Adaptation Indicators for Biodiversity

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1. Introduction

In April 2009, the European Commission (EC) published a White Paper on adapting to climate change (EC, 2009a). This presents a framework for adaptation policies and measures to reduce the vulnerability of the European Union (EU) to climate change. To further help policy and decision-makers respond to the effects of climate change, the EC plans to publish a Communication on mainstreaming mitigation and adaptation in 2011 and an EU adaptation strategy in 2013.

The adaptation White Paper states that climate change will increasingly drive the loss of biodiversity and ecosystems and the related services on which society depends. Climate change impacts can be reduced by certain (planned) policies, measures and actions. The primary purpose of adaptation indicators is to monitor their implementation and effectiveness. Adaptation indicators can also be used to:

- Justify, target and monitor funding for adaptation
- Mainstream adaptation within and between sectors
- Communicate adaptation to policy and decision-makers and other stakeholders
- Compare adaptation achievements across sectors, regions and countries
- Inform international climate change negotiations.

Indicators simplify, quantify, standardise and communicate complex and often disparate data and information. They should be based on reliable, readily available or accessible data that are both continuous and representative of the factors being measured.

Within the biodiversity sector, the SEBI 2010 (Streamlining European 2010 Biodiversity Indicators) process identified a set of indicators to monitor progress towards the EU 2010 target of halting biodiversity loss. This includes an indicator to assess the impacts of climate change on biodiversity (impacts on European bird populations), but not to assess adaptation. The European Topic Centre on Air and Climate Change (ETC ACC) has established a theoretical and practical basis for the development of adaptation indicators. It has used this framework to show how indicators to monitor and evaluate the effectiveness of adaptation policies, measures and actions for biodiversity might be defined.

2. Policy relevance

The loss of biodiversity and ecosystems is inextricably linked with climate change, alongside habitat destruction, fragmentation and degradation caused by land-use change, over-exploitation, unsustainable practices, invasive species, ocean acidification and pollution. Whilst the effects of climate change on biodiversity can have negative consequences for

human well-being, biodiversity can also make an important contribution to both climate change adaptation and mitigation through the ecosystem services it supports. The discussion paper *Towards a strategy on climate change, ecosystem services and biodiversity* (EUAHEWGBCC, 2009) explores these issues in detail. Additionally, strengthening 'green infrastructure' will improve the functional and spatial connectivity of ecosystems by reducing fragmentation, improving resilience and biodiversity protection. This will, in turn, enhance the adaptation and mitigation potential of ecosystems, thereby increasing the value of the goods and services that they provide. LIFE-funded projects have made a substantial contribution to the knowledge base needed to develop and support such an approach in Europe (EC, 2010a).

In April 2009, the EU held a high-level conference in Athens to frame post-2010 biodiversity policy. In accepting that the EU's 2010 target will not be met, the resulting *Message from Athens* set out eight key priorities, one of which is concerned with climate change (EC, 2009b). This states that biodiversity loss cannot be halted without addressing climate change, and that it is equally impossible to tackle climate change without addressing biodiversity loss. Subsequently, in March 2010, the EU agreed a new vision for biodiversity to 2050 (EC, 2010b): *Biodiversity and ecosystem services – the world's natural capital – are preserved, valued and, insofar as possible, restored for their intrinsic value and so that they can continue to support economic prosperity and human well-being as well as avert catastrophic changes linked to biodiversity loss.* This is accompanied by a headline target for 2020: *Halt the loss of biodiversity and ecosystem services in the EU by 2020 and restore them insofar as possible, and step up the EU's contribution to averting global biodiversity loss*. Both reflect the urgency of the biodiversity crisis and the value of biodiversity, ecosystems and the services they provide.

In October 2010, the Convention on Biological Diversity's (CBD's) COP-10 in Nagoya, Japan resulted in international agreement being reached on a new Strategic Plan for 2011-2020 and a wider vision for biodiversity conservation to 2050. Biodiversity and climate change was one of six key issues for in-depth consideration and these discussions were informed by the outputs of CBD's *Ad Hoc* Technical Expert Group on Biodiversity and Climate Change (CBD, 2009). One of the outcomes was the suggestion that "*Parties consider developing mechanisms to streamline reporting and data collection related to the biodiversity and climate change interface at the national and sub-national level, in accordance with national circumstances*" (CBD, 2010).

3. Development of adaptation indicators

The principle objective of adaptation indicators is to monitor the implementation of adaptation policies and measures, and to show whether vulnerability can be reduced effectively through adaptation actions. There are, however, likely to be many factors that contribute to or hinder the adaptation process and its outcomes, so indicators of other drivers of and barriers to adaptation and of other factors that decease or increase vulnerability are also desirable.

A conceptual framework for the development of adaptation indicators was established at a first *Expert meeting on climate change vulnerability and adaptation indicators*, convened by the European Environment Agency (EEA) in Szentendre, Hungary in September 2008. Here, the fundamental concepts surrounding the development and delineation of adaptation indicators were rehearsed (Harley *et al.*, 2008).

The conceptual framework considers planned adaptation to climate change impacts and captures the 'processes' associated with the development of adaptation policies and delivery of adaptation measures, and the 'outcomes' of adaptation actions. It does not consider autonomous adaptation. Figure 1 shows the relationship between adaptation indicators that are process-based (i.e. indicators for monitoring the development and implementation of adaptation policies and measures) and those that are outcome-based (i.e. indicators for measuring the effectiveness of adaptation actions, which are themselves determined by policies and measures). Adaptation policy indicators should consider policies that are closely related to available national adaptation strategies and policies that bring together local knowledge and experience. Outcome-based indicators should assess the effectiveness of adaptation actions in reducing vulnerability and be considered alongside data about other factors that decrease or increase vulnerability. Without this, it would be impossible to attribute the success or failure of an adaptation action to the effectiveness or ineffectiveness of that action.

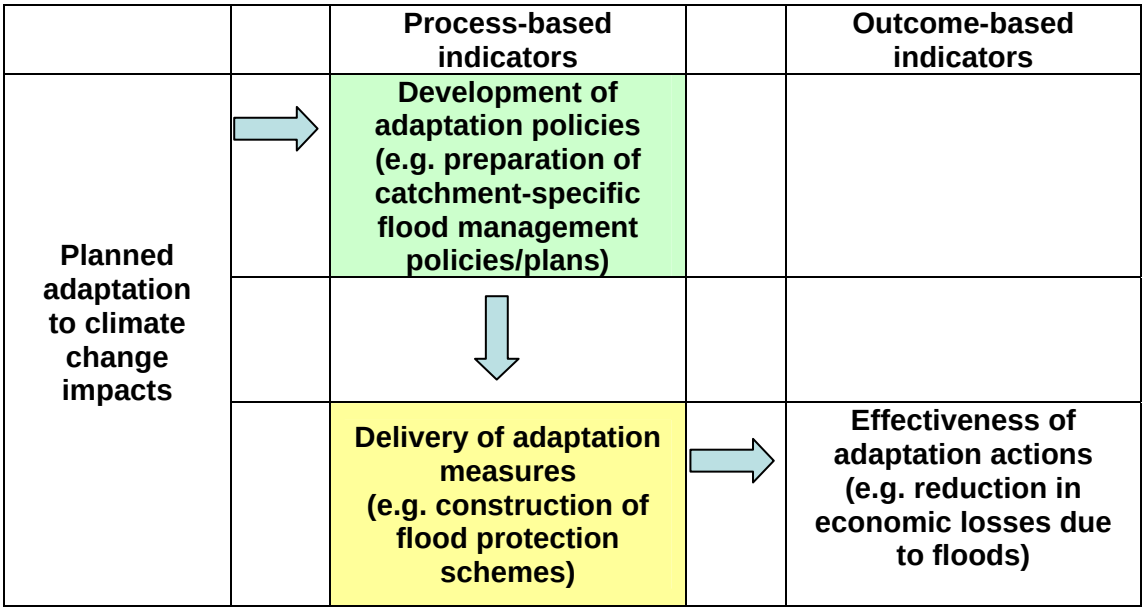

Figure 1: Conceptual framework for adaptation indicators

As adaptation to climate change is a relatively new policy area, process-based indicators are likely to be of greater importance in the short term, with outcome-based indicators increasing in prominence in the longer term.

4. Adaptation principles for biodiversity and its conservation

There is increasing concern in the biodiversity sector about the impacts of climate change on vulnerable species, habitats and ecosystems. Increasing importance is also being attached to the role of biodiversity in both climate change adaptation and mitigation (EUAHEWGBCC, 2009). Recent reviews of existing international and national guidance on adaptation have identified principles to guide the development of adaptation policies, measures and actions to conserve species, habitats and ecosystems (e.g. Harley & Hodgson, 2008; Smithers *et al.*, 2008, Vonk *et al.*, 2010). Harley & Hodgson (2008) identified seven overarching adaptation principles for biodiversity and its conservation (which can be used for defining adaptation indicators - see section 5, below):

- **Take action now** - uncertainties surrounding the precise nature of future climate change and its impacts on biodiversity should not delay practical conservation action
- **Maintain and increase ecosystem resilience** - the ability of ecosystems to absorb and recover from change should be enhanced to enable the widest range of biodiversity to survive and adapt to climate change
- **Accommodate the impacts of climate change** - an increasingly dynamic and innovative approach to biodiversity conservation is needed to address the impacts of both gradual changes in climate and extreme weather events
- **Facilitate knowledge transfer and action between partners, sectors and countries** - successful adaptation requires biodiversity conservation to be integrated with other land and water management activities across relevant sectors and the wider ecosystem service benefits to be recognised
- **Develop the knowledge/evidence base and plan strategically** - the best available evidence should be used to make decisions that will allow biodiversity to adapt in an uncertain future
- **Use adaptive conservation management** - effective conservation in a changing climate requires continual evaluation and review to progressively increase resilience and reduce vulnerability
- **Undertake monitoring and identify indicators** - monitoring using robust indicators will provide essential knowledge of impacts, help shape adaptive management and measure outcomes.

A second *Adaptation indicators expert meeting*, held at EEA, Copenhagen in July 2009, discussed in more detail the utility of the conceptual framework for adaptation indicators and developed it further for wider application (Harley & van Minnen, 2009). The meeting focussed on two case studies, one of which showed how adaptation principles might be used in the development of adaptation indicators for biodiversity. The principles can be linked to a range of generic conservation activities that relate to policies, measures and actions, from which it is possible to exemplify how both process-based indicators and outcome-based indicators can be derived.

As an example, a key approach to reducing the impacts of climate change on biodiversity is to improve the dispersal capacity of species by facilitating their movement through the landscape. Policies to achieve this may be initiated at EU and national levels, and process-based indicators are needed to monitor their implementation. These policies underpin the delivery of national and regional measures to establish ecological networks, which again should be monitored with suitable process-based indicators. The functioning of ecological networks is determined by local actions to improve habitat connectivity and, therefore, the ability of species to move. The outcome of these actions is increased resilience of those species most vulnerable to climate change. The effectiveness of these actions, and of associated policies and measures, should be monitored and measured by outcome-based indicators.

5. Adaptation indicators for biodiversity

A third *Expert workshop on possible adaptation indicators for biodiversity* was held at EEA, Copenhagen on 5 October 2010. The purpose of the workshop was to develop specific adaptation indicators for use in the biodiversity and associated sectors. Working with those involved in the SEBI process and other European experts, and building on the outputs of the 2009 meeting, the focus was on determining precisely how adaptation principles (Harley & Hodgson, 2008) might be translated into an agreed set of process-based and outcome-based indicators for biodiversity. The specific objectives of the workshop were to:

- Gain consensus on the proposed approach to developing climate change adaptation indictors
- Identify a preliminary set of adaptation indicators for biodiversity, ecosystems and their services
- Consider how the approach can support the EC in terms of climate change/biodiversity policy.

In addition, a number of wider issues were addressed. These included:

- The specific purposes of monitoring and evaluating biodiversity adaptation (as these influence the types of indicators that will be needed)
- The range of sectors likely to be involved in monitoring biodiversity adaptation
- Links with existing biodiversity indicators (especially SEBI impact indicators) and the need for new indicators.

Experts attending the workshop agreed the proposed approach to indicator development and the use of the seven adaptation principles (described in section 4, above) as the basis for a set of adaptation indicators for biodiversity. Experts then assessed each of the adaptation measures associated with the principles in terms of their suitability for the development of individual process-based and outcome-based indicators. Following the workshop and in liaison with key experts, the level of relevance (high, medium, low) of the principles and measures, and therefore the indicators, to the biodiversity sector and six associated sectors was established (Annex 1). This enabled possible indicators to be prioritised and a preliminary set (those with a high level of relevance) to be identified. These include process-based indicators for adaptation policy (P1) and adaptation measures (P2), and outcome-based indicators for adaptation actions (O). Three examples from each group are given below.

Process-based indicators for biodiversity – adaptation policy
Adaptation policies are likely to be principally focussed on increasing adaptive capacity in a sector, cross-sector and institutional sense, and at spatial scales ranging from the EU, to Member States, regional and local. The following illustrate the types of adaptation policy indicators (P1) that could be derived from the adaptation principles/measures (Annex 1):

- Existing relationships are being strengthened and new partnerships built - derived from adaptation measure 4a
- Awareness of the benefits that biodiversity provides and its role in adaptation is increasing - derived from adaptation measure 4d
- Best practice is being communicated and information exchanged on successful adaptation - derived from adaptation measure 4e.

Process-based indicators for biodiversity – adaptation measures
Adaptation measures will be determined by adaptation policies to “change the characteristics of a system that can easily be changed”. Adaptation measure indicators (P2) should reflect the delivery of these measures. Examples include:

- Vulnerability assessments of biodiversity and ecosystems are being undertaken - derived from adaptation measure 5b
- New approaches are being piloted - derived from adaptation measure 5d
- Adaptation actions are being continually monitored and re-assessed - derived from adaptation measure 6a.

Outcome-based indicators for biodiversity

The effectiveness of adaptation policies and measures will ultimately be reflected in the outcomes of adaptation actions. Robust adaptation actions will reduce vulnerability. Outcome-based indicators are needed to assess the effectiveness of these actions (i.e. to measure the reduction in vulnerability). These should be considered alongside data about other factors that might decrease or increase vulnerability. Outcome-based indicators (O) that could be derived from the adaptation principles/measures include:

- Other sources of stress and harm are being reduced - derived from adaptation measure 1a
- Buffer zones are being established around conservation areas - derived from adaptation measure 2c
- Networks of interconnected protected areas and intervening habitat mosaics are being established - derived from adaptation measure 3d.

6. Next steps

The expert workshop in October 2010 identified a preliminary set of possible adaptation indicators for biodiversity, ecosystems and their services. The next step is to prepare the ground within the biodiversity and related sectors for embedding the indicators as a tool for monitoring and evaluating the implementation and effectiveness of adaptation policies, measures and actions in reducing vulnerability to climate change. This work may be undertaken in 2011 and comprise the following activities:

1. Identify and agree with the EEA and relevant ETCs a list of stakeholders from a range of sectors and Member States with which to discuss and define the use of biodiversity-related adaptation indicators in their work. The intention is to have detailed iterations with a representative sample of stakeholders working at a range of spatial scales within these Member States (e.g. the sector groups responsible for the delivery of the England Biodiversity Strategy). Consultation with nature/biodiversity staff in EC DG Environment will be part of this process and will include consideration of the relevance of these indicators to the development of EU policies on adaptation and the EU Climate Change Impacts, Vulnerability and Adaptation Clearinghouse.

2. Conduct detailed discussions with these stakeholders to gain consensus on the applicability and utility of the adaptation indicators and determine the support required in the embedding process (e.g. most suitable indicators, data needs and spatial resolution of indicators, data gathering, timing and presentation of information, etc).

3. Propose a process, based on the outputs of Activity 2, for embedding the indicator set in relevant sectors across the EU (EC, EU Member States and other stakeholders) and agree this with the EEA and relevant ETCs.

4. Prepare a technical report describing the outcomes of the project (i.e. the stakeholder consultations, the list of proposed indicators, and the process to embed them at different governance levels).

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Annex 1: Adaptation principles, measures and possible indictors and their sector relevance

Adaptation principle (Harley & Hodgson, 2008)	**Adaptation measure (& possible indicators)**	**Sector relevance of principles & measures**						
		Biodiversity	Agriculture	Energy & transport	Fresh water	Forestry	Land use planning	Marine & fisheries
1.Take action now Uncertainties surrounding precise nature of future climate change & its impacts on biodiversity should not delay practical conservation action.	a) Reduce other sources of stress & harm not directly linked to climate change. (O)	H	H	H	H	H	H	H
	b) Maintain existing conservation activities in protected areas & intervening habitats. (O)	H	H	H	H	H	H	H
	c) Deliver current biodiversity policy & legislative commitments & agreements. (P1)	H	H	H	H	H	H	H
2. Maintain & increase ecosystem resilience Ability of ecosystems to absorb & recover from change whilst maintaining & increasing biodiversity should be enhanced.	a) Maintain & restore ecosystem function &, where appropriate & cost effective, relocate & create new habitats. (O)	H	H	H	H	H	H	H
	b) Conserve range & variability of species, habitats & ecosystems. (O)	H	H	H	H	H	H	H
	c) Establish buffer zones with ecologically sensitive management regimes around conservation areas. (O)	H	H	H	H	H	H	H
	d) Control and limit succession of invasive species. (O)	H	M	H	H	H	H	H
3. Accommodate impacts of climate change Both gradual change & extreme weather events will be experienced.	a) Increase understanding of climate change & acceptance that it is unavoidable. (P1)	H	H	H	H	H	H	H
	b) Work with ecological succession & not against it. (P2)	H	M	M	M	M	M	M
	c) Adopt principle of 'potential native' species. (-)	-	-	-	-	-	-	-
	d) Establish networks of interconnected protected areas (terrestrial,	H	H	H	H	H	H	H

	freshwater & marine) & intervening habitat mosaics to increase permeability & aid gene flow. (O)							
	e) Plan future conservation areas to ensure vulnerable species groups & habitats types are protected. (O)	H	H	M	H	H	H	H
	f) Allow for changing configuration of coasts & rivers by avoiding development in these areas. (O)	H	M	H?	H	L	H	M
	g) Consider role of species translocation & *ex-situ* conservation, especially for threatened species. (O)	L	L	L	L	L	L	L
4. Facilitate knowledge transfer & action between partners, sectors & countries Successful adaptation requires that biodiversity conservation is integrated with other land & water management activities.	a) Strengthen existing relationships & build new partnerships. (P1)	H	H	H	H	H	H	H
	b) Ensure policy & practice is integrated across sectors & borders. (P1)	H	H	H	H	H	H	H
	c) Coordinate adaptation & mitigation measures to avoid mal-adaptation within & across sectors. (P2)	H	H	H	H	H	H	H
	d) Increase awareness of benefits biodiversity provides to society & its role in adaptation strategies across all sectors. (P1)	H	H	H	H	H	H	H
	e) Communicate best practice & exchange information on successful adaptation. (P1)	H	H	H	H	H	H	H
5. Develop knowledge/evidence base & plan strategically To effectively plan for an uncertain future, it is essential that best available evidence is used to	a) Continually review evidence base & identify knowledge gaps & research opportunities. (P2)	H	H	H	H	H	H	H
	b) Undertake vulnerability assessments of	H	H	H	H	H	H	H

develop techniques that allow biodiversity to adapt.	biodiversity & associated ecosystems. (P2)							
	c) Undertake scenario assessments & identify 'no regrets' actions. (P2)	H	H	H	H	H	H	H
	d) Pilot new approaches through demonstration projects. (P2)	H	H	H	H	H	H	H
	e) Develop 'win-win' adaptation measures & use to build resilience & accommodate change. (P2)	H	H	H	H	H	H	H
6. Use adaptive conservation management Effective conservation in a changing climate will require a flexible approach.	a) Continually monitor & re-assess adaptation actions as new information & research becomes available. (P2)	H	H	H	H	H	H	H
	b) Review & amend biodiversity policy, legislation & agreements to ensure conservation objectives reflect challenges presented by climate change. (O)	H	H	H	H	H	H	H
7. Monitoring & indicators Monitoring is a key contributor to evidence base &, as such, existing schemes must be strengthened & new requirements incorporated.	a) Identify indicators to monitor impacts (direct & indirect) of climate change on biodiversity & to assess vulnerability & adaptation. (P2)	H	H	H	H	H	H	H
	b) Continue to monitor observed impacts of climate change on biodiversity & establish procedures to validate projections. (P2)	H	H	H	H	H	H	H
	c) Monitor effectiveness of adaptation measures & adaptive conservation management in maintaining & increasing ecosystem resilience & accommodating	H	H	H	H	H	H	H

	change. (AI)							
Notes	*P1: process-based indicators (adaptation policy* *P2: process-based indicators (adaptation measures)* *O: outcome-based indicators* *AI: purpose of adaptation indicators*	*H: high level of relevance to sector* *M: medium level of relevance to sector* *L: low level of relevance to sector*						