Nature Based Solutions for Climate Change Adaptation – Knowledge Gaps

An Analysis of Critical Knowledge Gaps, Needs, Barriers and Research Priorities for Adaptation

Ali Raza Rizvi and Kirstin van Riel
## Contents

ABSTRACT ................................................................................................................................. 3

ABBREVIATIONS AND ACRONYMS ......................................................................................... 4

1. INTRODUCTION .................................................................................................................. 5
   1.1 CONTEXT AND RATIONALE .......................................................................................... 5
   1.2 METHODOLOGY ............................................................................................................ 6
   1.3 STRUCTURE OF THE PAPER ........................................................................................ 8

2. THE CRITICAL KNOWLEDGE GAPS AND NEEDS IN ADAPTATION RESEARCH ................. 9

3. ADDRESSING KNOWLEDGE BARRIERS, LIMITS AND CHALLENGES FOR EbA AND CCA .... 14
   3.1 DEALING WITH UNCERTAINTY .................................................................................... 14
   3.2 SCIENCE-POLICY BARRIERS ....................................................................................... 15
      3.2.1 Knowledge and Action on the ground ................................................................. 15
      3.2.2 Limited Capacity ................................................................................................. 16

4. THE WAY FORWARD ............................................................................................................ 16
   4.1 RECOMMENDATIONS FOR FURTHER ACTION ......................................................... 17
   4.2 PRIORITY AREAS FOR FURTHER RESEARCH ......................................................... 21

5. CONCLUSION ....................................................................................................................... 22

REFERENCES ............................................................................................................................ 23

ANNEX-I Glossary of commonly used terms ............................................................................. 26
ABSTRACT

Adapting to climate variability and change has become a growing priority area and many countries and regions, both developing and developed, recognize the urgency thereof. In response, a vast array of information and knowledge have been generated over the years through completed and ongoing research on climate related impacts and risks, vulnerability and adaptation to climate variability and change. In light of this, it is essential to assess the current state of knowledge available and what specific information is still required in order to identify areas that require attention and research to further our understanding. This information is useful to inform policy and decision-makers on viable and appropriate adaptation options.

Drawing on from available, recent literature, this paper provides an analysis of current and prevailing knowledge gaps, needs and barriers concerning climate change adaptation in general, and ecosystem-based adaptation in particular. In addition, priority areas for further research and action were identified.

The identified knowledge gaps and needs are both general and sector-specific and span a range of interconnected themes. The barriers and challenges relate to uncertainty, the science-policy-action interface as well as limited institutional capacity. To address these barriers the following recommendations are proposed: i) strengthening action learning and knowledge management inter- and cross sectoral and with multiple stakeholders; ii) ensure active participation, the integration of local, traditional knowledge and gender consideration; iii) advance the scientific case for ecosystem-based adaptation; iv) mainstream climate change and ecosystem-based adaptation initiatives into policies and plans; v) build capacity at multiple levels; vi) develop and test tools/methods for implementing and assessing different ecosystem-based adaptation approaches, and vii) ensure ongoing monitoring and evaluation of climate change and ecosystem-based adaptation approaches necessary for the sustainable management of natural resources and the resilience of both human society and the natural environment to climate.

Keywords: Adaptation, Capacity building, Climate change, Ecosystem-based Adaptation, Knowledge gaps, Knowledge management, Resilience and Vulnerability.
## Abbreviations and Acronyms

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
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<tbody>
<tr>
<td>AR5</td>
<td>The Intergovernmental Panel on Climate Change Fifth Assessment Report</td>
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<td>CBA</td>
<td>Community-based Adaptation</td>
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<td>CBD</td>
<td>Convention on Biological Diversity</td>
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<td>CCA</td>
<td>Climate Change Adaptation</td>
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<td>CBNRM</td>
<td>Community-based Natural Resource Management</td>
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<td>DRR</td>
<td>Disaster Risk Reduction</td>
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<tr>
<td>EbA</td>
<td>Ecosystem-based Adaptation</td>
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<td>EPIC</td>
<td>Ecosystems Protecting Infrastructure and Communities project</td>
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<td>GEF</td>
<td>Global Environment Facility</td>
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<td>IPCC</td>
<td>Intergovernmental Panel on Climate Change</td>
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<td>IUCN</td>
<td>International Union for the Conservation of Nature</td>
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<td>MCA</td>
<td>Multi-Criteria analysis</td>
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<td>M&amp;E</td>
<td>Monitoring and Evaluation</td>
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<td>NAPA</td>
<td>National Adaptation Programmes of Action</td>
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<td>SIDS</td>
<td>Small Island developing states</td>
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<td>SWOT</td>
<td>Strengths, Weaknesses, Opportunities &amp; Threats analysis</td>
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<tr>
<td>UNDP</td>
<td>United Nations Development Programme</td>
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<td>UNEP</td>
<td>United Nations Environment Programme</td>
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<td>UNFCCC</td>
<td>United Nations Framework Convention on Climate Change</td>
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1. INTRODUCTION

1.1 CONTEXT AND RATIONALE

Climate variability and change and the related risks and impacts, have gained growing momentum and global awareness over the years. The significant adverse impacts of climatic changes (i.e. rising sea levels, increased temperatures) and climate-related extreme events (i.e. floods, drought) across regions, the natural environment and human society - which are projected to amplify and create new risk- has urged nations to recognize the urgent need to plan for and implement viable adaptation options (strategies and measures) (IPCC, 2014; Meinke et al., 2009).

Accordingly, adapting to climate variability and change has become a priority area and has increasingly gained recognition within the context of international negotiations on climate change (refer to Box 1). In response, many countries and regions, both developing and developed, have started to incorporate potential adaptation strategies into their overall development planning processes through national adaptation strategies and action plans (i.e. National Climate Change Adaptation Plans – NAPA’s) (IPCC, 2014; UNFCCC, 2011).

Climate change adaptation (CCA) approaches taken by a country or region is specific to its context and adaptation needs and could include the following: hard, engineered infrastructure-based investments (i.e. sea walls); community-based adaptation (CBA) and/or the use of nature-based solutions such ecosystem-based adaptation approaches (EbA). Ecosystem-based adaptation approaches have gained growing recognition and are intended to help people and communities adapt to climate change through the use of biodiversity and ecosystem services into an overall adaptation strategy (Doswald et al., 2014).

As adaptation has gained importance in addressing climate change issues, concerted efforts by research institutes, government agencies and multiple national and international organizations has led to a significant amount of research concerning climate change, vulnerability and adaptation. The information and knowledge gathered through the research enhance and improve our understanding on climate related impacts, vulnerability and adaptation, intended to increase the resilience of human society and the natural environment (Davis & Turner Walker, 2013). The recently published Fifth assessment report (AR5) by the Intergovernmental Panel on Climate Change (IPCC, 2014:4) indicated that the number of scientific publications available for assessing climate-change impacts, adaptation, and vulnerability more than doubled between 2005 and 2010, with a rapid increase in published resources related to adaptation in particular.

With such a vast array of information and knowledge products generated through completed and ongoing research, it is essential to assess the current state of knowledge available and what specific information is required. Furthermore, as stated by Davoudi et al. (2011:7), the “progress and effectiveness of adaptation and policies needs to be continuously reviewed by identifying the critical gaps between increasing knowledge of adaptation challenges, resilience policy and actual implementation”. The findings are important to inform policy, decision-makers and practitioners on viable and appropriate adaptation options. In addition, it can improve and guide forthcoming research so as to advance adaptation (Meinke et al., 2009; Mercer et al., 2012).
The purpose of this paper is therefore to provide an analysis of current and prevailing knowledge gaps and needs in CCA and EbA particularly, as well as the barriers and challenges that hinder adaptation planning and implementation. In addition, this paper will provide insight into where potential research should be focused for future knowledge generation. Specifically, this paper intends to address the following questions:

- **What are the current, critical knowledge gaps and needs for climate change adaptation and ecosystem-based adaptation in particular?**
- **What further action must be undertaken to close the identified knowledge gaps and aid development of strategies for adapting to climate change?**

### Box 1 Adaptation within international negotiations on climate change

The United Nations Framework Convention on Climate Change (UNFCCC) and its Kyoto Protocol, accepted in 1997, have been the principal institutional frameworks by which climate policy is developed. The UNFCCC encourages its Parties (from developed and developing countries) to formulate, implement, publish and update adaptation measures, as well as to cooperate on adaptation action. It provides several support mechanisms for the implementation of adaptation in developing countries, such as measures on the provision of funding, insurance and technology transfer as well as scientific and technical assistance for all Parties to enhance their knowledge base.

In 2005 the Parties to the UNFCCC established the Nairobi Work Programme as a comprehensive approach to addressing adaptation. This programme on impacts, vulnerability and adaptation to climate change serves as a platform for the dissemination of scientific and technical knowledge, and aims to support and facilitate the implementation of adaptation.

Beyond the UNFCCC process, a host of other international institutions contribute to and support climate policy and/or work alongside governments, multilateral and bilateral agencies, public and private sectors and local communities on adaptation projects. Such international institutions include, for example, the Intergovernmental Panel on Climate Change (IPCC), the United Nations Environment Programme (UNEP), the Global Environment Facility (GEF), the United Nations Development Programme (UNDP) and the World Bank.

Throughout recent years, the significance and enhanced action on adaptation has been continuously reiterated through, for example, the IPCC’s Assessment Reports; the Organisation for Economic Co-operation and Development (OECD) Declaration on Integrating Climate Change Adaptation into Development Co-operation report; the Bali Action Plan (2007), and the Cancun Adaptation Framework (2010).

**Source:** OECD, 2009; Spearman & McGraw, 2011 and UNFCCC, 2010.

### 1.2 Methodology

This analysis is based on a rapid assessment of a broad range of available and recent literature on knowledge gaps and needs, barriers and challenges as well as areas for further action and research in relation to CCA and EbA in particular. The literature reviewed covered different geographical regions (mainly Europe, Asia, Africa and Small Island developing states – SIDS) and a broad range of sectors. However, it should be mentioned here that it will not extensively include country or sector specific gaps, needs and barriers, due to time constraints and lack of available information thereof.
In addition, the analysis also draws on the recently published International Union for Conservation of Nature (IUCN) Ecosystem Based Adaptation Mapping Analysis \(^1\) by A. R. Rizvi (2014). This mapping analysis covered the various EbA related projects that IUCN Regions and Thematic Programmes are currently implementing or have already completed.

For a common understanding of some of the key terminologies used within this paper, definitions are provided in Box 2. A more extensive glossary of terms related to climate change adaptation is provided in ANNEX-I.

### Box 2: Definitions of Key Terminologies

<table>
<thead>
<tr>
<th><strong>Definition</strong></th>
<th><strong>Description</strong></th>
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<tr>
<td><strong>Climate change</strong></td>
<td>“Refers to a change in the state of the climate that can be identified (i.e. by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcing’s such as modulations of the solar cycles, volcanic eruptions, and persistent anthropogenic changes in the composition of the atmosphere or in land use” (IPCC, 2014:4).</td>
</tr>
<tr>
<td><strong>Climate change Adaptation (CCA)</strong></td>
<td>“Adjustments in natural or human [social and economic] systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities” (IPCC, 2014:4).</td>
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<tr>
<td><strong>Ecosystem-based Adaptation (EbA)</strong></td>
<td>As defined by the CBD (2009:41): “EbA is the use of biodiversity and ecosystem services as part of an overall adaptation strategy to help people to adapt to the adverse effects of climate change. Ecosystem-based adaptation uses the sustainable management, conservation, and restoration of ecosystems to provide services that enable people to adapt to the impacts of climate change”. (^2)</td>
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<tr>
<td><strong>Vulnerability</strong></td>
<td>“The degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity” (IPCC, 2014:5).</td>
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<tr>
<td><strong>Resilience</strong></td>
<td>“The capacity of social, economic, and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity, and structure, while also maintaining the capacity for adaptation, learning, and transformation” (IPCC, 2014:5).</td>
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<td><strong>Disaster Risk Reduction (DRR)</strong></td>
<td>“The concept and practice of reducing disaster risks through systematic efforts to analyse 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” (UNISDR, 2011).</td>
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<tr>
<td><strong>Knowledge gaps and needs</strong></td>
<td>“The gaps that need to be filled in order to further the understanding of climate change impacts, vulnerabilities, and innovative adaptation approaches. Knowledge needs also relate to identifying the tools and services [i.e. skills and networks] that would be most useful to enhance adaptation practices and successful project implementation” (Egan, 2013:4).</td>
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<tr>
<td><strong>Knowledge products</strong></td>
<td>“Products designed to meet different needs and to reach different audiences - core knowledge products include i.e. concept notes (e.g. short discussion papers) &amp; lessons learned papers (e.g. case studies), extract lessons from past and on-going projects that can be applied, and to replicate successes” (Egan, 2013:4).</td>
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<tr>
<td><strong>Knowledge Management</strong></td>
<td>“The practice of capturing, storing, access and sharing knowledge so that lessons can be learnt from the past as well as through case studies, and apply them in the future” (Egan, 2013:4).</td>
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<tr>
<td><strong>Action Learning – learning by doing process</strong></td>
<td>An approach for project implementation and action through a process of learning, research and critical reflection in order to act more effectively. In addition, Action Learning generates...</td>
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insights and understanding relevant to similar situations. This approach involves a varied group of stakeholders with a shared issue of concern.^

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<tr>
<th>Adaptation Barriers</th>
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<td>As defined by IPCC (2014:8): “Factors that make it harder to plan and implement adaptation actions [as it] restricts the variety and effectiveness of options for [a stakeholder] to secure their existing objectives, or for a natural system to change in ways to maintain productivity or functioning”. In addition, barriers hinder the way with which uncertainty and complexities surrounding global change (i.e. climate, socio-economic and/or ecological) are addressed (adapted from Naumann, 2011:40).</td>
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<th>Capacity building</th>
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<td>“The [ongoing] process of developing the technical skills and institutional capability to effectively address the causes and results of climate change” (Nang, 2013:34). “The goal of which is to enhance the ability to evaluate and address the crucial questions related to policy choices and modes of implementation among development options, based on an understanding of environment potentials, limits and of needs perceived by the people of the country concerned” (ISET,2008:38).</td>
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1.3 Structure of the Paper

This paper is structured into five sections:

Section 1 provides an introduction and includes information on the background and rationale of the paper, as well as the method carried out;

Section 2 outlines and describes the identified knowledge gaps, needs and further research areas;

Section 3 presents and discusses the identified barriers, limits and challenges that constrain the identification and effective implementation of viable adaptation options with regards to CCA and EbA.

Section 4 provides the way forward. This includes recommendations for action to fill the identified knowledge gaps and needs, followed by an overview of research priorities.

Section 5 concludes this paper.

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2. THE CRITICAL KNOWLEDGE GAPS AND NEEDS IN ADAPTATION RESEARCH

Drawing on the literature review, the findings identified a number of recurring, thus critical knowledge gaps and needs for CCA and EbA specifically, that will require further research and attention. These gaps and needs are both general and sector-specific, and span a range of interconnected themes.

The identified gaps and needs as well as priority areas for further research are as follows:

- **The implications of climate change on the natural system and human society need to be better understood**

  Understanding *how* and the *extent* to which climate change affects ecosystems, ecosystem services and human society (i.e. human health and economic development) is imperative at the onset of an adaptation approach. However, specific knowledge regarding this is still limited and there are severe knowledge gaps on the short and long-term implications of the impact of climate change on the natural environment and human society.

Based on the gap analysis, there is a specific need for information and knowledge products on the following:

- **Downscaled projections of climate change impacts and meteorological data.** Although downscaling is being carried out to some extent, there is still an issue of a lack of existing and accessible data (Davis & Turner Walker, 2013; UNECA, 2011);

- **Sector-specific information on the implications of projected climate change.** For example, agriculture, marine resources, water resources, forest ecosystems, ‘hot spots’ such as major river deltas, as well as human health and infrastructure (Davis & Turner Walker, 2013; Sterrett, 2011);

- **The relation between climate, hydro-geological changes and water induced hazards such as floods and droughts.** Particularly in Laos and the Himalayas and their downstream river basins (Davis & Turner Walker, 2013; Kuylenstierna et al., 2009; Sterrett, 2011);

- **The combined impacts of climate change and economic development on specific sectors** (i.e. agriculture, natural resources, food security and livelihoods) (Nang, 2013);

- **The influence of other drivers of global change, such as deforestation, invasive species, and human population growth, on the ability of ecosystems underpinning EbA to sustainably deliver adaptation services** (Davis and Turner Walker, 2013; Jones et al., 2012; Meinke et al., 2009; Nang, 2013);

- **The socio-economic aspects of climate change impacts related to water resources** (i.e. water demand and human health) (IPCC, 2008; Kuylenstierna et al., 2009);

- **The potential impacts of climate change on existing and future water development infrastructures** (UNEC, 2011);

- **The various facets of environmental vulnerabilities in the context of natural hazard risks** (i.e. flood, wildfires and drought) and *how it can affect ecosystems and natural resources* (UNSDR, 2011).
With respect to the implications of climate change on human society specifically, there are knowledge gaps in Asia of how communities in a certain location are and may be affected by climate change. Climate change induced migration requires attention in this context (Nang, 2013; Sterrett, 2011). Furthermore, while there is greater recognition of the linkages between gender and climate in research, knowledge and our understanding of gender-differentiated impacts of climate change is still limited (Nelson, 2007). For example, Nang (2013:27) identified that there is a knowledge gap on “the role of women in integrated water resources management as well as participatory irrigation development and management in the context of CCA”.

Besides the knowledge gaps of how climate change has and will affect the natural system and human society, there is also a “high need for information and knowledge on addressing the occurring impacts of climate change”. Such impacts include, for example, water shortage, loss and damage and decreased food security (Connelly, 2010:27).

Advance the evidence base of EbA and CCA effectiveness

The concept and practice of CCA, and EbA in particular, are still emerging and EbA remains underutilized by decision-makers. It is therefore of utmost importance to enhance and advance the evidence base of EbA and CCA approaches.

In this regard, the following key knowledge gaps and needs in relation to EbA were identified:

- **Whether EbA is being supported by local, national and international adaptation policies** (i.e. has it received attention within relevant policy documents such as NAPAs and sectoral strategies);
- **The success factors of EbA projects that instigated a policy change**;
- **Limited evidence of EbA effectiveness to support and encourage the implementation of EbA initiatives**.

(Doswald et al., 2014; Munang et al., 2014; Rizvi, 2014; UNEP, 2009).

With regards to CCA specifically, in Africa there is a need to mainstream CCA into policies and plans with respect to the water sector, in order to cope with the impacts of climate variability and change on water resources (UNECA, 2011).

Relevant to the above knowledge needs is the ongoing need for shared experiences and lessons learned on adaptation. This entails detailing both the successes and the challenges of particular adaptation initiatives and programmes as well as to promote knowledge generation and dissemination (IPCC, 2014; Sterrett, 2011). Moreover, there is a need for guidance on how best to implement adaptation strategies on ground (IPCC, 2014).

Knowledge gap and need of the cost and benefits of EbA and CCA measures

EbA measures are commonly cited as cost effective and some case studies have demonstrated the cost-effectiveness thereof. However, a strong evidence base for the overall effectiveness, costs and benefits of EbA concerning the actual and potential environmental and socio-economic effects is still deficient.
Several authors therefore emphasized the need for further research on the environmental, social and economic costs and benefits of EbA approaches and of different adaptation options in general (i.e. Andrade Pérez et al., 2010; IPCC, 2014; Munroe et al., 2011; Nang, 2013; Reid, 2011; Rizvi, 2014).

Particularly the following areas require greater attention and further research:

- **The economic costs of EbA approaches;**
- **Detailed comparisons between EbA and alternative strategies.**
  There is a knowledge gap of the potential trade-offs and benefits between Ecosystem-based approaches and hard, engineered investments as well as the combined effect when these approaches are used in combination (Munang et al., 2014; Munroe et al., 2011). In addition, there is a need for studies providing an analysis of two comparable sites, such as a ‘before and after’ situation or between sites with and without the implementation of adaptation measures (Reid, 2011). Moreover, the transboundary/downstream effects will need to be assessed.
- **Environmental and social costs and benefits in monetary (quantifiable data) and non-monetary terms (i.e. cultural values, human health and ecosystem services)** (UNFCCC, 2011).

The data from, in example, a cost-benefit analysis or economic valuation studies in addition to baseline data, are needed to influence policy and assist researchers and decision-makers to monitor and evaluate adaptation options. This leads to the next critical knowledge gap:

- **The continued Monitoring and Evaluation (M&E) of EbA and the wide range of CCA approaches**

The nature of climate change is complex and long-term, it is therefore essential that the implementation of adaptation actions are regularly monitored, evaluated and revised.

However, according to the recent AR5 of the Intergovernmental Panel on Climate Change (IPCC, 2014), there is insufficient monitoring and evaluation of the processes of implementation and the effects in terms of the progress, effectiveness, efficiency and overall utility of adaptation approaches. Accordingly, there is an urgent need for continued M&E to better quantify and understand the value of EbA and the range of CCA approaches, their progress, as well as the effects of climate change on ecosystems (IPCC, 2014; Mercer et al., 2012; Munang et al., 2014).

Furthermore, there is a need for information and practical guidance on how to monitor and evaluate CCA approaches (Sterrett, 2011).

- **Define a set of adaptation criteria and indicators**

In relation to the aforementioned knowledge gaps of the cost-effectiveness and the need for ongoing M&E, there is a need to develop a set of adaptation criteria and indicators to define, assess and monitor the effectiveness of CCA and EbA. These indicators need to be context and ecosystem specific. Currently, such criteria and indicators are lacking or too broad (Rizvi, 2014).

- **More research is required of the role of ecosystems in CCA and disaster risk reduction**

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There is a need for further research to enhance the understanding and quantify more systematically the cost-effectiveness and overall role (i.e. hazard protection, livelihood recovery) of ecosystems in disaster risk reduction (DRR) for different types of natural hazards (i.e. floods and drought) (PEDRR, 2013). Likewise, the report on adaptation knowledge needs by the United Nations Development Programme (UNDP) identified a “high need for CCA knowledge products on the linkages between CCA adaptation and both DRR and biodiversity, as well as climate change mitigation” (Connelly, 2010:27).

The role of ecosystems in DRR and CCA has not received sufficient attention in the current Hyogo Framework for Action (HFA) (UNISDR, 2011). With the upcoming third United Nations World Conference on DRR in 2015, there is a priority knowledge need to integrate and mainstream EbA, DRR and CCA into national and sub-national development planning and policy processes (Connelly, 2010; Davis and Turner Walker, 2013; PEDRR, 2013; UNISDR, 2011).

In line with the above, there is also a need for guidance on combined hard, engineered investments, ecosystem-based approaches and disaster risk management solutions (UNEP, 2009).

It is worthwhile to acknowledge here that efforts to fill these gaps are currently undertaken by ongoing projects, such as the Ecosystems Protecting Infrastructure and Communities project (EPIC). This is a multi-country, multi-agency and multi-stakeholder led initiative aimed at demonstrating the role of ecosystems in reducing the risks of disasters (i.e. droughts, landslides and coastal storms) for human resilience to climate change.

☐ Integrating local and scientific knowledge for CCA is needed

A number of authors specified that local, traditional knowledge is often underrepresented in adaptation initiatives (Davis & Turner Walker, 2013; Egan, 2013; Mercer et al., 2012; Munang et al., 2014). Accordingly, there is still a need to ensure the integration of local, traditional knowledge with scientific knowledge in the adaptation process. This is crucial in effectively and efficiently responding and adapting to climate change and to identify appropriate solutions (Davis & Turner Walker, 2013; Egan, 2013; IPCC, 2014).

☐ Understanding the potential thresholds, boundaries and tipping points across a range of EbA approaches

A limited number of studies have focused on the potential limitations of EbA approaches in relation to ‘thresholds’, ‘boundaries’ and ‘tipping points’ that could be exceeded in the future (near- to long-term) (see Box 3 for definitions). Such studies are required in order to inform and guide policy and decision-makers on adaptation options (IPCC, 2014; Munroe et al., 2011).

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5 EPIC Project link for further information:
<http://iucn.org/about/work/programmes/ecosystem_management/disaster/solutions/ecosystems_protecting_infrastruc
ture_and_communities/>
Several authors also identified a knowledge gap of the range of potential future climatic conditions under which particular EbA are effective. There is also a need for greater consideration on the temporal and spatial aspects of EbA effectiveness (Jones et al., 2012; Munroe et al., 2011). Thus, vulnerability assessments, scenario analysis and spatial analysis will need to be carried out.

**Box 3: Definitions of ‘Thresholds’, ‘Boundaries’ and ‘Tipping Points’**

| Thresholds | ‘Limit of climatic impact to which the approach can still provide adaptation benefits’. |
| Boundary | ‘Minimum size or the state of ecosystem necessary to provide the adaptation benefits’ |
| Tipping points | ‘The degree of disturbance – climatic as well as i.e. degradation, pollution, invasive species – that an ecosystem can cope with and still provide the ecosystem services that provide adaptation benefits’. |

Source: Munroe et al., 2011

- Develop and improve tools and methods

A key knowledge need is for improving the capacity of existing tools and methods and the dissemination and access thereof. In addition, there is a need to provide relevant guidance on the applicability and appropriate use of tools and methods. Moreover, there is a need for the development of new tools and methods.

Drawing on from the findings from the recent mapping analysis of IUCN’s EbA related projects (Rizvi, 2014); there is a need for the following:

- Appropriate tools for implementing the different EbA approaches;
- Tools for evaluating the impact of EbA strategies, and
- Defining and developing a standard operational framework for EbA.

Particularly, there is a critical need for an integrated tool or toolbox that addresses both communities’ vulnerabilities and those faced by local biodiversity and ecosystems. The capacity to undertake integrated assessments is still absent in many countries and the tools needed to facilitate such assessments are not always available or readily accessible (UNFCCC, 2010).

Additional tools that need to be developed include:

- Tools to assess the impacts of climate variability and change on freshwater resources (IPCC, 2008);
- To facilitate adaptive and anticipatory learning in the face of risks and uncertainties (Tschakert & Dietrich, 2010);
- Calculate the costs of adjustment to climate variability (ISET, 2008);

In a survey conducted by the UNDP (Connelly, 2010:42), respondents highlighted a need for knowledge products (i.e. guidance materials, case studies and tools) on climate change risk and impact assessments, vulnerability assessments, and adaptation.
Furthermore, a research priority in Cambodia as highlighted by Nang (2013:33) is to identify “how the Community-based natural resources management (CBNRM) model could be developed to maintain or improve its contribution to climate change adaptation and food security?”

3. ADDRESSING KNOWLEDGE BARRIERS, LIMITS AND CHALLENGES FOR EBA AND CCA

In order to effectively address the aforementioned knowledge gaps and needs, it is crucial to identify, understand and address the barriers, limits and challenges that constrain the identification and effective implementation of viable adaptation options.

Adaptation barriers are constraints which hinder the way with which uncertainty and complexities surrounding global change (i.e. climate, socio-economic and/or ecological) are addressed as well as the adaptation process (planning, design, implementation and integration). Consequently, opportunities and the range of adaptation options could become limited, potentially leading to actions that may undermine sustainability and/or increase vulnerability (maladaptation). (IPCC, 2014; Naumann, 2011).

Limits in this context are referred to as the point at which a stakeholders’ (i.e. researcher, decision-maker, organization) objectives or the natural systems’ needs cannot be secured from intolerable risks through adaptive actions, such as exceeding thresholds or reaching tipping point (IPCC, 2014).

There are various barriers and challenges that may be encountered and include: Structural or operational (i.e. institutional funding structures and incentive programmes); Governance (i.e. existing laws, regulations, institutional arrangements and adaptive capacity); Social and cultural (i.e. social norms, values, education and awareness); Biological (i.e. intensity and frequency of natural hazards, temperature and precipitation), and Capacity barriers (i.e. lack of financial resources, lack of awareness or access to information or technology and limited human-individual, organizational, and societal-capabilities) (IPCC, 2014; Naumann, 2011).

These various barriers and challenges interrelate and are specific to a country, region or organizational context. For that reason, this section will only address those that are commonly cited and thus the key barriers, limits and challenges in the process and knowledge base of ecosystem-based and climate change adaptation.

3.1 DEALING WITH UNCERTAINTY

The exact nature and magnitude of future climate change and climate variability impacts, as well as the socio-economic development, is coupled with uncertainty and unpredictability. This provides a major challenge for researchers, practitioners, policy and decision-makers alike in the formulation and implementation of adaptation approaches and policies (Davis & Turner Walker, 2013; ISET, 2008).
The limited understanding and high level of uncertainty of future climate projections and how systems will respond to long-term effects of climate variability and change could limit both CCA and EbA approaches as well as the intended impact thereof.

In addition, an uncertain factor for EbA specifically relates to the knowledge gap of its threshold, boundary conditions and potential tipping point (Andrade Pérez et al., 2010). This knowledge gap could restrict the widespread application of EbA and makes it difficult to justify the full potential of this approach in terms of socio-economic and environmental effectiveness (Doswald et al., 2014).

Furthermore, the level of uncertainty in terms of the complexity and long-term process of climate change poses a challenge on existing tools and models. This is with regards to their sufficiency for evaluating long time frames and sudden changes in the natural environment and socio-economic conditions (Tschakert & Dietrich, 2010).

Dealing with such uncertainties and the long timescales associated with climate change requires a longer-term view, even though the project context is short-term (AFB, 2009).

3.2 SCIENCE-POLICY BARRIERS

In addition to uncertainty, there are a number of barriers that hinder the integration of science and decision-making. These are described below.

3.2.1 Knowledge and Action on the ground

Contributions from past and ongoing CCA and EbA has generated a vast amount of information, however, these are often not disseminated or remain inaccessible to decision-makers (Davis & Turner Walker, 2013; Tschakert & Dietrich, 2010). This can primarily be attributable to uncertainty on what type of knowledge should be generated and shared, how this will be tailored to reach the different audiences, and who are responsible for disseminating the information as well as how it is applied in practice (Egan, 2013; ISET, 2008). Consequently, the information and knowledge generated do not always meet the demand and needs of different user-groups.

The identified challenges for effectively communicating and sharing knowledge include the following:

- **Language barrier.** There is a demand for climate and adaptation research to be written in national and local languages. Additionally, scientific findings are often in a technical language difficult to understand (Davis & Turner Walker, 2013; Tschakert & Dietrich, 2010; UNISDR, 2011).

- **Communication platforms/networks are scarce.** While a number of communication/knowledge platforms exist, there are few that provide relevant information that is tailored and communicated to the public and decision-makers. Particularly for Africa, such platforms are limited (i.e. in relation to water resource management) (Davis & Turner Walker, 2013; Tschakert & Dietrich, 2010; UNECA, 2011);

- **Barriers to access climate change and adaptation knowledge such as infrastructure and technology** (UNEC, 2011). Particularly in developing countries there is a need for government established centres and institutions that provide research, education and scientific and technical support in relation to climate change, adaptation and DRR (IPCC, 2014; UNISDR, 2011).
Where information and knowledge products are accessible, the uptake and use thereof is not always sufficient. Decision-makers need to be informed on how to apply the knowledge in practice and make decisions based upon the available information (Davis & Turner Walker, 2013);

Inadequate collaboration and cooperation among different agencies, multi-sectoral institutions and relevant stakeholders leading to fragmented adaptation efforts. This is partly due to a lack of consensus and conceptual understanding (Sterrett, 2011; UNECA, 2011). In addition, there is minimal cross-fertilization or shared learning (ISET, 2008; Rizvi, 2014).

It should be noted here though that the barriers and access to information and knowledge varies across regions and institutional levels. As pointed out by Davis and Turner Walker (2013), across Asia, the countries which have faced major hazards and risks (i.e. Philippines and Bangladesh) have established a substantial knowledge base, while other countries have limited information and hence lack a knowledge base.

Furthermore, limited institutional capacity of a country will augment the above barriers.

3.2.2 Limited Capacity

Limited institutional capacity, defined as deficiencies in human, financial, scientific and technical resources, is a significant barrier in both developing and developed countries. The reason being that insufficient capacity constrains a country’s ability to effectively and sustainably manage natural resources and adapt to climate-related risks and impacts (Davis and Turner Walker, 2013; Nang, 2013). In addition, it hinders research and the adaptation process, leading to limited relevant information and knowledge products on climate change and adaptation options (Egan, 2013). This in turn constrains effective decision-making concerning CCA and EbA and consequently, limits the development and implementation thereof.

There is therefore an urgent need to build capacity at multiple levels (from community to national), particularly in regions across Asia and Africa, and enhance the development of relevant national policies and integrated implementation strategies (Egan, 2013; Johnson, 2010; Tschakert & Dietrich, 2010). This, however, requires increased multi-stakeholder involvement and collaboration as well as an increased level of awareness amongst decision-makers and the general public (Naumann, 2011).

To support the adaptation process and capacity building critical for human resilience, it is also of prime importance to facilitate knowledge sharing (i.e. lessons learned, experiences, best and failed practices, tools and skills) and Action learning among researchers, practitioners, policy, decision-makers and local communities. Action learning is an approach for project implementation through a collaborative process of learning, research and critical reflection (‘learning by doing’) (Fisher & Jackson, 1999).

4. THE WAY FORWARD

While extensive progress has already been made, and a number of ongoing and proposed projects address some of the identified gaps and needs, our knowledge base is far from complete and more remains to be done. Bridging the knowledge gaps and addressing the needs is imperative to support and promote evidence-based policy and decision-making processes.
Addressing the gaps and needs as well as overcoming barriers will however require concerted and joint action by all relevant stakeholders, agencies and multi-sectoral institutions at different levels of governance.

This analysis thus emphasizes the need for further research and action to bridge these gaps and overcome the identified barriers through a multi-stakeholder process in a coordinated and collaborative manner; improve our understanding, and build capacity at multiple levels so as to advance adaptation for climate resilience.

Besides addressing the gaps and needs, it is important to understand that adapting to climate change is a complex, long-term and iterative process that will require amending practices, resources, programmes and plans to best suit the changed conditions. There is therefore also a need for flexibility and long-term commitment from all concerned.

The findings of this analysis provide useful insights on current knowledge gaps and needs related to EbA and CCA in general, to inform the stakeholder groups and various expert organizations involved in the adaptation process (from planning to actual implementation and integration). In addition, the findings can be useful to guide and strengthen the adaptation programmes of IUCN and its partners.

Recommendations intended to fill the identified knowledge gaps and support the development of strategies for adapting to climate change are provided in the next part of this section. Following this is an overview of research priorities.

4.1 RECOMMENDATIONS FOR FURTHER ACTION

Drawing on the findings provided in the previous sections, the following recommendations for further action are proposed. These recommendations are targeted at the various stakeholder groups involved in the adaptation process concerning EbA and CCA.

- **Strengthening Action Learning and Knowledge Management**
  Managing knowledge (i.e. generating, storing and disseminating) and undertaking Action learning are vital in supporting adaptation actions throughout the entire adaptation process, and need to be strengthened and ongoing for the following reasons: i) to effectively guide projects; ii) influence policy; iii) enhance collaboration and coordination between organizations, the public, private sectors and countries; iv) improve our understanding and v) to enhance awareness.

  These processes also involve the joint development of research needs and consensus building among researchers, practitioners and policy-makers. In turn, this will help policy and decision-makers make better-informed adaptation decisions in spite of uncertainty.

- **Strengthen and/or establish information-sharing systems that facilitate better integration, uptake and exchange of information and knowledge to inform policy/decision-making.**
  The vast amount of generated information, data and knowledge products concerning CCA and particularly EbA, need to be collated and effectively managed in information-sharing systems and services (i.e. web-based global/national knowledge platforms, portals and forums). This will make
existing knowledge widely available to different-user groups and the public, enhance knowledge sharing, cross fertilization, and promotes learning.

Such a system will also allow for the identification and assessment of what is already known, the efficacy of the knowledge products and what is still required in terms of information and knowledge products.

For the generated information and knowledge products to reach a wider audience, researchers and practitioners should write this in an easily understandable manner and tailored to different target audiences.

Box 4 highlights various valuable global and regional knowledge platforms concerning climate and adaptation.

**Box 4: Links of a few valuable global and regional knowledge platforms concerning Climate and Adaptation**

- Regional Climate Change Adaptation Knowledge Platform for Asia (AKP): http://www.climateadapt.asia/
- WeAdapt: http://weadapt.org/
- Adaptation Learning Mechanism (ALM) facilitated by the UNDP: http://www.adaptationlearning.net
- Knowledge for Climate: http://knowledgeforclimate.climateresearchnetherlands.nl/

☐ Ensure active participation, the integration of local, traditional knowledge, and incorporate gender- and rights- based considerations

A multi-stakeholder, participatory process that incorporates a gender- and rights- based approach is important for the long-term success of an adaptation process. The reason is that it allows for the recognition of diverse interests and needs as well as the exchange of different knowledge relevant to the issue at hand. A gender- and rights based approach is particularly necessary in the agricultural, fishery and forestry sectors.

Researchers and practitioners need to ensure the integration of local, traditional knowledge of communities, promote gender equity, and support a greater representation of women in both the decision-making and implementation processes for adaptation initiatives.

Policy-makers on the other hand should empower the ability of local stakeholders to participate in decision-making processes.

A few useful methods for knowledge co-creation and sharing are presented in Box 5.
Advance the scientific case for EbA.
The scientific case for EbA needs to be further advanced for the following reasons:

- To gain political commitment across different levels (local to national, predominantly at the national);
- For better informed decision-making;
- Encourage its implementation;
- To ensure the systematic integration of EbA approaches into broader adaptation strategies, such as CCA, national adaptation programmes of action (NAPA’s), disaster risk reduction planning and into overall conservation and development planning;
- Ensure the provision of funding.

In this regard, and to address the need thereof, it is important to develop an economic argument of integrating EbA approaches. Accordingly, assessing the cost and benefit thereof needs to be an integral part of an EbA project.

Guidance is however required on how to effectively implement the approaches concerning EbA and CCA.

Mainstreaming CCA and EbA initiatives into policies and plans.
Practitioners and policy-makers are well placed to support, advocate and facilitate mainstreaming efforts needed for the systematic integration of EbA and CCA approaches into national development and sectoral policies and plans.

It is however important to adopt an integrative bottom-up (locally-driven, ‘learning by doing’) and top-down (government and institution driven using climate modelling) approach to ensure the integration of EbA approaches into broader adaptation strategies as it improves linkages (Andrade Pérez et al., 2010; Groot et al., 2014; Mastrandrea et al., 2010; Sterrett, 2011).

In Africa, CCA approaches need to be mainstreamed into policies and plans concerning the water sector.

Capacity Building at Multiple Levels
Capacity building should be a relevant component of an adaptation project for the following reasons: i) to allow for effective, multi-stakeholder, participatory processes integrating scientific and local, traditional knowledge; ii) to raise awareness; iii) for generating and disseminating knowledge on an on-going basis; iv) to enhance learning and v) for necessary resource allocation and financial support.

Box 5: Few methods for knowledge co-creation and sharing.

- Strengths, Weaknesses, Opportunities & Threats analysis (SWOT) analysis;
- Multi-criteria analysis (MCA);
- Scenario building workshops, and
- Visualization techniques/tools.

Source: Groot et al., 2014
Ways in which this can be achieved are provided in Box 6.

**Box 6: Few examples of ways to achieve capacity building**

- **Advocacy**: i.e. through media and policy briefings;
- **Multi-stakeholder workshops and forums**;
- **Allocating adequate financial, technological and knowledge resources**;
- **Conduct situation analysis, needs assessment** or **a National Capacity Self-Assessment** for the identification of country specific priority sectors, barriers and policy needs (Johnson, 2010);
- **Establish centres and institutions** that provide research, education & training services as well as scientific and technical support.

Capacity building is one of the guiding principles of EbA and completed EbA projects have played an important role in this regard. For example, the project “Building Resilience to Climate Change, Coastal Southeast Asia” currently (2011-2014) undertaken by IUCN in Thailand, Cambodia and Vietnam has led already to enhanced capacities. This in turn resulted in a better understanding of climate change issues as well as to plan and integrate CCA and DRR approaches within their provincial development strategies and sectoral activities (Rizvi, 2014).

- **Overcoming Uncertainties**
  Uncertainties will remain an inherent factor to adaptation decision-making. Therefore, they should be acknowledged and taken into account in the adaptation process in order to support decision-making. Researchers should communicate uncertainties with practitioners, policy and decision-makers and provide guidance on how they can deal with it.

A high level of collaboration and cooperation between researchers, practitioners, policy and decision-makers is also required. This will allow for the identification of robust, no-regret adaptation options through an iterative processes of action learning, reviewing and adjusting plans when needed (Groot *et al.*, 2014).

- **Develop and Test Tools and Methods**
  There will be a constant need for the development and provision of new research tools and methods as well as updating existing ones as our understanding improves and as the environment and socio-economic circumstances change.
  The new and existing tools and methods need to be pilot tested in the field to assess their value and efficiency as well as to identify those best suited to specific needs and contexts.

In addition, the dissemination, guidance (i.e. through training) and the use of the methods and tools need to be enhanced.

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6 This information draws on the IUCN EbA projects’ mapping analysis survey questionnaire which was distributed to IUCN’s Regional Offices and Global Thematic Programmes. Information on the knowledge products from this project as well as other IUCN EbA related projects can be found in the report by A.R. Rizvi (2014): [https://cmsdata.iucn.org/downloads/eba_in_iucn___mapping_analysis.pdf](https://cmsdata.iucn.org/downloads/eba_in_iucn___mapping_analysis.pdf).
It will be beneficial to collate the various available tools and methodologies employed in EbA and CCA projects in a centralised source of information (i.e. inventory).

Ensure On-going Monitoring and Evaluation (M&E)

Given the constantly changing environment, it is important that M&E activities are enhanced and its continuation ensured in terms of validating adaptation actions, including projects, policies and programmes. This is essential for decision-making and the implementation of effective adaptation approaches. In addition, undertaking M&E will support the necessary generation of an evidence base of EbA and CCA in general.

Furthermore, M&E provides a valuable means to enhance ‘learning by doing’ and the potential to adapt planned actions to changing conditions. It is therefore imperative that it becomes a part in the process of any adaptation policy and approach. M&E activities can be undertaken throughout the adaptation process and/or after the implementation thereof. (Andrade Pérez et al., 2010:162; Tschakert & Dietrich, 2010).

4.2 Priority Areas for Further Research

A number of further research needs were identified and highlighted in section 2 of this paper. A summary thereof is provided in the Table below.

Table 1 Overview of priority research areas and needs

<table>
<thead>
<tr>
<th>Theme</th>
<th>Research needs</th>
<th>Specific priority areas (where applicable)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climate change impacts</td>
<td>How and the extent to which climate change effect ecosystems, ecosystem services and human society (i.e. human health, water demand, food security and economic development)</td>
<td>- Study the potential implications of projected climate change on specific sectors;</td>
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<td></td>
<td></td>
<td>- Asses how communities in a certain location are and may be affected by climate change (i.e. climate change induced migration and gender-differentiated impacts of climate change);</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Analyse the combined impacts of multiple stressors on specific sectors (i.e. agriculture, natural resources, food security);</td>
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<tr>
<td></td>
<td></td>
<td>- Assess the occurring impacts of climate change in relation to water shortage, loss and damage and decreased food security.</td>
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</table>

<p>| Assess a range of potential future climatic conditions under which particular EbA options are effective | - Assess potential thresholds, boundary conditions and tipping points of EbA approaches;                                                                                   |
|                                                                                                           | - Assess temporal and spatial aspects of EbA effectiveness.                                                                                                                |</p>
<table>
<thead>
<tr>
<th>Effectiveness of EbA and CCA approaches</th>
<th>Advance research on lessons learned (successes &amp; challenges) and documenting best and failed practices (i.e. through case studies) for EbA and CCA in general</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assess the environmental, social and economic cost and benefits of EbA and CCA approaches.</td>
<td>• The economic costs of EbA approaches; • Detailed comparisons between EbA and alternative strategies; • Measure and value the monetary and non-monetary aspects of adaptation approaches.</td>
</tr>
<tr>
<td>Advance research on the role of ecosystems in DRR for different types of natural hazards.</td>
<td>• Conduct cost-effectiveness studies of ecosystem services in the context of disasters; • Generate and share knowledge on the linkages between CCA, DRR, biodiversity and climate mitigation.</td>
</tr>
<tr>
<td>Tools and Methods</td>
<td>Investigate and develop a set of adaptation criteria and indicators</td>
</tr>
<tr>
<td>Develop, research and test tools and guidance material</td>
<td>Context and ecosystem specific performance indicators to define, assess, monitor &amp; evaluate the impact and effectiveness of CCA and EbA.</td>
</tr>
<tr>
<td>Develop:</td>
<td>• Participatory, learning &amp; guidance tools; • Integrative vulnerability assessment tools.</td>
</tr>
<tr>
<td>Assess and evaluate:</td>
<td>• climate change risk, impact, vulnerability and adaptation; • Impact and actual implementation of adaptation approaches.</td>
</tr>
<tr>
<td>Examine how the Community-based Natural Resources Management model could be developed to maintain or improve its contribution to CCA and food security.</td>
<td></td>
</tr>
<tr>
<td>Capacity</td>
<td>Conduct research to identify country specific priority sectors, barriers and policy needs as well as opportunities</td>
</tr>
<tr>
<td>This can be through, in example:</td>
<td>• Situation analysis; • Needs assessment; • National Capacity Self-Assessment</td>
</tr>
</tbody>
</table>
5. CONCLUSION

The purpose of this paper is to analyse the current state of knowledge gaps and needs concerning CCA and EbA in particular. In addition, it addressed the barriers, limits and challenges that hinder adaptation planning and implementation as well as identified potential priority areas for further research and action.

Based on the findings, it is clear that there are several knowledge gaps and needs to be addressed. However, lack of institutional capacity, weak knowledge generation and management as well as monitoring and evaluation are key persistent issues. This research paper highlights the need for enhanced knowledge and capacity development, strengthening knowledge management processes, robust and ongoing monitoring and evaluation as well as taking the action learning (‘learning by doing’) approach. This requires a long-term commitment of and coherent coordination between all relevant stakeholders, agencies and multi-sectoral institutions at multiple governance levels. In so doing it will support the generation of an evidence base of EbA and CCA for decision-making, the long-term effectiveness and efficiency of an adaptation approach and to prevent maladaptation.
References


Endnotes


5EPIC Project link for further information: http://iucn.org/about/work/programmes/ecosystem_management/disaster/solutions/ecosystems_protecting_infrastructure_and_communities/

6This information draws on the IUCN (International Union for Conservation of Nature) EbA projects’ mapping analysis survey questionnaire which was distributed to IUCN’s Regional Offices and Global Thematic Programmes. Information on the knowledge products from this project as well as other IUCN EbA related projects can be found in the report by A.R. Rizvi (2014): https://cmsdata.iucn.org/downloads/eba_in_iucn__mapping_analysis.pdf


ANNEX-I Glossary of commonly used terms
This glossary is provided as a general reference to help in a common understanding of the multiple climate change adaptation related terms and concepts used throughout this paper.

| **Action Learning – learning by doing process** | An approach for project implementation and action through a process of learning, research and critical reflection in order to act more effectively. In addition, Action Learning generates insights and understanding relevant to similar situations. This approach involves a varied group of stakeholders with a shared issue of concern (Fisher & Jackson, 1999). |
| **Adaptation assessment** | “The practice of identifying options to adapt to climate change and evaluating them in terms of criteria such as availability, benefits, costs, effectiveness, efficiency, and feasibility”. (IPCC, 2012) |
| **Adaptation Barriers** | As defined by IPCC (2014:8): “Factors that make it harder to plan and implement adaptation actions [as it] restricts the variety and effectiveness of options for [a stakeholder] to secure their existing objectives, or for a natural system to change in ways to maintain productivity or functioning”. In addition, barriers hinder the way with which uncertainty and complexities surrounding global change (i.e. climate, socio-economic and/or ecological) are addressed (adapted from Naumann, 2011:40). |
| **Capacity building** | “The [ongoing] process of developing the technical skills and institutional capability to effectively address the causes and results of climate change” (Nang, 2013:34). “The goal of which is to enhance the ability to evaluate and address the crucial questions related to policy choices and modes of implementation among development options, based on an understanding of environment potentials, limits and of needs perceived by the people of the country concerned” (ISET, 2008:38). |
| **Climate change** | “Refers to a change in the state of the climate that can be identified (i.e. by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcing’s such as modulations of the solar cycles, volcanic eruptions, and persistent anthropogenic changes in the composition of the atmosphere or in land use” (IPCC, 2014:4) |
| **Climate Change Adaptation (CCA)** | “Adjustments in natural or human [social and economic] systems in response to actual or expected climatic stimuli or their effects, which moderate harm or exploits beneficial opportunities” (IPCC, 2014:4). |
| **Climate-related extreme events (aka extreme weather or extreme climate event)** | “The occurrence of a value of a weather or climate variable above (or below) a threshold value near the upper (or lower) ends of the range of observed values of the variable”. (IPCC, 2012). For simplicity, in this paper, both extreme weather events and extreme climate events are referred to collectively as ‘climate-related extreme events’. |
| **Climate projection** | “A projection of the response of the climate system (interactions between the atmosphere, oceans, cryosphere, land surface & the biosphere) to emissions or concentration scenarios of greenhouse gases and aerosols, or radiative forcing scenarios, often based upon simulations by climate models”. “Climate projections depend upon the emission/concentration/radiative-forcing scenario used, which are based on assumptions concerning, e.g., future socioeconomic and” |
technological developments that may or may not be realized and are therefore subject to substantial uncertainty”. (IPCC, 2012).

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climate variability</td>
<td>“Climate variability refers to variations in the mean state and other statistics (such as standard deviations, the occurrence of extremes, etc.) of the climate at all spatial and temporal scales beyond that of individual weather events. Variability may be due to natural internal processes within the climate system (internal variability), or to variations in natural or anthropogenic external forcing (external variability)”. (IPCC, 2012).</td>
</tr>
<tr>
<td>Disaster risk</td>
<td>“The likelihood over a specified time period of severe alterations in the normal functioning of a community or a society due to hazardous physical events interacting with vulnerable social conditions, leading to widespread adverse human, material, economic, or environmental effects that require immediate emergency response to satisfy critical human needs and that may require external support for recovery”. (IPCC, 2012).</td>
</tr>
<tr>
<td>Disaster Risk Reduction (DRR)</td>
<td>“The concept and practice of reducing disaster risks through systematic efforts to analyse 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” (UNISDR, 2011).</td>
</tr>
<tr>
<td>Ecosystem-based Adaptation (EbA)</td>
<td>As defined by the CBD (2009:41): “EbA is the use of biodiversity and ecosystem services as part of an overall adaptation strategy to help people to adapt to the adverse effects of climate change. Ecosystem-based adaptation uses the sustainable management, conservation, and restoration of ecosystems to provide services that enable people to adapt to the impacts of climate change”. (CBD, 2009)</td>
</tr>
<tr>
<td>Evaluation</td>
<td>A process for systematically and objectively determining the effectiveness of an adaptation measure in the light of its objectives</td>
</tr>
<tr>
<td>Knowledge gaps and needs</td>
<td>“The gaps that need to be filled in order to further the understanding of climate change impacts, vulnerabilities, and innovative adaptation approaches. Knowledge needs also relate to identifying the tools and services [i.e. skills and networks] that would be most useful to enhance adaptation practices and successful project implementation” (Egan, 2013:4).</td>
</tr>
<tr>
<td>Knowledge Management</td>
<td>“The practice of capturing, storing, access and sharing knowledge so that lessons can be learnt from the past as well as through case studies, and apply them in the future” (Egan, 2013:4).</td>
</tr>
<tr>
<td>Knowledge products</td>
<td>“Products designed to meet different needs and to reach different audiences - core knowledge products include i.e. concept notes (e.g. short discussion papers) &amp; lessons learned papers (e.g. case studies), extract lessons from past and on-going projects that can be applied, and to replicate successes” (Egan, 2013:4).</td>
</tr>
<tr>
<td>Maladaptation</td>
<td>As defined by the IPCC (2014): “any change in natural or human systems that inadvertently increase vulnerability to climatic stimuli; an adaptation that does not succeed in reducing vulnerability but increases it instead”.</td>
</tr>
<tr>
<td>Monitoring</td>
<td>“The purpose of monitoring is to keep track of progress made in implementing a specific adaptation measure in relation to its objectives and inputs, which include financial resources. Monitoring enables planners and practitioners to improve adaptation efforts by adjusting processes and targets”.</td>
</tr>
<tr>
<td>National Adaptation Programme of Action (NAPA)</td>
<td>NAPA’s are developed by Least Developed Countries to identify priority activities that respond to their urgent and immediate needs with regard to adaptation to climate change (OECD, 2009:73).</td>
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<tr>
<td>‘No regrets’ options</td>
<td>“Options that would generate net social benefits whether or not there is anthropogenic climate change” (IPCC, 2014*).</td>
</tr>
<tr>
<td>Resilience</td>
<td>“The capacity of social, economic, and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity, and structure, while also maintaining the capacity for adaptation, learning, and transformation” (IPCC, 2014:5).</td>
</tr>
<tr>
<td>Scenario</td>
<td>“A plausible and often simplified description of how the future may develop based on a coherent and internally consistent set of assumptions about driving forces and key relationships. Scenarios may be derived” (IPCC, 2012).</td>
</tr>
<tr>
<td>Uncertainty</td>
<td>“An expression of the degree to which a value or relationship is unknown. Uncertainty can result from lack of information or from disagreement about what is known or even knowable. It may originate from many sources, such as quantifiable errors in the data, ambiguously defined concepts or terminology, or uncertain projections of human behaviour. It can therefore be represented by quantitative measures, for example, a range of values calculated by various models, or by qualitative statements, for example, reflecting the judgment of a team of experts”. (IPCC, 2012).</td>
</tr>
<tr>
<td>Vulnerability</td>
<td>“The degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity” (IPCC, 2014:5).</td>
</tr>
</tbody>
</table>