management and the Marine and Coastal Resource management Act 2015. Now, the working group is focusing sustainable marine and coastal management and promotion of Eco-DRR in Thailand as a methodology that will contribute to the SDGs.
- A policy brief has been prepared and disseminated to 100 key stakeholders.
- The Eco-DRR approach, as well as the CBEMR approach, has been introduced to different stakeholders — communities, government officers at the local and national levels; the provincial, regional and national officers of the DMCR at various fora.
- IUCN and DMCR have established a formal collaboration platform (through a MoU) for marine and coastal resource management.
- A collaborative work plan under this platform is being prepared for the establishment of a CBEMR demonstration site, which is currently halted because the position of the Director of the Mangrove Resource Conservation Office is vacant.
- Land tenure is the single largest barrier to restoring abandoned shrimp ponds in Thailand, and must be solved for larger scale restoration to occur. The project has also raised awareness about the complex land tenure issues in Thailand, which must be first resolved before many of the abandoned prawn farm areas in Thailand can be restored.

2.6.4 Lessons learned in Thailand
- Creation of awareness about CBEMR, and through it Eco-DRR, to Thai society was a major achievement, as these approaches are new compared to other kinds of climate change related approaches such as mitigation and adaptation.
- Implementing hydrological restoration in the field with local people was an effective way to transfer CBEMR knowledge. The hydrological correction field work involved much hand-digging following the excavation by the backhoe digger over a period of many months, usually for a period of 1-2 days per month. This allowed many community members to join in the work and learn, hands-on, about CBEMR. Community members learn best from hands-on experience, observing and implementing. Such field work also helps build interest.
- The local EPIC Project Advisory Committee was a very important instrument to support project implementation and it helped not only in providing solutions to problems and feedback, but its members became ambassadors of the CBEMR approach.
- Incorporating silvofisheries and CBEMR is unsuccessful. A deep outer channel was excavated by backhoe around the entire perimeter of the restoration so that fauna could enter the pond but not leave. Approximately, a half meter of water remained in these deeper channels during the low tide period. Controlling the high tidal energy of the semi-diurnal tides (with a tidal range of up to three metres) was not possible even though several types of sluice gates were used. In addition, water did not drain sufficiently from the pond, so that the site remained too wet for too long.

To combine aquaculture with mangrove restoration on a multi-pond site, it would be best to undertake aquaculture in one pond where water can be controlled, and restore mangroves in the other ponds.

- Involvement of research institutions should be prioritised to provide socioeconomic valuation of mangroves restored by CBEMR. Such solid evidence is essential so that the cost effectiveness of the methodology can be presented to DMCR and other related agencies.
- The Department of Disaster Prevention and Mitigation should have been included for policy discussions, instead of focussing only on the DMCR. This is a missed opportunity for the introduction of Eco-DRR into a key government agency.
- CBEMR should be used as a means of introducing the larger approach of Eco-DRR. In EPIC Thailand, this could have been better reinforced.

© IUCN/Fabiola Monty

Chapter 3

Lessons learned from EPIC

Camille Buyck, Fabiola Monty and Radhika Murti

3.1 EPIC achievements and ingredients of success

All EPIC case studies used the same Science-Practice-Policy operational framework to guide the implementation of activities. However, there were different levels of success across the six case studies with great variations in the extent and type of science-based knowledge generated, field-based interventions and policy influence results. This unevenness in success was largely shaped by the different local and national contexts and engagement as well as the partners involved in each case study. But as a pilot project, EPIC provides important learning opportunities for replication as well as scaling up. Overall, through engagement with a diverse range of stakeholders, the project has been very successful in increasing awareness of the importance of ecosystem-based approaches for disaster risk reduction and in influencing policy (Miththapala, 2017). Also for each case study, there was at least one aspect (science, practice and policy) that was very successful. This provides a unique opportunity for comparisons and to assess the key ingredients of success.

3.1.1 Building resilience and reducing vulnerability

It is generally acknowledged that healthy and bio-diverse ecosystems provide a range of goods and services including food, timber and non-timber products, water, fresh air, and protection against natural hazards. In Nepal, Thailand, Burkina Faso and Senegal, the field-based interventions included efforts to build community resilience. In Burkina Faso and Senegal, the implementation of locally-adapted techniques (such as stone bunds, zaï, anti-salt bunds and assisted natural regeneration) can contribute to better soil condition for cultivation and improved water availability. In Thailand, it is reported through the monitoring activities that restored ponds are bringing crab species back that are used for food consumption. In Nepal, people are able to sell grass used for bio-engineering as a source of income, and their access to markets has been improved thanks to better road conditions.

Ingredients of success

- Participatory approach and giving a voice to local people
- Integrating livelihood improvement strategies with Eco-DRR/EbA interventions
- Adaptive management to incorporate learning and community interests
- Developing and/or building on existing local partnerships
- Exchange visits between communities

3.1.2 Mitigation of hazards and impacts of climate change

The activities implemented in the EPIC sites were informed by vulnerability assessments as well as desk-based review of existing information on impacts of climate change. They are thus relevant to the local challenges in terms of disaster and climate change. Research conducted in Nepal, China and Chile provides evidence that the approaches used and ecosystems can be effective in providing physical protection from hazards. For example, in the case of Nepal, planted grasses effectively allow the control of gully erosion and landslides, and actions have been taken to prevent the pilot sites being affected by drought and floods (through the use of drought-resistant species and the establishment of a drainage system). It is worth noting that in Thailand, priority is given to site restoration and demonstration of the CBEMR technique to policy makers, while the effectiveness of restored sites in terms of disaster protection could be assessed in the future when the mangrove will be fully developed.

Ingredients of success

- Vulnerability and capacity assessment (VCA)
- Participatory approach and responding to communities' immediate worries

- Integration of VCA with existing information on climate change impacts
- Involvement of research partners

3.1.3 Generating science-based knowledge

In each EPIC country, IUCN has partnered with a research institute or university in charge of documenting the approach or techniques being implemented. As a consequence, EPIC has generated several studies that help to enhance the knowledge base on Eco-DRR, particularly when it comes to the role of vegetation in reducing risks of landslides and avalanches and provides opportunities for more actions on the ground. For example, INRA has generated a database of suitable species for slope stabilisation, aiming at informing future bio-engineering work in China. Similarly, a manual on community-based bio-engineering for eco-safe roadsides has been produced in Nepal. In Chile, SLF has mapped risky areas and has investigated the protective role of forests against snow avalanches. In Burkina Faso and Senegal, the impact of climate change on local livelihoods has been assessed.

Ingredients of success

- Early and constant collaboration with research institutions
- Building on existing relationships with local networks and institutions

3.1.4 Building capacities of local people

In all countries, workshops have been organised so as to raise awareness of local stakeholders on climate change and disaster risks in their area, as well as on ecosystem-based approaches to respond to those risks. Except in China and Chile where EPIC doesn't interact directly with a community, capacity-building workshops have been organised regularly to train local people on specific techniques such as CBEMR in Thailand, bio-engineering in Nepal, and agricultural practices, including nurseries development, in Burkina Faso and Senegal. These training events are key to ensure communities' ownership of the activities. In addition, the participatory approach undertaken for instance in West Africa allows communities' to build capacities on activity planning and appraisal.

Ingredients of success

- Inclusive approach and community involvement
- Including peer-to-peer learning opportunities between local people

3.1.5 Strengthening institutional capacities

Through various meetings and workshops held at local and national levels as well as field visits, EPIC effectively raised awareness on Eco-DRR issues and approaches; through concrete examples from the pilot sites, policy makers were able to understand Eco-DRR principles and to appreciate that ecosystem-based approaches also constitute solutions for risk reduction and climate change adaptation. In this regard, it is important to bring together relevant stakeholders, for instance local conservation officers and development officers. For example, in Nepal, where bio-engineering was already included on the policy agenda, it was critical to build capacities and to show how it could be implemented at local level, and how effective it was for coping with landslide risks. Organising workshops including field visits to the sites is an effective way to raise awareness and to demonstrate that Eco-DRR is a relevant and cost-effective approach to deal with natural hazards.

Ingredients of success

- Awareness-raising
- Organising frequent events including workshops and field visits to increase capacity
- Producing and distributing knowledge of products

3.1.6 Policy influence

In some countries, EPIC is being taken as a model and there is growing interest to integrate Eco-DRR in national policies. As highlighted in the different case studies, there are different emerging entry-points following EPIC's work. For example, in Thailand, a MoE has been signed between IUCN and the Department of Marine and Coastal Resources (DMCR), and a joint action plan is under development for developing mangroves conservation work for climate change adaptation in Thailand. In Senegal, EPIC's work has led to the establishment of a departmental commission on risk prevention and management thanks to efforts through the project. An action plan will be developed for strengthening the work on Eco-DRR in the area.

Ingredients of success

- Multi-stakeholder engagement
- Working at different levels from local to global level
- Linking capacity building with policy advocacy
- Awareness-raising activities
- Seeking information on upcoming policy reviews

3.2 Towards the effective implementation of Eco-DRR/CCA: lessons learned and recommendations

EPIC's experience demonstrates that effective Eco-DRR/CCA implementation requires working on three main aspects, namely science, policy and practice, so as to 1) make Eco-DRR activities sustainable; 2) document evidences; and 3) make the case for Eco-DRR. The interactions between science, policy and practice are multiple and can work in different ways. As showcased by EPIC, Eco-DRR/CCA can work from the local to global level by collating science, applying science and informing with best practices for policy change or strengthening. This can be done in different ways, including:

- through establishing sound policies based on credible science that drive informed practices (science>policy>practice);
- through applying science as new approaches (practices) to influence policies (science>practice>policy);
- through using good practices to influence policy change and establish resources to address research gaps (practices>policy>science).

In EPIC, a bottom-up approach was adopted, where local activities were implemented and documented so as inform policies and drive opportunities for scaling up. Policy was influenced from local to national levels through the multi-stakeholder engagements, which guided the project's implementation as well as strategic policy advocacy. It is important to highlight that there are several discussions on how to take the Eco-DRR/CCA agenda forward and the challenges that need to be addressed (Box 3.1).

Lessons learned from EPIC's achievements and challenges provide important contributions to further inform the field of practice as well as efforts to integrate Eco-DRR and EbA. Before looking at lessons learned and recommendations to successfully implement science, practice and policy influence respectively, it is important to note that unevenness in how these three aspects were implemented across the case studies indicates potential trade-offs particularly between practice and science. This is particularly relevant for all the case studies except Nepal. In the other five case studies, there has indeed been either strong science, for example Chile and China, or strong practices, for example Burkina Faso, Senegal and Thailand. One common factor among the case studies that showed strong science is that a research institution was a main partner (See Table 3) and was involved from the very beginning as the project was being developed at global level. Case studies that showed strong practice also shared common factors that could explain the success including previous experience working with community-

Box 3.1 Eco-DRR/CCA: emerging issues and challenges for scaling up

The increased acknowledgement of the linkages between ecosystems and disasters and the increased recognition of the importance of ecosystem management in risk reduction still remain to be translated into large-scale actions. Recent and on-going progress at the science and policy level already provides the right enabling factors to advance Eco-DRR.

Indeed Eco-DRR has been increasingly promoted in the scientific literature. A recent review of recent advances for coastal, riverine and mountain ecosystems reveals a growing interest in the concept by the scientific and practitioner community (Renaud et al., 2016). The EPIC case studies surely build on such literature, particularly showcasing the importance of vegetation in mitigating the impacts of avalanches and landslides. The China case studies also highlight the importance of plant diversity and traits in restoration efforts to mitigate hazard risks. Yet there still remain several knowledge gaps that need to be addressed, for example there is a lack of knowledge: on the role of ecosystems in mitigating slow-onset hazards (Renaud et al., 2016) and on ecosystem threshold levels to various hazards (Estrella and Saalismaa, 2013). The case study from Nepal also provides a good example of the economic benefits of Eco-DRR, particularly over time. However, demonstrating the economic benefits of ecosystem-based approaches is difficult and as they are important tools to influence policy, they often need to be site-specific or at least geographically relevant.

In terms of scaling up, several barriers need to be addressed if we are to move towards the implementation of the key global policies recently adopted. The 2017 Global Platform for Disaster Risk Reduction held in Mexico was focused on translating the Sendai commitments into concrete action for risk reduction. Discussions during several sessions on ecosystem management at the event were geared towards a better understanding of why ecosystem-based approaches are not yet fully adopted and integrated in disaster risk reduction. Some of the main challenges highlighted by participants were the following:

- Nature-based solutions are not easily seen as a solution and there is a perceived uncertainty about their value
- Ecosystem-based approaches need patience and the benefits takes time to manifest
- There is a lack of practical knowledge and information on the subject
- There is a lack of capacity
- There is a need for solutions that are accepted by communities and that demonstrate clear benefits

Estrella et al. (2016) also identified the “lack of standardised, technical guidelines for designing and using ecosystem-based measures for disaster and climate risk reduction” as a key barrier to the uptake of Eco-DRR.

Taking Eco-DRR/CCA forward will require that the lessons learned from pilot projects are compiled and that the good examples are made more visible and accessible to different stakeholders. It is also important that these lessons learned contribute to build trust and confidence in Eco-DRR/CCA solutions and start to guide the implementation process of such initiatives, particularly for those that are still not familiar with the approach.

based approaches, building on existing good relationships with local stakeholders and a strong overlap between local demand and the project's activities.

3.2.1 Lessons learned and recommendations for effective Eco-DRR/CCA science: documenting effectiveness

Science has a key role to play in documenting Eco-DRR/CCA evidence, either as leverage points to influence policy as showcased in some of the case studies, particularly Nepal, or to inform evidence-based field interventions. It is therefore important to set up the basics for strong science from the early stages in an initiative, and to also engage with the scientific community to create interest in contributing to knowledge creation on scientific evidence and good practices.

Recommendations

- Identify scientific needs of an initiative from the project design phase and engage early on with different scientific partners or groups of scientists that can support the development and implementation of the planned scientific studies including baselines.
- Encourage research thesis topics on Eco-DRR/CCA by using Eco-DRR projects for research and partnering with research institutes for resources mobilisation. In EPIC, this strategy allowed to partner with various research institutes and universities that were able to document the effectiveness of the approach and/or to give recommendations for Eco-DRR implementation.
- Gather knowledge and experience with multiple actors and at different levels; this could be done through organising field visits, participating in scientific conferences and policy meetings, publishing scientific results and translating them into recommendations for practitioners or policy-makers.

3.2.2 Lessons learned and recommendations for effective Eco-DRR/CCA practice: making our actions sustainable

An important component of Eco-DRR/CCA initiatives is their participatory nature. To ensure community mobilisation, adoption of and interest to continue the field-based interventions, these need to be relevant for the local communities. It is also important to empower local people through capacity building and to engage them in project design, implementation and monitoring.

Recommendations:

- Adopt a participatory approach by involving all relevant stakeholders from the start of the project, and by involving them in the design of the activities (through consultation meetings or Vulnerability and Capacity Assessment workshops, for instance).
- Create and maintain ownership of the project by giving clear roles and responsibilities to community members and local partners, including monitoring of the activities. This can be done, for instance, through partnerships with local partners active in the area, or through the establishment of community-led monitoring social institutions.
- Take any opportunities to invite local people to participate in relevant meetings at national, regional or global level, so as to give them a voice and allow them to give their testimony on the project.

When designing the activities, seek traditional practices that may have been abandoned or need to be replicated or scaled up. Communities are often willing to apply their own knowledge for designing activities. It is also a good opportunity to (re)discover practices that would otherwise be lost, and to promote them.

3.2.3 Lessons learned and recommendations for effective Eco-DRR/CCA policy influence: making the case for Eco-DRR/CCA

Making the case for ecosystem-based approaches is probably the most important aspect to scale-up such work. They do not only need to be mainstreamed into different policies but also into different sectors. In the case of EPIC, there are lessons learned mainly with regards to mainstreaming ecosystem-based approaches into different policies including disaster risk reduction and climate change adaptation. Constant engagements through several meetings and training events with local and national policy-makers have been instrumental to influence policy. These close collaborations and exchanges during workshops and field visits can also facilitate policy influence even when the field-based interventions take time to manifest as showcased by the case study in Thailand.

Recommendations

- Involve different policy sectors and ministries early in the project, so as to raise awareness of Eco-DRR/CCA and planned activities. Encourage cross-sectorial dialogues through the organisation of round table discussions or workshops.
- Make the case for Eco-DRR/CCA by using scientific data and evidences on the effectiveness of the approach; make recommendations for future implementation of Eco-DRR/CCA in the country, based on research outputs. This can be done through the development of policy briefs, or through the organisation of meetings and field visits.
- Build capacities on Eco-DRR/CCA through joint capacity development amongst policy actors such as Protected Area managers, disaster management planners and agencies for CCA.
- Act at multiple levels (from local to global) for promoting Eco-DRR/CCA, because each level of governance has its own mandates and responsibilities. For instance, it is strategic to seek for local governments' support in the field, which can then be used for advocating at national and global levels.

3.3 Towards the integration of Eco-DRR and EbA

Throughout this publication, the term Eco-DRR/CCA has been used to describe EPIC as it aims to address both disaster risk reduction and climate change adaptation. An important initial point of convergence in the EPIC case study is the integration of hazard and climate change vulnerability assessment. A combination of desk-based review on disaster and climate change challenges with socio-economic vulnerability assessment helped to inform the project on short-term disaster challenges as well as long-term climate change challenges.

The CBD COP 13 saw an important achievement with the adoption of the decision XIII/4 on Biodiversity and climate change. For the first time linkages between EbA and Eco-DRR were included in a CBD decision. This recent policy development mirrors the increased coherence in different global policies. It is thus particularly timely to go beyond informing Eco-DRR and EbA separately and to link scaled-up actions with integration.

Given such cross-cutting issues, integrated approaches provide the opportunities to bring multiple sectors together and to tap into different types of resources and financing mechanisms. Furthermore, ecosystem-based approaches can provide multiple co-benefits and if well designed and involving the right stakeholders, Eco-DRR/CCA initiatives have the potential to go beyond disaster risk reduction and climate change adaption.

The EPIC case studies from the previous chapter and lessons from EPIC as discussed in earlier sections provide guidance on the operational approach for Eco-DRR/CCA projects. However, there are also some gaps and opportunities for improvement and to add value to such initiatives:

- Assessment of ecosystem services: in the case of EPIC, besides information collected during the VCA, there was no detailed assessment of ecosystem services at early stages of the project. If conducted at landscape level, such assessments can pinpoint where ecosystem-based approaches are relevant. For example, ecosystems that provide important ecosystem services for risk reduction and climate change adaptation can be targeted.
- Assessment of ecosystem trends and health: this is linked to the point discussed above. EPIC was mostly focused on social vulnerability assessment, particularly for those case studies that had strong practice. While ecosystem services assessment can pinpoint ecosystems of interest, it is also important to understand the state of these ecosystems, their health, factors contributing to degradation and trends in land-use change. This will in turn help to inform the type of actions needed to protect important ecosystems.
- Climate proofing: To ensure that ecosystem-based approaches are effective, it is important to assess their potential limits and how field interventions can be affected by hazards and climate change. Such assessments can be integrated with the ecosystem assessment above. Citizen science may be useful to gather historical data on the impacts of hazards on ecosystems and combined with modelling techniques to determine threshold levels for different ecosystem health. Climate change scenarios and modelling ecosystem responses can be used to assess how the ecosystems of interest will be affected by climate change.
- Ecosystem-based mitigation: At the global policy scene, there are not only calls for the integration of Eco-DRR and EbA but also ecosystem-based mitigation. The latter can no doubt be a co-benefit of Eco-DRR/CCA approaches, particularly when it comes to protection and restoration of ecosystems. Forests, for example, are known to be important carbon stocks. Recently there has been increased interest in the role of mangrove forests as carbon sinks. For example, a recent review of scientific evidence on the role of marine ecosystems and its components as viable long-term carbon sinks found that “Coastal blue carbon ecosystems (mangroves, tidal marshes, and seagrasses) represent important climate mitigation opportunities” (Howard et al., 2017) with high rates of carbon sequestration particularly in the soils. Though not part of the EPIC case study in Thailand, the projects sites were used for a study to assess carbon stocks. However, the results were not available at the time that this publication was being produced. Integrating carbon stock monitoring with Eco-DRR/CCA can show the added value of these projects as a tool to implement multiple policy commitments.

Chapter 4

To conclude and align the lessons learned from EPIC with the current demand for coherent actions and technical guidance, this chapter builds on existing guidelines for EbA implementation and informed by the experience of EPIC, proposes the first guidance to implement integrated Eco-DRR and EbA initiatives.

Fabiola Monty, Radhika Murti and Camille Buyck

There are multiple case studies published in the literature, which includes lessons and recommendations to inform development of Eco-DRR initiatives, but currently, there are no specific step-by-step guidelines on how to implement such initiatives or hybrid ones. In an effort to move one step further, a step-by-step guide (Figure 22) to implement Eco-DRR/CCA is proposed, which integrates lessons from EPIC with existing guidelines on EbA, namely: 1) the EbA framework developed by FEBA, 2) Principles and Guidelines for Integrating Ecosystem-based Approaches to Adaptation in Project and Policy Design (Andrade et al., 2012), 3) a guide for setting up an EbA intervention developed by IUCN Netherlands (Jiménez Hernández, 2016), and 4) the proposed integration points at project level by Doswald and Estrella (2015).

The current guidance is meant to guide project set-up in a specific country. The latter may be chosen based on existing demands or partnerships. It is expected: 1) that this guidance will remain flexible and can be adapted to different scales of focus and the local context, 2) some of the initial steps may not be needed depending on existing information and preliminary work conducted, 3) some steps may be merged together particularly the first and second steps and 4) that some steps can or need to be implemented simultaneously.

Figure 22. Proposed steps to implement Eco-DRR/CCA initiatives

STEP 1 Exploring opportunities for Eco-DRR/CCA

Goal

To determine Eco-DRR/CCA opportunities and needs within the country under consideration

Approach

- Multi-stakeholder survey
- Multi-stakeholder meetings and/or workshops
- Desk-based literature review including policy analysis, disaster risk profiling and synthesis of existing climate change vulnerability studies

Successful factors checklist

- Use of both disaster and climate information
- Build on existing relationships with local, national and global networks and institutions to maximise data collection as well as to explore potential new partnerships for the new project
- Use this step to start engagement with policy-makers of interest
- Integrating this step with a capacity building workshop can facilitate future multi-stakeholder involvement and also provide incentives for engagement

Outcomes:

- Identification of policy entry points for Eco-DRR/CCA
- Understanding of institutional set-up for conservation, disaster risk reduction and climate change adaptation
- Overview of national government future priorities in terms of DRR and CCA
- Overview of priority disaster and climate change challenges
- Overview of possible drivers of vulnerability
- Overview of activities of key institutions and organisations and experiences with ecosystem-based measures
- Understanding of existing gaps and needs in terms of Eco-DRR/CCA
- Understanding of barriers to the implementations of Eco-DRR/CCA

STEP 2 Understanding the geographical context and defining project goals

Goal

To identify target sites, provide an understanding of the local context and defining project goals

Approach

- Define and gather multi-disciplinary teams and group of partners
- Identify potential target sites within the country
- Multi-stakeholder surveys and/or discussions (meetings/ workshops)

Outcomes:

- Project team defined
- Local stakeholder overview with information on actors that have influence on land use change, actors that are changing land uses
- Qualitative land use analysis at the targeted sites including information on key ecosystems
- Project scope and goals defined including expected co-benefits in terms of biodiversity conservation and climate mitigation
- Establish adequate partnerships to support delivery of project's goal
- Development of a preliminary theory of change

Successful factors checklist

- Project goals need to be relevant for the targeted site
- Selection of appropriate geographical scale for project intervention
- Integrate local knowledge to ensure project relevance
- Add value to the project by integrating potential co-benefits of Eco-DRR/CCA projects, for example conservation, mitigation and livelihood development into the project core
- The expertise and multi-disciplinary team gathered need to match the project goals
- Seek information on upcoming policy reviews (local and national) that can be targeted

STEP 3 Ecosystem services appraisal and ecosystem assessment

Goal

To document ecosystem services at the target sites and their relevance for risk reduction and climate change adaptation; to assess state of key ecosystems of interest and trends

Approach

- Field-based ecosystem services assessment
- Ecosystem assessment

** See Table 9 (page 81) for potential tools*

Outcomes:

- Site-based documentation and/or mapping of key ecosystems and services contributing to resilience
- Understanding of how these key ecosystems are changing with respect to environmental and social changes
- Identification of research gaps and elements that require monitoring during the project

Successful factors checklist

- Integration of science-based, local and traditional knowledge
- Early and close collaboration with research institutions

STEP 4 Integrated vulnerability assessment

Goal

To conduct localised social vulnerability assessments

Approach

- Participatory workshop and rural appraisals

** See table 10 (page 82) for potential tools*

Outcomes:

- Social vulnerability assessment with regards to disasters and climate change
- Analysis of local coping strategies and adaptive capacities
- Identification and prioritisation of local innovations

Successful factors checklist

- Participatory approach and integration of traditional knowledge
- Involvement of different partners besides communities: for example government technical officers, local NGOs, local research institutions
- Account for all drivers and hazards

STEP 5 Develop strategy and ecosystem-based measures

Goal

To build the Eco-DRR/CCA strategy, defining priorities and design ecosystem-based measures

Outcomes:
- Theory of change created
- Clearly defined project strategy
- Local action plan developed
- Identification of research needs to develop a robust project baseline and to document effectiveness of ecosystem-based measures proposed

Approach

- Integrate results from steps 3 and 4 and, along with multidisciplinary team, define priorities: which ecosystems (and services) are to be managed to (1) reduce vulnerability, (2) mitigate the impacts of disasters and (3) increase future adaptive capacity
- Propose a set of ecosystem-based measures including local innovations identified in step 4
- Update theory of change and develop a set of indicators for monitoring
- Share and validate the strategy with multiple stakeholders
- Development and validation of local action plan (covering a specific time frame, for example one year) to implement strategy

Successful factors checklist

- Include trade-off analysis of ecosystem-based options
- Ensure ecosystem-based options are climate smart and climate proof
- Ensure that the strategy is fed by local knowledge
- Integrate FEBA's qualification criteria and standards in the project strategy and theory of change (Table 11)
- Articulate how ecosystem-based measures can help to achieve DRR and CCA
- Participatory development and validation of local action plan
- Prioritise measures that provide multiple benefits and that also have positive effects for different sectors
- Address more than one sector to promote synergies and provide opportunities to mainstream Eco-DRR/ CCA into other practices, strategies and policies
- Identify opportunities to integrate the private sector
- Include policy targets (local, national and global) and strategies to be used to achieve these

STEP 6 Implementation

Goal

To effectively implement the developed strategy and local action plans

Outcomes:
- Database of baseline indicators
- Ecosystem-based measures implemented
- Science-based knowledge generated
- Strengthening of local capacities
- Policy influence

Approach

- Before any field-based interventions, and based on the theory of change, choose adequate indicators and set up a qualitative and quantitative baseline *
- Simultaneous implementation of Science-Practice-Policy operational framework
- Action plans evaluated and updated at pre-determined intervals through participatory workshops

*This is linked to step 7 on monitoring and evaluation

Successful factors checklist

- Provision of materials to local communities for project implementation
- Capacity building of different actors
- Support equitable governance
- Integrate livelihood improvement strategies with Eco-DRR/CCA interventions
- Ensure adaptive management and support “learning-by-doing”
- Strong and constant collaboration with research institutions
- Multi-stakeholder engagement
- Working at different levels from local to global level
- Linking capacity building with policy advocacy
- Inclusive approach and community involvement
- Promote south to south learning and exchanges between local people
- Include mechanisms to ensure sustainability of interventions even after project closure: for example development of community groups and local committees and strategies to generate local funding

STEP 7 Monitoring and evaluation

Goal

To set up a monitoring and evaluation system (M&E)

Outcomes:

- A sound M&E framework is in place and implemented
- Learning outcomes on what works or not in the Eco-DRR/CCA intervention

Approach

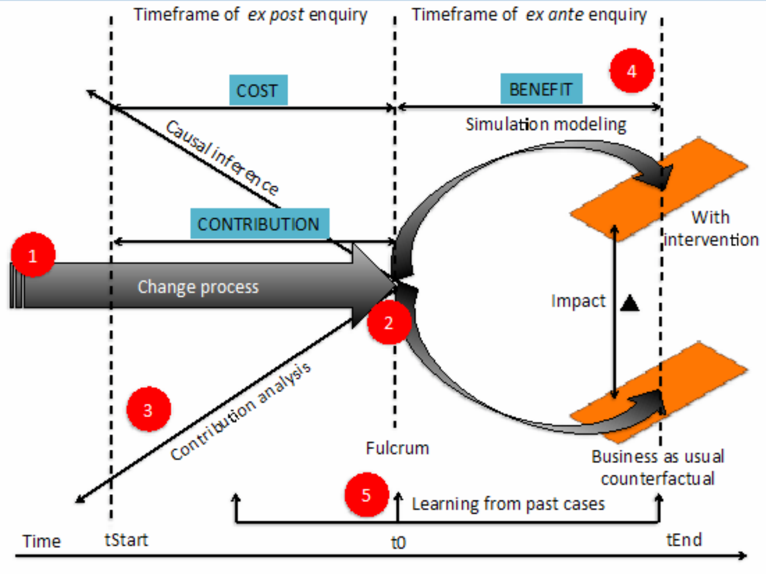
- Step 6 establishes the baseline to guide monitoring and evaluation
- There are several M&E tools and frameworks that can be used, though most are focused on EbA projects only (Box 4.1; Table 12).

Successful factors checklist

- Involve local communities and project partners in the M&E
- Ensure an adequate time period and operate at the most appropriate scale to assess project effectiveness
- Choose adequate indicators that reflect resilience and good governance (linked to step 6)
- Ensure M&E also generates information on the interventions' efficiency and sustainability
- Embed learning as part of assessment of progress and impacts

Box 4.1 Combined impact framework and cost-benefit analysis

IUCN is currently describing the application of an impact framework combined with a cost-benefit analysis to assess the value for money aspect of its Forest Landscape Restoration project in Guatemala. The impact framework has five components which overall help to look at contribution to change as well as project the future benefits of that change.



1. A change process is the main element of the impact framework. It can be, for example, policy formulation, changes in social network dynamics and changes in land use patterns.
2. The line defines a specific point in the change process which distinguishes between the past and the future (t0)
3. The first type of assessment is an analysis of changes that happened to predetermined baseline indicator variables (What happened from tStart to t0?). An analysis of contribution is also conducted (Who contributed what?).
4. Simulation modelling is used to assess future benefits of identified changes. The impact is defined as the difference between business as usual (no intervention) and intervention scenarios.
5. The last component involves using evidence from past cases to validate the findings.

Following the impact assessment, a value for money assessment was conducted using the Redstone Strategy's cost-benefit analysis approach. This allows the calculation of an Expected Return on Investment (EROI) (EROI= contribution * benefit/cost).

Source: Colomer et al., In prep; Colomer, Pers comm.

Table 9. Potential tools and frameworks to assess ecosystem status and ecosystem services (Source: Lo, 2016; Bland et al, 2017)

Tool	Description
Assessing Ecosystem Services	
The Toolkit for Ecosystem Service Site-based Assessment (TESSA)	Piloted in Protected Areas, TESSA guides non-specialists through methods for identifying which ecosystem services may be important at a site, and for evaluating the magnitude of benefits that people obtain from them currently, compared with those expected under alternative land use.
Integrated Valuation of Environmental Services and Tradeoffs (InVEST)	InVEST is a suite of software models used to map and value the goods and services from nature that sustain and fulfil human life. This tool enables decision makers to assess quantified trade-offs associated with alternative management choices and to identify areas where investment in natural capital can enhance human development and conservation.
Exploring Nature-Based Solutions: The role of green infrastructure in mitigating the impacts of weatherand climate change-related natural hazards	This report proposes a simple, practical methodology for screening (rather than assessing) ecosystem services in areas where GI may contribute to reducing current (or future) weather- and climate-related natural hazards. The hazards addressed include landslides, avalanches, floods, soil erosion, storm surges and carbon stabilisation by ecosystems. Several case studies at the European level outline the screening process and also summarise recent estimates of the economic value of GI.
Assessing Ecosystem status	
IUCN Red List of Ecosystems	The IUCN Red List of Ecosystems is a global framework for monitoring the status of ecosystems. The basis of the IUCN Red List of Ecosystems is the IUCN Red List of Ecosystems Categories and Criteria, a set of eight categories and five criteria that provide a consistent method for assessing the risk of ecosystem collapse. The eight categories of ecosystem risk are: Collapsed (CO), Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Near Threatened (NT), Least Concern (LC), Data Deficient (DD) and Not Evaluated (NE).

Table 10. Potential tools and frameworks for vulnerability assessments (Source: Lo, 2016; IUCN, n.d)

Tool	Description
Climate Resilience Evaluation for Adaptation Through Empowerment (CREATE) – Integrated Vulnerability and Capacity Assessment Method	CREATE is designed to integrate existing methods such as CRiSTAL, CARE's CVCA, etc. and provides a broad framework together with general guidelines and suggestions, allowing people to assess and analyse their vulnerability and capacity, identify adaptation options and begin the planning process.
CRiSTAL (Community-based Risk Screening Tool – Adaptation and Livelihoods)	CRiSTAL is a tool developed by IISD, SEI and IUCN to help project planners and managers integrate climate change adaptation and risk reduction into community-level projects.
Climate Vulnerability and Capacity Analysis Handbook	Developed by CARE, the handbook assesses hazard impacts on each of the five categories of livelihood resources and provides a framework for community-based adaptation.
CEDRA – The Climate change and Environmental Degradation Risk and Adaptation	Analyses risks posed by climate change and environmental degradation and supports NGOs in understanding communities' experiences of environmental change (Tearfund).
Risk and Vulnerability Assessment Methodology Development Project (RiVAMP) in Jamaica	This training manual was developed by UNEP to provide instruction on how to implement a methodology that helps to quantify the role of ecosystems in DRR and climate change adaptation, based on a pilot project implemented in Jamaica from 2009-2010.
Integrated Strategic Environmental Assessment in Sri Lanka	UNEP and UNDP collaborated together to modify the existing Strategic Environmental Assessment (SEA) used for sustainable development planning. The new version, Integrated Strategic Environmental Assessment (ISEA), includes more disaster sensitivities into the analysis framework of SEAs. This tool was tested in Sri Lanka's Northern Province, which helped to map out the distribution of space and resources available for development with minimum environment and disaster constraints. This tool can enable other countries to promote integrated area development that is both sustainable and disaster-resilient.
Scenario Planning for Climate Change Adaptation: A Guidance for Resource Managers	A step-by-step guide to using scenarios to plan for climate change adaptation. The intended audience includes natural resource managers, planners, scientists and other stakeholders working at a local or regional scale to develop resource management approaches that take future possible climate change impacts and other important uncertainties into account.
http://webra.cac.sc.edu/hvri/products/sovi.aspx	SoVi is a comparative metric that facilitates the examination of the differences in social vulnerability among countries. It graphically illustrates the geographic variation in social vulnerability. It shows where there is uneven capacity for preparedness and response and where resources might be used most effectively to reduce the pre-existing vulnerability. The index synthesises 32 socioeconomic variables, which the research literature suggests contribute to reduction in a community's ability to prepare for, respond to, and recover from hazards. The data were culled from national data sources, primarily those from the United States Census Bureau.

Tool	Description
Promoting Local Innovations (PLI)	PLI is designed to engage men and women from communities in community-driven climate change adaptation planning and action. The PLI approach uses a workshop based on interactive learning among different stakeholder groups in the local context. The workshop aims to engage participants in open communication and provide a forum for an exchange of knowledge and experience. It facilitates the merging of different forms of knowledge, ideas and competencies, allowing discussions about problems and potential solutions beyond the constraints of social hierarchies.
Community Vulnerability Mapping	The major aim of the developed approach is to provide the community members with appropriate decision support and awareness tools to identify and reduce their own vulnerabilities. A central element is the provision of community maps, which should significantly assist the community with their decision-making. Therefore, this manual can contribute significantly in the support of community-based disaster risk reduction measures, but has to be embedded in the context of an integral disaster risk reduction programme.

Table 11. Qualification criteria and standards for EbA (Source: FEBA, 2017)

Element A – "Helping people to adapt"	
Qualification criteria	Quality standards
1. Reduces social and environmental vulnerabilities	1.1 Use of climate information 1.2 Use of local and traditional knowledge 1.3 Taking into account findings of vulnerability assessment 1.4 Vulnerability reduction at the appropriate scale
2. Generates societal benefits in the context of climate change adaptation	2.1 Quantity & quality of societal benefits compared to other adaptation options 2.2 Timescale of societal benefits demonstrated 2.3 Economic feasibility & advantages compared to other adaptation options 2.4 Number of beneficiaries 2.5 Distribution of benefits
Element B – "Making active use of biodiversity and ecosystem services"	
3. Restores, maintains or improves ecosystem health	3.1 Appropriate scale of management 3.2 Prioritisation of key ecosystem services within management 3.3 Monitoring of ecosystem services health & stability 3.4 Protection and management area coverage / diversification of land use 3.5 Level of co-management (government, communities, private sector)

Element A – 'Helping people to adapt'	
Qualification Criteria	**Quality standards**
1. Reduces social and environmental vulnerabilities	1.1 Use of climate information 1.2 Use of local and traditional knowledge 1.3 Taking into account findings of vulnerability assessment 1.4 Vulnerability reduction at the appropriate scale
2. Generates societal benefits in the context of climate change adaptation	2.1 Quantity & quality of societal benefits compared to other adaptation options 2.2 Timescale of societal benefits demonstrated 2.3 Economic feasibility & advantages compared to other adaptation options 2.4 Number of beneficiaries 2.5 Distribution of benefits
Element B – 'Making active use of biodiversity and ecosystem services'	
3. Restores, maintains or improves ecosystem health	3.1 Appropriate scale of management 3.2 Prioritization of key ecosystem services within management 3.3 Monitoring of ecosystem services health & stability 3.4 Protecion and management area coverage / diversification of land use 3.5 Level of co-management (government, communities, private sector)
Element C – "Part of an overall adaptation strategy"	
4. Is supported by policies at multiple levels	4.1 Compatibility with policy and legal frameworks & policy support 4.2 Multi-actor & multi-sector engagement (communities, civil society, private sector)
5. Supports equitable governance and enhances capacities	5.1 Accountability & group representation 5.2 Consideration of gender balance and empowerment 5.3 Status of indigenous and local knowledge and institutions 5.4 Long-term capacity to ensure sustainable governance

Table 12. Potential tools and frameworks for monitoring and evaluation (Source: Jiménez Hernández, 2016)

Tool	Description
A Review of Monitoring and Evaluation Approaches for Ecosystem-Based Adaptation	This is a desk review of documentation on frameworks and approaches to EbA
Measuring adaptation to climate change – a proposed approach (2010)	This report outlines a proposed approach to measuring adaptation to climate change at the national level.
Making Adaptation Count Concepts and Options for Monitoring and Evaluation of Climate Change Adaptation	This report aims to provide adaptation and development practitioners with a practical framework for developing monitoring and evaluation systems that can track the success and failure of adaptation initiatives in the development context.
AdaptMe: Adaptation Monitoring and Evaluation Toolkit	The AdaptME toolkit aims to get users to think through some of the factors that can make an evaluation of adaptation activities inherently challenging, and equip you to design a robust evaluation.
Learning Framework for IUCN's work on EbA (Ecosystem Based Adaptation) – Short Version	This document summarises a more detailed version of a learning framework and set of core learning questions for Union-wide learning on EbA.

References

ADB. (2017). *Inequality in Asia and the Pacific, trends, drivers and policy implications*. Bangkok: Asian Development Bank. 487 pp. Available at: https://www.adb.org/sites/default/files/publication/41630/inequality-asia-and-pacific.pdf [Retrieved July 2017].

Andrade, A; Córdoba, R; Dave, R.; Girot, P; Herrera-F., B; Munroe, R; Oglethorpe, J; Paaby, P; Pramova, E; Watson, E; Vergar, W; Suarez,I. (2012). Principles and Guidelines for Integrating Ecosystem-based Approaches to Adaptation in Project and Policy Design. *IUCN- CEM, CATIE. Turrialba, Costa Rica. 4p*.

Barbier, B., Yacouba, H., Karambiri, H., Zoromé, M. and Somé, B. (2009). Human Vulnerability to Climate Variability in the Sahel: Farmers' Adaptation Strategies in Northern Burkina Faso. *Environmental Management*, 43: 790-803.

Bland, L.M., Keith, D.A., Miller, R.M., Murray, N.J. and Rodríguez, J.P. (eds.) (2017). *Guidelines for the application of IUCN Red List of Ecosystems Categories and Criteria, Version 1.1.* Gland, Switzerland: IUCN. ix + 99pp.

Casteller A., Cortés, E. Podvin, K.,and Bebi, P. (Forthcoming) *Assessing the interaction between mountain forests and natural hazards at Nevados de Chillán, Chile, and its implications for Eco-DRR*. Natural Hazards and Earth System Sciences.

CBD (Convention on Biological Diversity) Secretariat. (2009). Connecting biodiversity and climate change mitigation and adaptation: report of the second ad-hoc technical expert group on biodiversity and climate change. CBD Technical series No.41, Secretariat of the Convention on Biological Diversity, Montreal, 126p.

CBD (Convention on Biological Diversity) Secretariat. (2010). X/33 Biodiversity and climate change, Decision Adopted by the Conference of the Parties to the Convention on Biological Diversity at its Tenth Meeting; UNEP/CBD/COP/DEC/x/33; 29 October 2010, Nagoya, Japan.

CBS. (2009). *Statistical Year Book of Nepal 2009.* Kathmandu: Central Bureau of Statistics, Government of Nepal.

Cohen-Shacham, E., Walters, G., Janzen, C. and Maginnis, S. (eds.) (2016). *Nature-based solutions to address global societal challenges*. Gland, Switzerland: IUCN. xiii + 97pp.

Colomer, J., Imbach, A.A., Raes, L., Parilla, U. Reinhard, F. and Fernandez, M. (Forthcoming) *IUCN value for money case – Guatemala Forest Landscape Restoration.*

CRED EM-DAT database. Available at: http://www.emdat.be/database [Accessed 17 July 2017].

DANIDA (2013). *Denmark-Burkina Faso Partnership Policy 2013-2018*. Copenhagen: Danish International Development Cooperation, Ministry of Foreign Affairs of Denmark. 24 pp.

Devkota, S., Sudmeier-Rieux, K. Jaboyedoff, M., Van Westen, C.,McAdoo, B.G., Adhikari, A. (submitted) Development of Monsoonal Rainfall Intensity-Duration-Frequency (IDF) Curves and Empirical Model for data-scarce situations: The case of Central-Western Hills of Nepal.

DoR [Department of Roads]. (2015). Road Network Data. Government of Nepal, Department of Roads. Available at: http://www.dor.gov.np/road_statistic_2008/Report%20Pages/tables/1.pdf. [Retrieved July 2017].

Doswald, N. and Estrella, M. (2015). *Promoting ecosystems for disaster risk reduction and climate change adaptation: Opportunities for Integration*. UNEP discussion paper.

Economic Commission for Latin America and the Caribbean (ECLAC). (2017). *CEPALSTAT | Databases and Statistical Publications.* Available at: http://estadisticas.cepal.org/cepalstat/WEB_CEPALSTAT/Portada.asp [Accessed July 2017].

Estrella, M. and N. Saalismaa. (2013). 'Ecosystem-based Disaster Risk Reduction (Eco-DRR): An Overview'. In F. Renaud, K. Sudmeier-Rieux and M. Estrella (eds.) *The role of ecosystem management in disaster risk reduction*, pp. 26-54. Tokyo: UNU Press.

Estrella, M., Renaud, F.G., Sudmeier-Rieux, K. and Nehren, U. (2016). 'Defining New Pathways for Ecosystem-Based Disaster Risk Reduction and Adaptation in the Post-2015 Sustainable Development Agenda', in F.G. Renaud, K. Sudmeier-Rieux and M. Estrella (eds). *Ecosystem-Based Disaster Risk Reduction and Adaptation in Practice*, pp. 553-591. Springer.

EPIC final report (INRA) (2017). The mechanical and hydrological effects of vegetation on slopes prone to landslides and erosion. 42 pp. Unpublished report.

FAO. (2011). *Resilience Analysis in Senegal 2011*. Rome: FAO. xii+48 pp http://www.fao.org/3/a-i6584e.pdf. Retrieved July 2017.

FEBA (Friends of Ecosystem-based Adaptation). (2017). *Making Ecosystem-based Adaptation Effective: A Framework for Defining Qualification Criteria and Quality Standards (FEBA technical paper developed for UNFCCC-SBSTA 46).* Bertram, M., Barrow, E., Blackwood, K., Rizvi, A.R., Reid, H. and von Scheliha-Dawid, S. (authors). GIZ, Bonn, Germany, IIED, London, UK, and IUCN, Gland, Switzerland. 14 pp.

Gao, X., Ma, X. and Li, X. (2011). The great triangular seismic region in eastern Asia: Thoughts on its dynamic context. *Geoscience Frontiers*, 2(1):57-65.

Geological Society (undated). *Continental/Continental: The Himalayas*. Available at: https://www.geolsoc.org.uk/Plate-Tectonics/Chap3-Plate-Margins/Convergent/Continental-Collision. [Retrieved July 2017].

Germanwatch. (2017). *Global Climate Risk Index 2017.* Available at: https://germanwatch.org/en/12978 [Retrieved July 2017].

Ghestem, M., Cao, K., Ma, W., Rowe, N., Leclerc, R., Gadenne, C. and A. Stokes. (2014). A Framework for Identifying Plant Species to Be Used as 'Ecological Engineers' for Fixing Soil on Unstable Slopes. *PLoS ONE* 9(8): e95876. https://doi.org/10.1371/journal.pone.0095876

González, M.E., Lara, A., Urrutia, R. and Bosnich, J. (2011). *Cambio climático y su impacto potencial en la ocurrencia de incendios forestales en la zona centro-sur de Chile (33º-42º S)*. *Bosque (Valdivia)*, *32*(3), pp. 215-219. Available at: http://www.scielo.cl/scielo.php?pid=S0717-92002011000300002&script=sci_arttext. [Retrieved July 2017].

Government of Chile. (2015). *Intended Nationally Determined Contribution (INDC) of Chile towards the Climate Agreement of Paris 2015*. Santiago, Chile. Available at: http://www4.unfccc.int/submissions/INDC/Published%20Documents/Chile/1/INDC%20Chile%20english%20version.pdf [Retrieved July 2017]

Hagenlocher, M. (2013). Identifying and Evaluating Hotspots of Climate Change in the Sahel and Western Africa. In S.L. Cutter and C. Corendea (Eds.) *From Social Vulnerability to Resilience: Measuring Progress towards Disaster Risk Reduction*, pp. 93-107. Studies of the University: Research, Counsel, Education Publication Series of UNU-EHS. No. 17/2013,=.

Howard, J., Sutton-Grier, A., Herr, D., Kleypas, J., Landis, E., Mcleod, E., Pidgeon, E. and Simpson, S. (2017). Clarifying the role of coastal and marine systems in climate mitigation. *Frontiers in Ecology and the Environment*, *15*(1): 42-50.

IMF. (2017a). Report for Selected Countries and Subjects (Burkina Faso). Available at: https://www.imf.org/external/pubs/ft/weo/2016/02/weodata/weorept.aspx?pr.x=63&pr.y=7&sy=2014&ey=2021&scsm=1&ssd=1&sort=country&ds=.&br=1&c=748&s=PPPPC&grp=0&a [Retrieved July 2017].

IMF. (2017b). Report for Selected Countries and Subjects (Chile). Available at: https://www.imf.org/external/pubs/ft/weo/2016/02/weodata/weorept.aspx?pr.x=71&pr.y=2&sy=2014&ey=2021&scsm=1&ssd=1&sort=country&ds=.&br=1&c=228&s=PPPPC&grp=0&a [Retrieved July 2017].

IMF. (2017c). Report for Selected Countries and Subjects (China). Available at: https://www.imf.org/external/pubs/ft/weo/2016/02/weodata/weorept.aspx?pr.x=63&pr.y=10&sy=2014&ey=2021&scsm=1&ssd=1&sort=country&ds=.&br=1&c=924&s=PPPPC&grp=0&a [Retrieved July 2017].

IMF. (2017d). Report for Selected Countries and Subjects (Nepal). Available at: https://www.imf.org/external/pubs/ft/weo/2016/02/weodata/weorept.aspx?sy=2017&ey=2021&scsm=1&ssd=1&sort=country&ds=.&br=1&pr1.x=33&pr1.y=10&c=558&s=PPPPC%2CLP&grp=0&a [Retrieved July 2017].

IMF. (2017e). Report for Selected Countries and Subjects (Senegal). Available at: https://www.imf.org/external/pubs/ft/weo/2016/02/weodata/weorept.aspx?pr.x=53&pr.y=11&sy=2014&ey=2021&scsm=1&ssd=1&sort=country&ds=.&br=1&c=722&s=PPPPC&grp=0&a= [Retrieved July 2017].

IMF. (2017f). Report for Selected Countries and Subjects (Thailand). Available at: https://www.imf.org/external/pubs/ft/weo/2016/02/weodata/weorept.aspx?pr.x=55&pr.y=7&sy=2014&ey=2021&scsm=1&ssd=1&sort=country&ds=.&br=1&c=578&s=PPPPC&grp=0&a= [Retrieved July 2017].

IPCC. (2014). *Climate Change 2014 Synthesis Report Summary for Policymakers*. n/a: IPCC. http://portal.mma.gob.cl/wp-content/uploads/2016/02/Plan-Nacional-Adaptacion-Cambio-Climatico-version-final.pdf [Retrieved July 2017.]

IUCN and ProAct (2013a). Strengthening Ecosystem-based Disaster Risk Reduction and Climate Change Adaptation Strategies in West Africa, Burkina Faso, baseline report. 78 pp. Unpublished report.

IUCN and ProAct (2013b). Quantifying and Improving the Protective Capacity of Forests against Snow Avalanches, Chile. Unpublished report.

IUCN and ProAct (2013c). Eco-engineering for the Stabilisation of Steep Slopes in Southern China Literature Review. 33 pp. Unpublished report.

IUCN and ProAct (2013d). Baseline Report and Literature Review Bio-engineering: Reducing Risks from Landslides and Flash Floods in Nepal. 54 pp. Unpublished report.

IUCN and ProAct (2013e). Strengthening Disaster Risk Reduction Based on Ecosystems and Changing Climate Adaptation Strategies in West Africa, Senegal. 58 pp. Unpublished report.

IUCN and ProAct (2013f). Demonstrating Community-based Ecological Mangrove Restoration (EMR) in *Thailand.* 49 pp. Unpublished report.

Jaquet, S., Schwilch, G., Hartung-Hofmann, F., Adhikari, A., Sudmeier-Rieux, K., Shrestha, G., Liniger, H.P. and Kohler, T. (2015). Does outmigration lead to land degradation? Labour shortage and land management in a western Nepal watershed. *Applied Geography* 62:157-170.

Jiménez Hernández, A. (2016). *Ecosystem-based Adaptation Handbook*. Amsterdam: IUCN..

Jorio, L. (2013). The Creeping Disease that Threatens Populations. Available at: http://swissinfo.ch/eng/science_technology/The_creeping_diisease_that_threatens_populations.html [Retrieved 11 December 2013].

Kalame, F.B., Kudejira, D. and Nkem, J. (2011). Assessing the Process and Options for Implementing National Adaptation Programmes of Action (NAPA): A Case Study from Burkina Faso. *Mitigation and Adaptation Strategies for Global Climate Change,* 16: 535-553.

Kisner, C. (2008). *Climate Change in Thailand: Impacts and Adaptation Strategies*. The Climate Institute. Available at: http://climate.org/archive/topics/international-action/thailand.htm [Retrieved July 2017].

Kyendrebeogo, M.E.M., Ouiminga, I. and dit Guérin, O.L. (2011). Building a Social Protection Floor: Burkina Faso. Successful Social Protection: Floor Experiences. *Sharing Innovative Experiences,* 18. UNDP, ILO and SUSSC.

Leibundgut, G., Sudmeier-Rieux, K. Devkota, S., Jaboyedoff, M., Derron, M-H., Penna, I. and Nguyen, L. (2016). Rural earthen roads impact assessment in Phewa watershed, Western region, Nepal. *Geoenvironmental Disasters,* 3 (13).

Le Plan Sénégal Émergent. (2014). 167 pp. https://www.sec.gouv.sn/IMG/pdf/PSE.pdf [Retrieved July 2017].

Lewis, RR. III. (2005). Ecological engineering for successful management and restoration of mangrove forests. *Ecological Engineering* 24(4):403-418.

Lo, V. (2016). *Synthesis report on experiences with ecosystem-based approaches to climate change adaptation and disaster risk reduction*. CBD Secretariat.

Maatman, A., Sawadogo, H., Schweigman, C. and Ouedraogo, A. (1998). Application of zaï and rock bunds in the northwest region of Burkina Faso: Study of its impact on household level by using a stochastic linear programming model. *NJAS Wageningen Journal of Life Sciences*, 46(1): 123-136.

MAP. (2017). Mangrove Action Project, CBEMR: A Successful Method of Mangrove Restoration. Available at: http://www.mangroveactionproject.org/cbemr/ [Retrieved 19 July 2017].

Mathez-Stiefel, S. and Murti, R. (2014). Promoting Local Innovations: A tool for adaptation to climate change and sustainable development in Mountains (Unpublished). In: World Mountain Forum. Cusco, Peru. 22-24 May 2014.

McBreen, J. (2016). *Regional Assessment on Ecosystem-based Disaster Risk Reduction and Biodiversity in South America*. A report for Resilience through Investing in Ecosystems – knowledge, innovation and transformation of risk management (RELIEF Kit) project. IUCN.

Michoud, C. and M. Jaboyedoff. (2017). LiDAR data of the EPIC Project. Assessment, processing, comparison and interpretation of terrestrial LiDAR acquisitions for the EPIC project, conducted in Nepal, Unpublished technical report. Terranum and UNIL. 14 February 2017, 24 pp.

Ministerio del Medio Ambiente (MMA). (2016). Tercera Comunicación Nacional de Chile ante la Convención Marco de las Naciones Unidas sobre Cambio Climático 2016. http://portal.mma.gob.cl/wp-content/doc/TCN-2016b1.pdf [Retrieved July 2017].

Ministry of Civil Affairs. (2017). The 13th Five-Year Plan on Integrated Disaster Prevention and Reduction. Available online: http://www.gov.cn/zhengce/content/2017-01/13/content_5159459.htm (in

Chinese). [Retrieved July 2017].

Ministry of Environment. (2014). *Thailand National Report on the Implementation of the Convention on Biological Diversity.* Thailand: MoE. 108 pp. Available at: https://www.cbd.int/doc/world/th/th-nr-05-en.pdf [Retrieved July 2017].

Ministry of Environmental Protection (2010). China National Biodiversity Strategy and Action Plan (2011-2030). Available online: http://www.zhb.gov.cn/gkml/hbb/bwj/201009/t20100921_194841.htm (in Chinese). [Retrieved July 2017].

Ministry of Environment and Protection of Nature. (2006). Plan D'Action National pour L'Adaptation aux Changements Climatiques. 84 pp. Available at: http://unfccc.int/resource/docs/napa/sen01f.pdf [Retrieved July 2017].

Ministry of Environment and Sustainable Development. (2015a). *Strategie Nationale & Plan National D'actions pour la Biodiversite*. 78 pp. Available at: https://www.cbd.int/doc/world/sn/sn-nbsap-v2-fr.pdf [Retrieved July 2017].

Ministry of Environment and Sustainable Development. (2015b). Contribution Prevue Determinee au Niveau National. 18 pp. Available at: http://www4.unfccc.int/submissions/INDC/Published%20Documents/Senegal/1/CPDN%20-%20S%C3%A9n%C3%A9gal.pdf [Retrieved July 2017].

Ministry of Finance (2015). Notification Document on the New Phase of the Grain for Green. Available online: http://tghl.forestry.gov.cn/portal/tghl/s/2166/content-846817.html (in Chinese). [Retrieved July 2017].

Miththapala, S. (2017). EPIC External review. Consultancy report.

MoHA. (2016). *Disaster Risk Reduction in Nepal: Achievements, Challenges and Ways Forward*. National Position Paper for the AMCDRR 2016 2-5 November, New Delhi, India. 2 pp.

MoHA/DpNET. (2015). *Nepal Disaster Report, 2015*. The Government of Nepal, Ministry of Home Affairs (MoHA) and Disaster Preparedness Network-Nepal (DPNet-Nepal).

Monty, F., Murti, R. and Furuta, N. (2016). *Helping nature help us: Transforming disaster risk reduction through ecosystem management*. Gland, Switzerland: IUCN. vi + 82 pp

Municipal Council, Djilor. (2009). Local plan for development. Unpublished document. 98 pp.

National Adaptation Plan of Action (NAPA). (2007). National Adaptation Plan of Action for Burkina Faso. 84 pp. Available at: http://unfccc.int/resource/docs/napa/bfa01f.pdf [Retrieved July 2017].

National Statistical Office. (2016). Executive summary. Available at:

http://web.nso.go.th/en/survey/popchan/data/2015-2016-Executive%20Summary.pdf [Retrieved July 2017].

National Statistics Bureau (2017). 2016 China National Statistics Yearbook. Available online: http://www.stats.gov.cn/tjsj/ndsj/2016/indexch.htm (in Chinese) [Retrieved July 2017].

NCDR (undated). China National Commission for Disaster Reduction. About the NCDR. Available online: http://www.jianzai.gov.cn//DRpublish/ywzsy/0001002300010001-1.html. [Retrieved July 2017].

Northern Regional Council. (2010). *Regional Development Plan*. Ouahigouya: Northern Regional Council. Unpublished document 291 pp.

Office of National Resources and Environmental Policy and Planning (ONEP). (2015). *Thailand's Climate Change Master Plan 2015-2050*. Available at: http://www.deqp.go.th/media/36631/%

E0%B9%81%E0%B8%9C%E0%B8%99%E0%B9%81%E0%B8%A1-%E0%B8%9A%E0%B8%97_2558_2593.pdf [Retrieved July 2017].

ONEMI. (2014). *Política Nacional para la Gestión de Riesgos de Desastres. Santiago de Chile* http://siac.onemi.gov.cl/documentos/POLITICA_NACIONAL_PARA_LA_RRD.pdf [Retrieved July 2017].

Piao, S., Ciais, P., Huang, Y., Shen, Z., Peng, S., Li, J., Zhou, L.,Liu, H., Ma, Y., Ding, Y., Friedlingstein, P., Liu, Kun Tan, C., Yu, Y., Zhang, T. and Fang, J. (2010). The impacts of climate change on water resources and agriculture in China. *Nature* 467: 43-51. doi:10.1038/nature09364

Provincial Directorate of Social Action and National Solidarity PDSANS (2012). *Etude sur la prévention et la gestion des catastrophes et crises humanitaires au Burkina Faso*, Tome 1 : Contexte général des catastrophes et crises humanitaires au Burkina Faso (Version provisoire).

Raks Thai Foundation. (2014). *Preliminary Study Vulnerability and Capacity Analysis, Baan Klongkam, Klong Prasong Sub-district, Muang District, Krabi Province. Bangkok, Thailand.*

Regmi, B. R., Pandit, A., Pradhan, B., Kovats, S. and Lama, P. (2006). *Climate Change and Health Country report, Nepal, Capacity Strengthening in the Least Developed Countries (LDCs) for Adaptation to Climate Change (CLACC)* Working Paper, Local Initiatives for Biodiversity, Research and Development (LI-BIRD), Pokhara Nepal. 23-24 pp.

Renaud, F.G., Sudmeier-Rieux, K. and Estrella, M. (2013). *The role of ecosystems in disaster risk reduction*. United Nations University Press.

Renaud, F.G., Sudmeier-Rieux, K. and Estrella, M. (2016). *Ecosystem-Based Disaster Risk Reduction and Adaptation in Practice*. Springer. https:/doi.org/10.1007/978-3-319-43633-3

San Martín, P. (2014). *Reserva de la Biosfera Corredor Biológico Nevados de Chillán – Laguna del Laja: de la amenaza de la extinción al desarrollo sustentable*. In: A. Moreira-Muñoz and A. Borsdorf (eds) *Reservas de la Biosfera de Chile: Laboratorios para la Sustentabilidad*. Academia de Ciencias Austriaca, Pontificia Universidad Católica de Chile, Instituto de Geografía, Santiago, serie Geolibros 17: 146-160. http://reservadelabiosfera.gorebiobio.cl/wp-content/uploads/2014/09/Reservas-de-la-Biosfera-de-Chile-Laboratorios-para-la-Sustentabilidad.pdf [Retrieved July 2017].

Setthasirot, B., Chitthaisong, B. and Chinwanno, S. (2015). Climate@Risk: Global Warming's Risks and the Future Thailand. Thailand Research Fund. (In Thai) pp. 19 (Unpublished report).

Sherpa, P. (2009). Climate change as seen in Nepal. Climate frontiers. Available at: http://www.climatefrontlines.org/en-GB/node/382 [Retrieved July 2017].

Shono, K., Cadaweng, E.A. and P. B. Durst. (2007). Application of Assisted Natural Regeneration to Restore Degraded Tropical Forestlands. *Restoration Ecology* 15 (4): 620-626.

Shrestha, A.B., Wake, C.P. Mayewski, P.A. and Dibb J.E. (1999). Maximum temperature trends in the Himalaya and its vicinity: An analysis based on temperature records for the period 1971-94. *Journal of Climate* 12: 2775-2787.

Sidle, R. C. and Ziegler, A.D. (2012). The dilemma of mountain roads. *Nature Geoscience* 5:437-438.

Shah. R., Adhikari. A. and Khanal, R. (2012). Scoping of Piloting Ecosystem Based Adaptation in Panchase. Unpublished report. Kathmandu, Nepal: IUCN. 10-12 pp.

Somé, D., Zombré, P.N., Zombré, G. and Macauley, H.R. (2004). Impact de la technique du zaï sur la production du niébé et sur l'évolution des caractéristiques chimiques des sols très dégradés (zipellés) du Burkina Faso. *Science et changements planétaires/Sécheresse*, 15(3), pp. 263-269.

State Forestry Administration (2016). The 13th Five-Year Plan on Forestry Development. Available online: http://www.forestry.gov.cn/main/72/content-873366.html (in Chinese). [Retrieved July 2017].

Steffen, W., Richardson, K., Rockström, J., Cornell, S.E., Fetzer, I., Bennett, E.M., Biggs, R., Carpenter, S.R., de Vries, W., de Wit, C.A. and Folke, C. (2015). Planetary boundaries: Guiding human development on a changing planet. *Science*, 347(6223), p.1259855.

Sthapit, K. M. and Tennyson L.C. (1991). Bio-engineering erosion control in Nepal. *Unasylva Watershed Management* 42 (164) FAO.

Sudmeier-Rieux, K. (2013). Operationalizing 'resilience' for disaster risk reduction in mountainous Nepal. *Disaster Prevention and Management (22) 4.*

Sudmeier-Rieux, K., Ash, N. and Murti, R. (2013). *Environmental Guidance Note for Disaster Risk Reduction: Healthy Ecosystems for Human Security and Climate Change Adaptation*. Gland, Switzerland: IUCN, iii+34 pp.

Sudmeier-Rieux, K., Penna, I., Khanal, R., Adhikari, A. and Devkota, S. (2014). Desk Review and Baseline Report — Nepal Ecosystems Protecting Infrastructure and Communities — EPIC. Unpublished document. 54 pp.

Sudmeier-Rieux, K., Adhikari, A., Derron, M-H, Devkota, S. Jaboyedoff, M. Leibundgut, G., Michoud, C., Tonini, M., Vicarelli, M. and Vulliez, C. (Submitted) Eco-safe roads in Nepal – Lessons in promoting bio-engineering for erosion and landslide mitigation, *International Journal of Disaster Risk Reduction.*

Thavanayagam, M. and T. Jayasingam. (2016). Present Status of Mangrove Restoration in Batticaloa District, Sri Lanka: Is it a success? (Abstract only), pp. 222 in Abstract Book Mangroves and Macrobenthos meeting 8-22 July 2016, St Augustine, Florida, USA.

TransRe. (2016). *Climate Change in Thailand*. Issue 2:1-6. Available at: http://www.transre.org/files/3114/6522/5151/Climate_Change_in_Thailand_TransRe_Fact_Sheet_No.2.pdf [Retrieved July 2017].

UNDP, UNEP and IUCN. (2012). Ecosystem-based adaptation in mountain ecosystems in Nepal, project document, for German government, BMU. 96 pp.

UNDP. (2016). *Human Development Report 2016: Human Development for Everyone*. United Nations Development Programme.

UNEP. (2015). *The Economics of Land Degradation in Africa*. ELD Initiative, Bonn, Germany. Available at www.eld-initiative.org. [Retrieved June 2016].

UNISDR. (2009). *UNISDR terminology on disaster risk reduction*. Geneva, Switzerland: United Nations.

UNISDR. (2017). *Global Assessment Report on Disaster Risk Reduction. Atlas: Unveiling Global Disaster Risk*. Geneva, Switzerland: United Nations Office for Disaster Risk Reduction (UNISDR).

United Nations. (2016). Report of the open-ended intergovernmental expert working group on indicators and terminology relating to disaster risk reduction. United Nations General Assembly A/71/644. 1 December 2016. New York, USA.

Vulliez, C. T., Sudmeier-Rieux, K. Devkota, S, Derron, M-H. and Jaboyedoff, M. (Submitted) Land use changes, landslides and roads in the Phewa Watershed, Western Nepal from 1979-2016.

World Bank. (2011). *Country Note on Disaster Risk Management and Adaptation to Climate Change in Burkina Faso*.

World Bank (2017). World Bank Open Data. Available at: http://data.worldbank.org/ [Accessed July

2017].

World Economic Forum. (2017). *The Global Risks Report 2017: 12th Edition*. Geneva, WEF.

World Risk Report. (2016). *Focus: Logistics and infrastructure. United Nations University*. Alliance Development Works.

Yeye, M.S. (2010). Confirmation of Government's Interest in Participating in the Forest Investment Programme. Submission to the Climate Investment Fund.

Zougmoré, R., Zida, Z. and Kambou, N.F. (2003). Role of nutrient amendments in the success of half moon soil and water conservation practice in semiarid Burkina Faso. *Soil and Tillage Research*, 71: 143-149. http://dx.doi.org/10.1016/S0167-1987%2803%2900050-3

Annex 1

Mapping questionnaires for EPIC based on the DRR-EbA learning framework

EPIC Project Intervention	Core Question 1	Learning Question 2	Learning Question 3	Learning Question 4	Learning Question 5	Learning Question 6
Quantifying and Improving the Protective Capacity of Forests against Snow Avalanches (Nepal and Chile)	What were the specific project interventions at the research sites that resulted in improved protective capacity of forests against snow avalanches?	What were the existing institutional and community capacities to deal with snow avalanches and what were the specific weaknesses?	What were the participatory process and how did they build institution and community capacity to manage forests against snow avalanches?	What were the partner institutions and what were the barriers pertaining to each one with regards to the research sites being studied?	Were the results of the studied research sites beneficial in scaling up locally or scaling out in other regions? How and why?	What role (negative and positive) did rights, governance, tenure, local control and political will play in forest functionality and benefit flows in the research sites?
	How did the protective capacity of forests against snow avalanches increase and reduce risk of snow avalanches ?	What type of risk analyses and climate scenarios were carried out and what were their roles in capacity building and establishing future DRR adaptive management strategies?	How did participatory processes lead to improved risk management and adaptive capacities?	What were the linkages if any to national DRR policies, NAPAs, climate change adaptation plans/ policies?	Were there any policy influences that emerged with regard to forest management for disaster risk reduction?	What were the existing livelihoods and did livelihoods diminish?

EPIC Project Intervention	Core Question 1	Learning Question 2	Learning Question 3	Learning Question 4	Learning Question 5	Learning Question 6
	What were the environmental, social and economic costs of lack of and increasing this capacity?			What were the policy and legal barriers to collaboration and joint implementation of the research sites being studied?		Did livelihoods improve after project interventions? How?
				What are the policy, institutional and legal aspects that need to be changed/ improved? How?		How did livelihoods influence forest ecosystem functions before and after project interventions?

EPIC Project Intervention	Core Question 1	Learning Question 2	Learning Question 3	Learning Question 4	Learning Question 5	Learning Question 6
Demonstrating Ecological Mangrove Restoration (Thailand)	What were the specific project interventions at the restoration sites that resulted in improved provision of mangrove ecosystems services?	What were the existing institutional and community capacities to deal with local coastal disasters what were the specific weaknesses?	What were the participatory process and how did they build institution and community capacity for restoration and sustainable management of mangroves?	What were the partner institutions and what were the barriers pertaining to each one with regards to restoration and sustainable management of mangroves as well as hazard management?	Were the results of the studied sites beneficial in scaling up locally or scaling out in other regions? How and why?	What role (negative and positive) did rights, governance, tenure, local control and political will play in mangrove ecosystem functionality and benefit flows at the sites?
	How were the risks of local coastal disasters reduced ? What were the specific disasters?	What were the results of the restoration site surveys and reference mangrove forest site studies ? How did the results help to build institutional and community capacity?	How did participatory processes lead to improved risk management and adaptive capacities?	What were the linkages if any to national DRR policies, NAPAs, climate change adaptation plans/ policies?	Were there any policy influences that emerged with regard to mangrove restoration and management for coastal disaster risk reduction?	What were the existing livelihoods and did livelihoods diminish?

EPIC Project Intervention	Core Question 1	Learning Question 2	Learning Question 3	Learning Question 4	Learning Question 5	Learning Question 6
	What were the environmental, social and economic costs of damaged mangroves and what were the economic social and environmental costs of restoring and sustaining natural hydrology?	What type of risk analyses and climate scenarios were carried out and what were their roles in capacity building implementation and demonstration?		What were the policy and legal barriers to collaboration and joint implementation?		Did livelihoods improve after project interventions? How?
		What role did capacity building play in demonstration and implementation?		What are the policy, institutional and legal aspects that need to be changed/ improved? How?		How did livelihoods influence forest ecosystem functions before and after project interventions?

EPIC Project Intervention	Core Question 1	Learning Question 2	Learning Question 3	Learning Question 4	Learning Question 5	Learning Question 6
An operational framework for Reducing Risk from Landslides and Flashfloods in Eastern Nepal's Churia Hills	What specific project interventions were identified that would assist in landslides and flooding risks at the project site?	What were the existing institutional and community capacities to deal with the floods and landslides as well as other associated hazards if any?	What were the participatory process and how did they build institution and community capacity for adopting, promoting and implementing bio-engineering solutions?	What were the partner institutions and what were the barriers pertaining to each one with regards understanding and promotion of bio-engineering solutions?	Are the results of the studied site beneficial in scaling up locally or scaling out in other regions? How and why?	What role (negative and positive) did rights, governance, tenure, local control and political will play in ecosystem functionality and benefit flows at the sites?
	How will these intervention reduce the risk of floods and landslides ? What were other hazards the area is prone to?	How did site specific studies/ research undertaken (such as the research done at the University of Lausanne) help to build institutional and community capacity?	How did participatory processes lead to improved risk management and adaptive capacities?	What were the linkages if any to national DRR policies, NAPAs, climate change adaptation plans/ policies?	Are there any policy influences that emerged or can emerge with regard to bio-engineering?	What were the existing livelihoods and did livelihoods diminish?

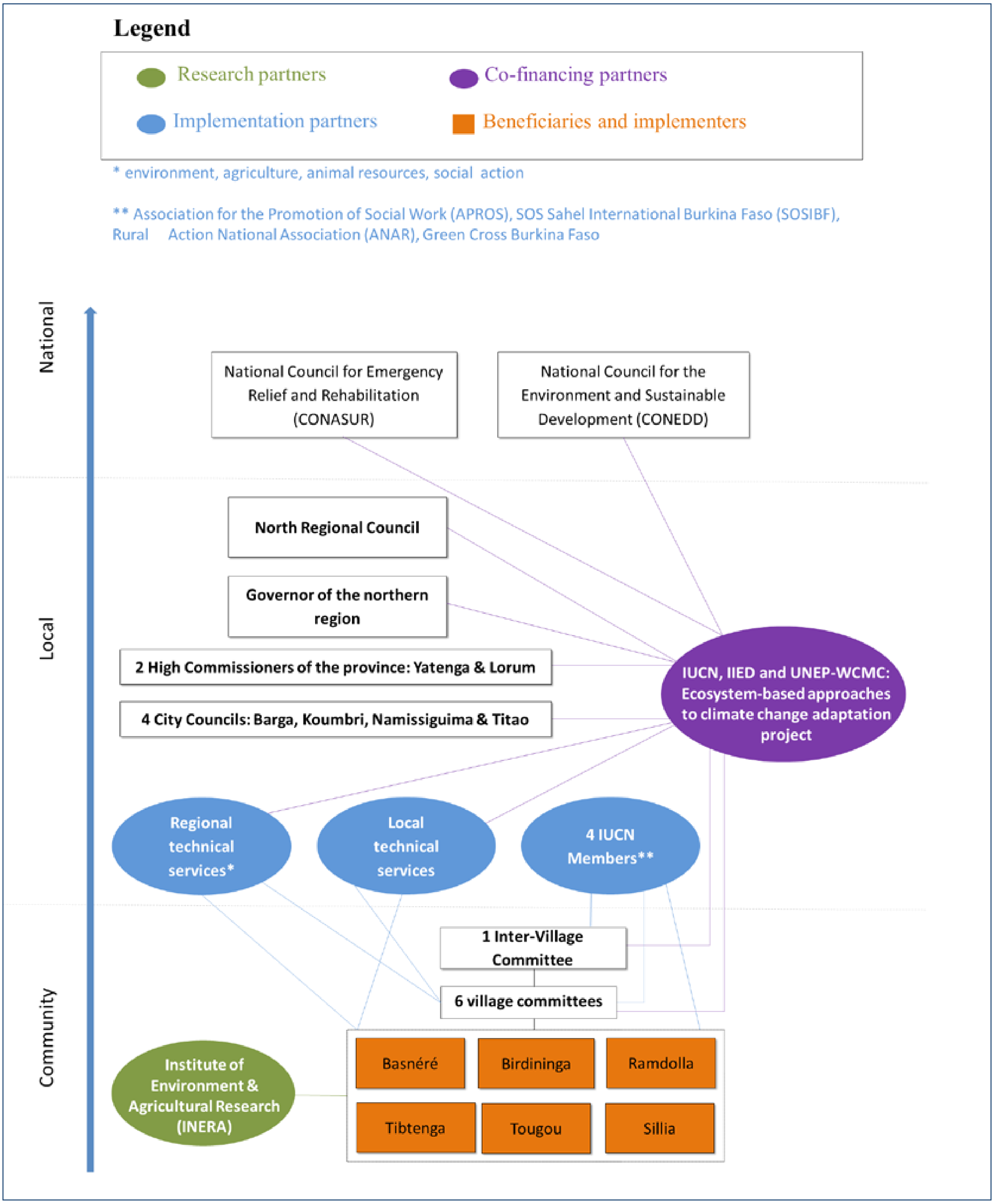
EPIC Project Intervention	Core Question 1	Learning Question 2	Learning Question 3	Learning Question 4	Learning Question 5	Learning Question 6
	What were the environmental, social and economic costs of floods and landslides and what are the economic social and environmental costs of the bio-engineering solutions being promoted?	What type of risk analyses and climate scenarios were carried out and what were/ are their roles in capacity building implementation and demonstration?		What were the policy and legal barriers to collaboration and joint implementation?		How did livelihoods improve or are likely to improve with project interventions?
		What role did capacity building play in demonstration and implementation and/ or promotion of bio-engineering solutions in future projects?		What are the policy, institutional and legal aspects that need to be changed/ improved? How?		

EPIC Project Intervention	Core Question 1	Learning Question 2	Learning Question 3	Learning Question 4	Learning Question 5	Learning Question 6
Strengthening local Climate Change Adaptation Strategies in West Africa (Senegal and Burkina Faso)	What specific endogenous strategies were identified that would assist in adapting to climate change in the site areas?	What were the existing institutional and community capacities to deal with the hazards?	What were the participatory process and how did they build institution and community capacity for adopting, promoting and implementing climate change adaptation strategies?	What were the partner institutions and what were the barriers pertaining to each one with regards understanding and promotion of climate change adaptation strategies?	Are the results of the demonstrations beneficial in scaling up similar adaptation strategies locally or scaling out in other regions? How and why?	What role (negative and positive) did rights, governance, tenure, local control and political will play in ecosystem functionality and benefit flows at the sites?
	How will these intervention reduce the risk hazards the area is prone to?	How did site specific studies/ research undertaken (such as inventories of endogenous strategies of adaptation to climate change) help to build institutional and community capacity as well as in implementation and demonstration?	How did participatory processes lead to improved risk management and adaptive capacities?	What were the linkages if any to national DRR policies, NAPAs, climate change adaptation plans/ policies?	Are there any policy influences that emerged or can emerge with regard to bio-engineering?	What were the existing livelihoods and did livelihoods diminish?

EPIC Project Intervention	Core Question 1	Learning Question 2	Learning Question 3	Learning Question 4	Learning Question 5	Learning Question 6
	What were the environmental, social and economic costs of identified hazards at the sites and environmental, social and economic costs of the solutions being promoted?	What type of risk analyses and climate scenarios were carried out and what were/ are their roles in capacity building implementation and demonstration?		What were the policy and legal barriers to collaboration and joint implementation?		Did livelihoods improve or are likely to improve with project interventions?
		What role did capacity building play in demonstration and implementation and/ or promotion of endogenous adaptation strategies in future projects?		What are the policy, institutional and legal aspects that need to be changed/ improved? How?		

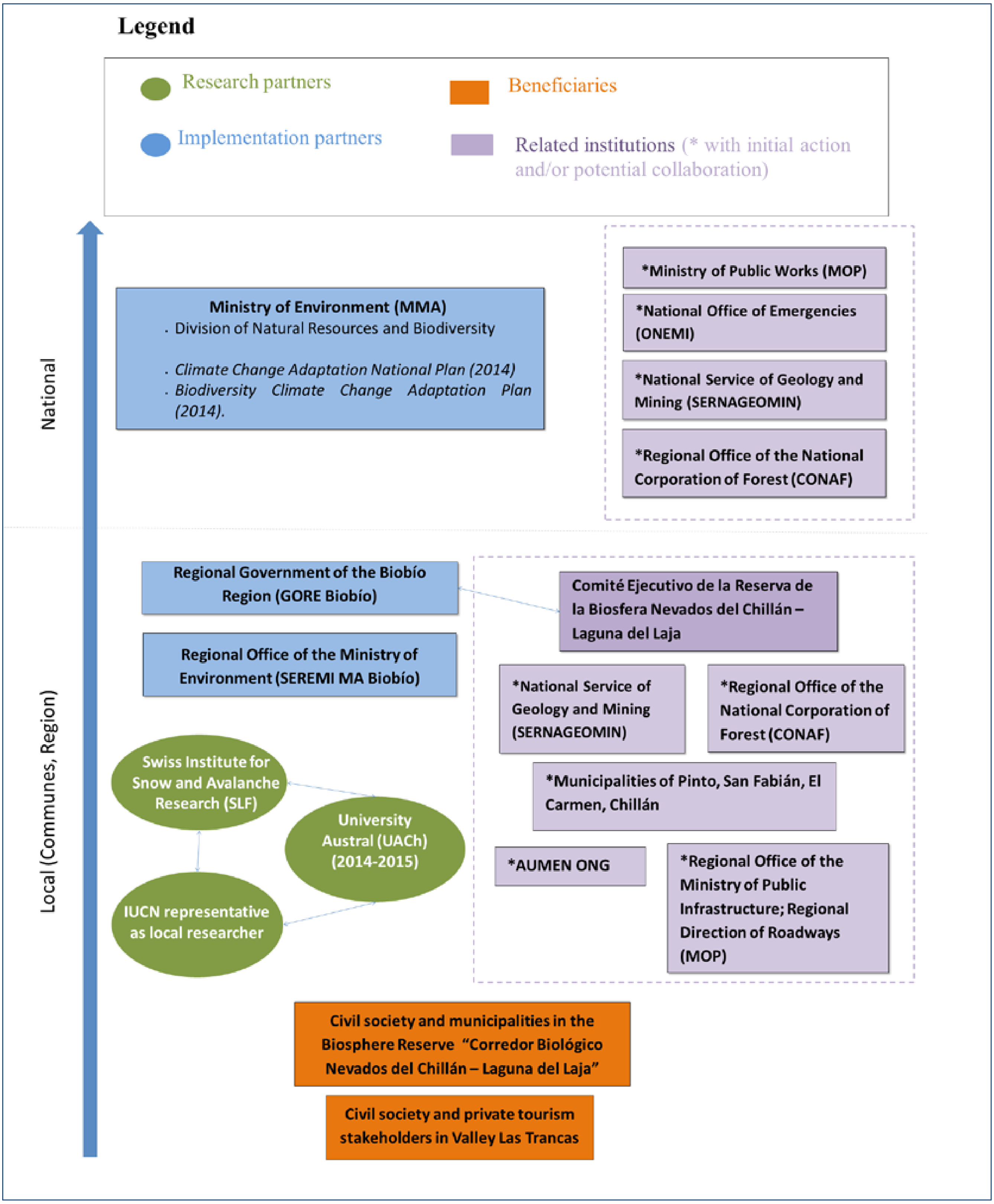
Annex 2

Multi-stakeholders involved with EPIC in Burkina Faso



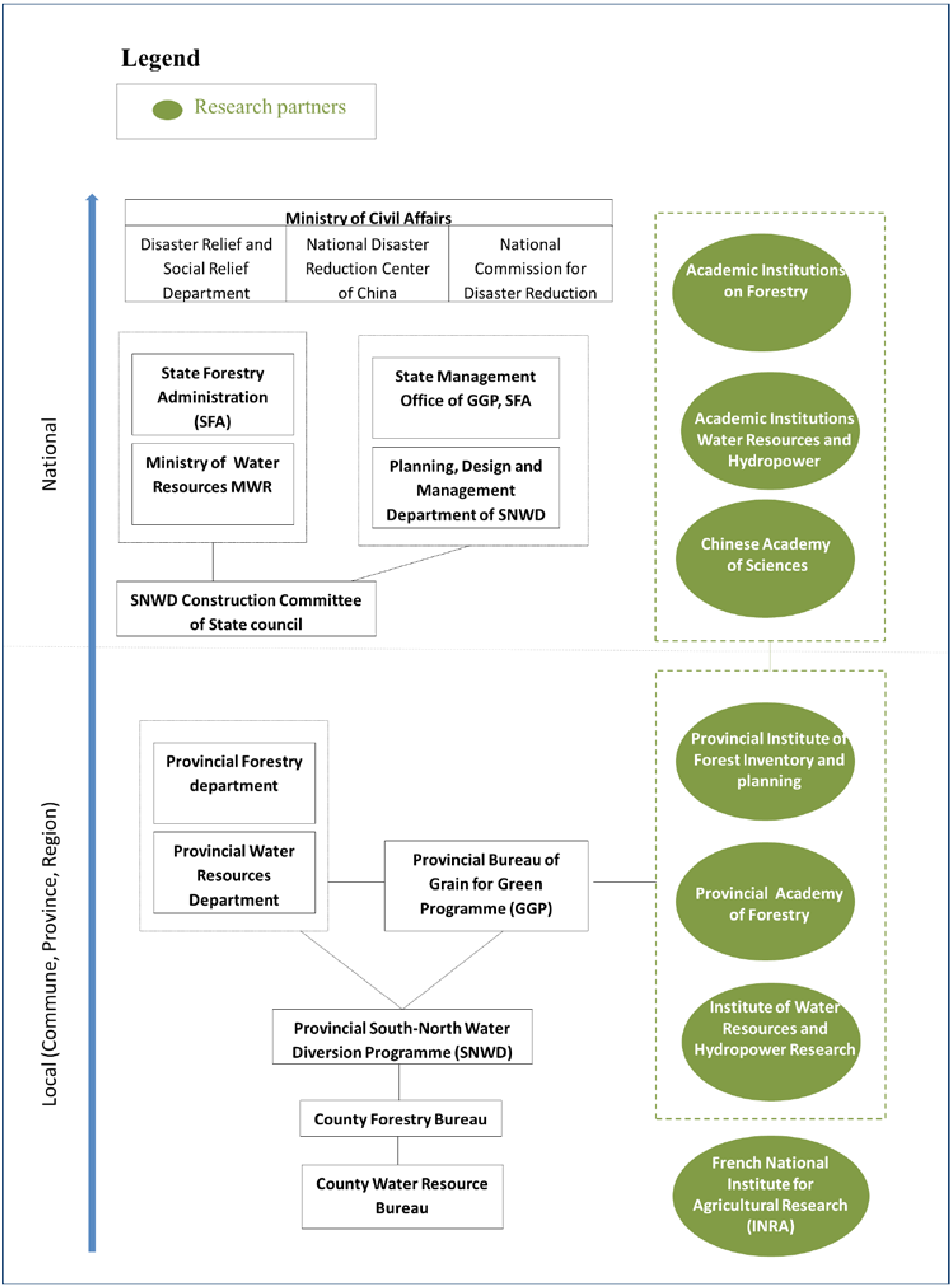
Annex 3

Multi-stakeholders involved with EPIC in Chile



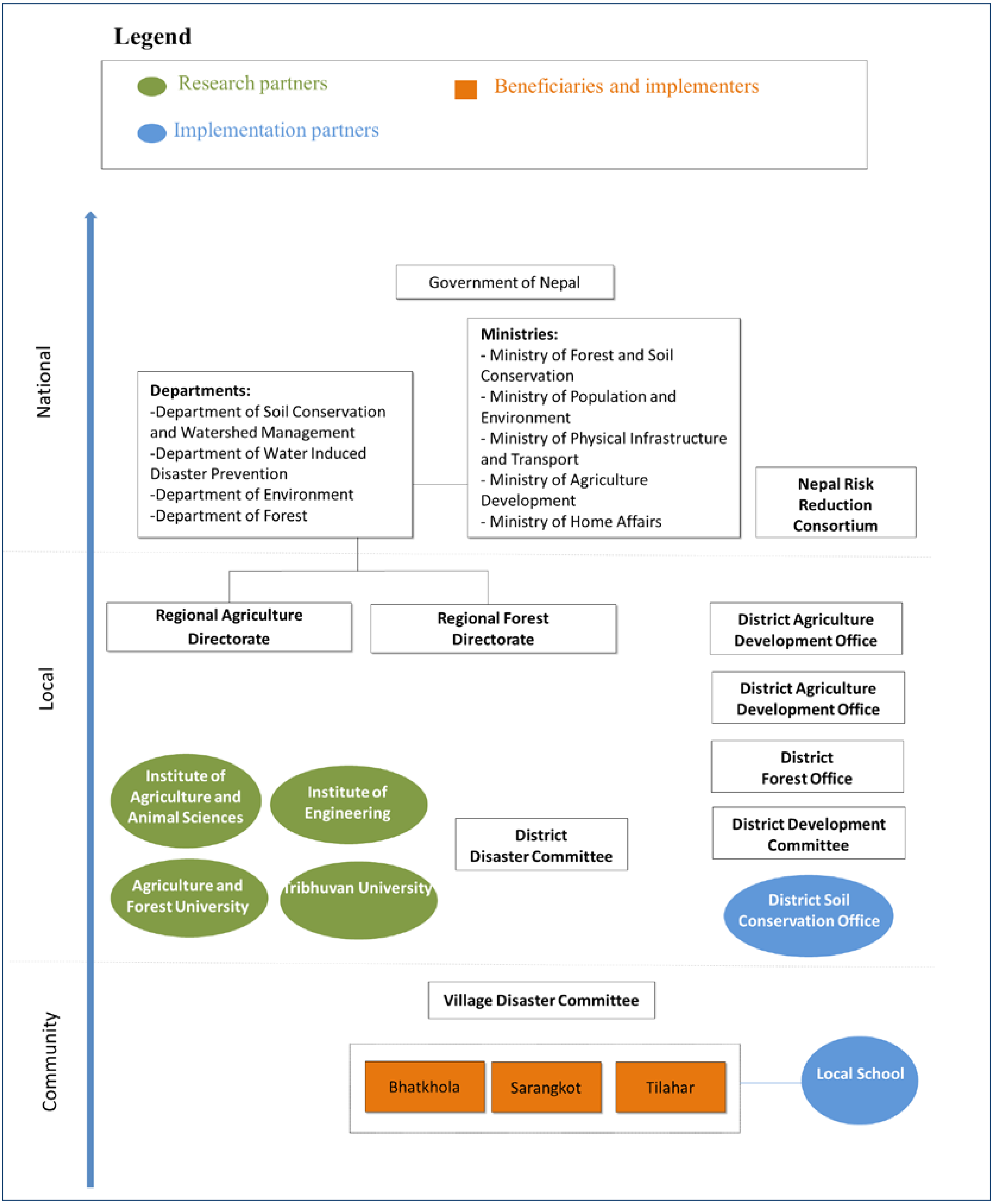
Annex 4

Multi-stakeholders involved with EPIC in China



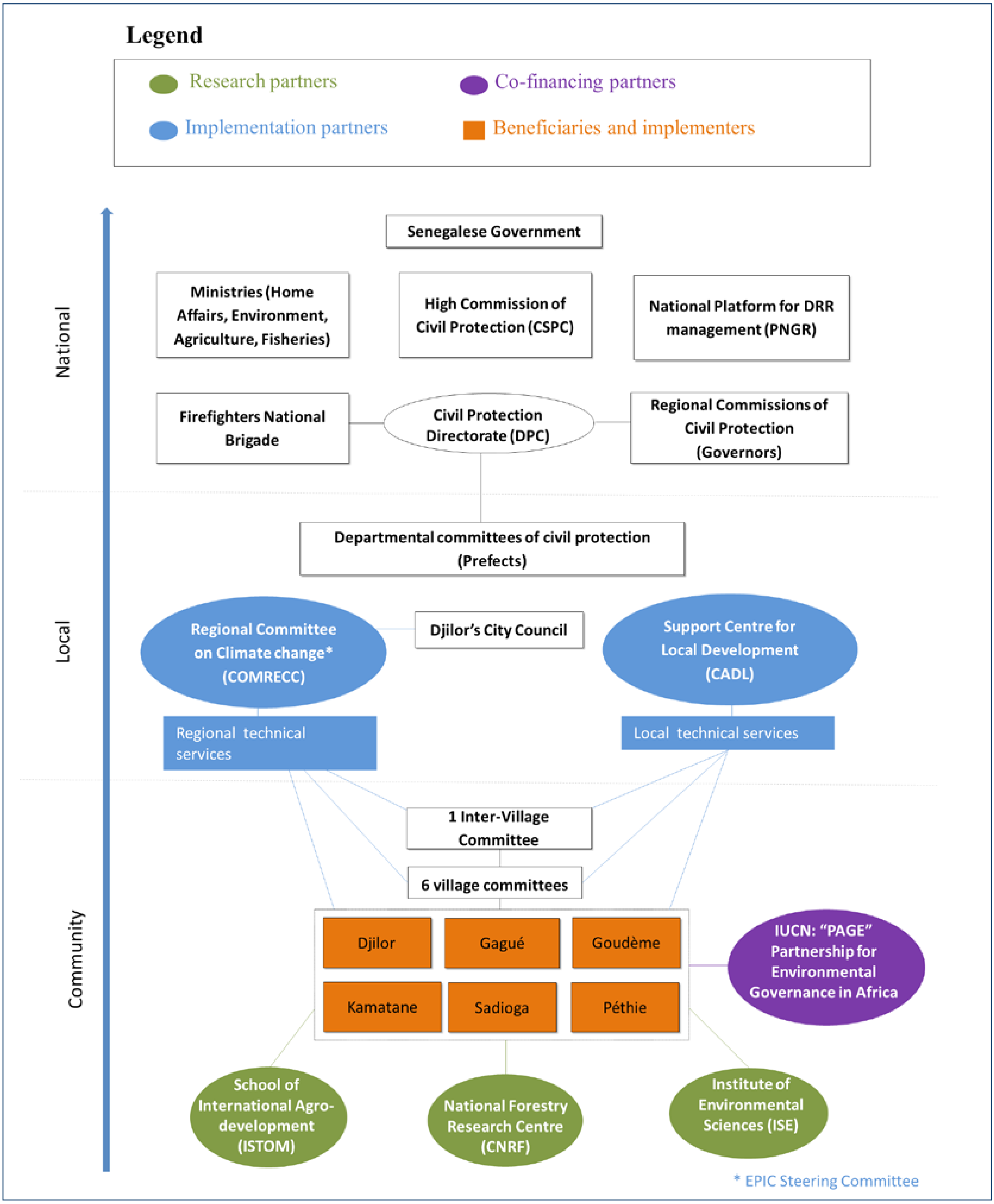
Annex 5

Multi-stakeholders involved with EPIC in Nepal



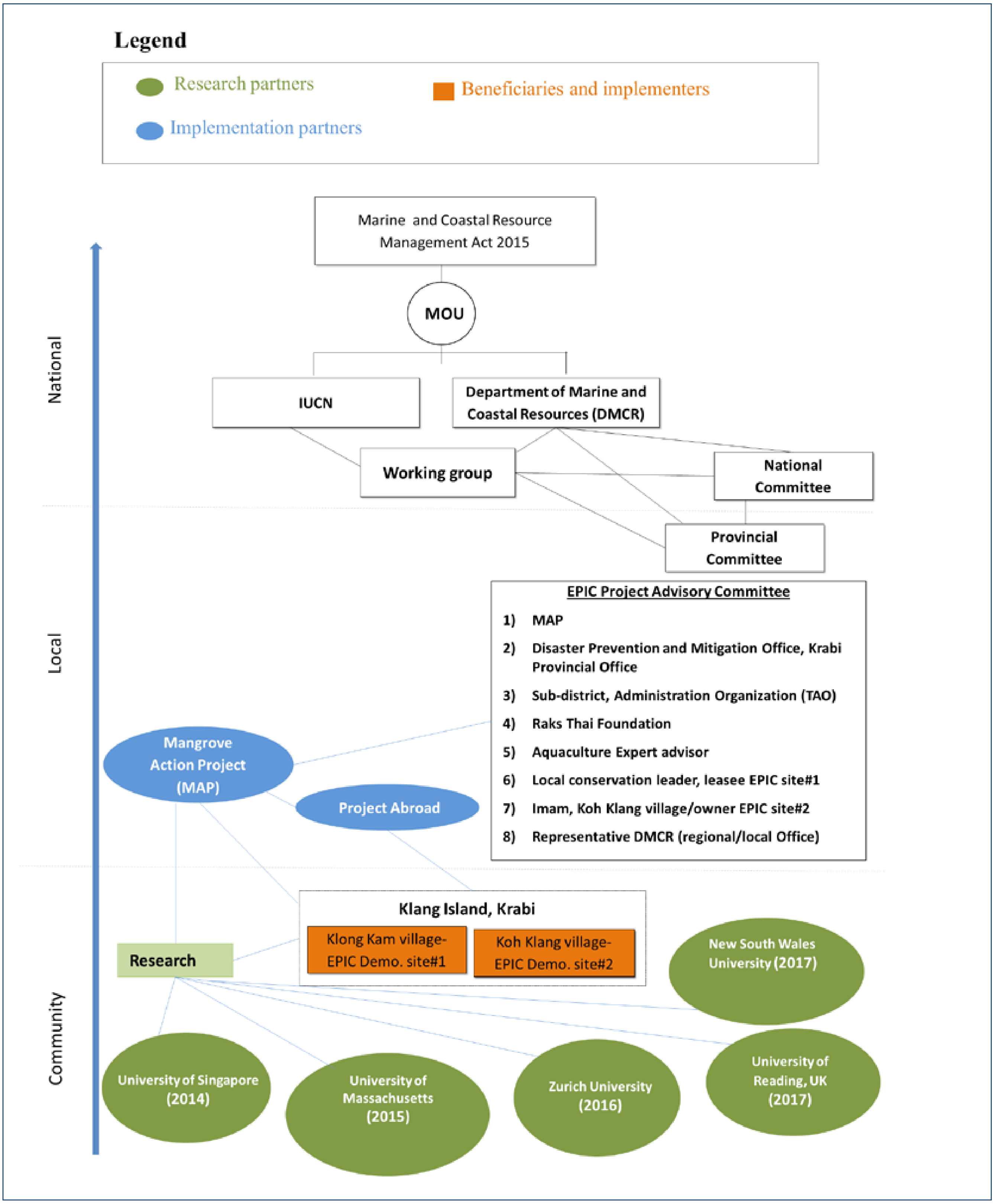
Annex 6

Multi-stakeholders involved with EPIC in Senegal



Annex 7

Multi-stakeholders involved with EPIC in Thailand



INTERNATIONAL UNION
FOR CONSERVATION OF NATURE

WORLD HEADQUARTERS
Rue Mauverney 28
1196 Gland, Switzerland
Tel: +41 22 999 0000
Fax: +41 22 999 0002
www.iucn.org