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Climate Change Adaptation for Natural World Heritage Sites

A Practical Guide

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Climate Change Adaptation for Natural World Heritage Sites

A Practical Guide

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Cover photo: Area de Conservación Guanacaste in Costa Rica is one of the World Heritage sites where the impacts of climate change on biodiversity loss are already visible. © OUR PLACE

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Foreword

There is an increasing concern worldwide over the threats posed by climate change to World Heritage properties, with negative consequences for human well-being. As the impacts of climate change unfold, understanding the vulnerability of the World Heritage to climate change will become an integral part of conservation work.

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The World Heritage Centre has developed this practical guide to assist those responsible for the management of natural World Heritage sites to better understand how climate change may affect those features of the site that contribute to its Outstanding Universal Value and offer ideas for identifying options for adapting to climate change with tailored management responses. The purpose is to ensure the World Heritage site's resilience in the face of climate change, and therefore to sustain its Outstanding Universal Value.

Factoring climate change into management of the World Heritage properties has many other benefits. Conservation of heritage will also increase the resilience of human communities to the impacts of climate change, for example through ecosystem services that World Heritage sites provide. Many World Heritage sites serve as natural buffers against climatic impacts and other disasters, or play a major role in climate change mitigation by reducing climate-altering carbon dioxide emissions in the atmosphere.

UNESCO is committed to working closely with various actors to address the multiple challenges posed by climate change, in particular to the precious and fragile cultural and natural heritage of the world. We welcome all the World Heritage stakeholders in joining and supporting these efforts.

Kishore Rao
Director
UNESCO World Heritage Centre

Preface

The impact of climate change on World Heritage natural and cultural properties was brought to the attention of the 29th session of the World Heritage Committee in 2005 by a group of concerned organizations and individuals. The Committee requested the UNESCO World Heritage Centre, in collaboration with its Advisory Bodies (ICCROM, ICOMOS and IUCN), interested States Parties and the petitioners who had drawn the attention of the Committee to this issue, to convene a broad working group of experts on the impact of climate change on World Heritage and prepare a strategy and report for dealing with the issue. These documents were endorsed by the Committee at its 30th session in July 2006.

The World Heritage Centre has since endeavoured to provide support to States Parties and site managers in tackling climate change threats, for example through field projects in Peru (Manú National Park) and Indonesia (Tropical Rainforest Heritage of Sumatra), as well as the publication of *Climate Change and World Heritage – Report on predicting and managing impacts of climate change on World Heritage and Strategy to assist States Parties to implement appropriate management responses,*[1] the *Policy Document on the Impacts of Climate Change on World Heritage Properties*,[2] and the compendium of *Case Studies on Climate Change and World Heritage.*[3]

This Practical Guide is an additional output from the World Heritage Convention's secretariat. We hope that it will be a good resource tool for World Heritage site managers interested in understanding how to respond to climate change, along with the climate change publications mentioned above.

1 UNESCO World Heritage Centre, 2007*b*, *Climate Change and World Heritage – Report on predicting and managing the impacts of climate change on World Heritage and Strategy to assist States Parties to implement appropriate management responses*. http://whc.unesco.org/en/activities/474

2 UNESCO World Heritage Centre, 2008, *Policy Document on the Impacts of Climate Change on World Heritage Properties*. http://whc.unesco.org/en/CC-policy-document/

3 UNESCO World Heritage Centre, 2007*a*, *Case Studies on Climate Change and World Heritage*. http://whc.unesco.org/en/activities/473\

Acknowledgements

We would like to thank the authors for going beyond the call of duty in assembling this very thorough guide. The authors were helped by an excellent team in the field, including representatives of the Soysambu Conservancy (Kenya), who agreed to participate in testing the guide in its draft format and to provide feedback for improvements. Contributions from senior government representatives from both Kenya Wildlife Service and the Indian Ministry of the Environment were also welcomed, as was support from the UNESCO Office in Nairobi. We also express appreciation for help in managing the field testing of this guide – in both Kenya (Robert Olivier) and India (Dr Vinod Mathur of the Wildlife Institute of India and his team). IUCN's involvement (notably via Bastian Bertzky and Marc Hockings) in helping to define the scope and focus of the guide at the outset was of great value. This work would have taken much longer had it not been for the help of Bandiougou Diawara and Elsa Loubet, of the World Heritage Centre's Africa Unit who administered much of the process during field testing.

Finally, UNESCO would like to thank the people of the Netherlands and Belgium, who, through support from the Netherlands Funds-In-Trust and the Belgian Federal Public Service Health, Food Chain Safety and Environment, helped to finance the development and production of this Practical Guide.

Special thanks to the men and women in the field who provided crucial feedback on the first draft of the guide while testing it at their own World Heritage sites:

Kenya	India
Mount Kenya National Park/Natural Forest	**Keoladeo National Park**
Simon Gitau	Khayati Mathur
James Mathenge	Sudarshan Sharma
Chripine Ngesa	Bhumesh Bhadouria
C. F. A. Githiria	**Nanda Devi and Valley of Flowers National Parks**
Joseph Nzumbi	B. K. Gangte
Warden Chogoria	Rajiv Dhiman
Warden Kamweti	Hem Chander
Kenya Lake System in the Great Rift Valley	**Indian National Agencies**
Muteru Njauini	S. D. Attri
Kathryn Combes	Jagdish Kishwan
Alice Bett	Vinay Bhargav
John Wambua	Akash Verma
Rauni Munene	B. S. Adhikari
James Kimaru	V. P. Uniyal
Raphael Kimosop	S. Sathyakumar
Amos Chege	K. Sivakumar
Hellen Jerotich	S. A. Hussain
Steve Araka	
Kenya Wildlife Service Headquarters	
James Njogu	
Chrispin Ngesa	

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Using the guide

Phong Nha-Ke Bang National Park (Viet Nam). © OUR PLACE

1.1 The purpose of this guide

This guide is intended primarily to:

- assist those responsible for the management of a natural World Heritage site to understand how climate change may affect those features of the site that contribute to its Outstanding Universal Value (OUV);
- offer a framework for putting site-level climate change effects into the management context;
- provide guidance on how to assess risk to the site's OUV;
- offer ideas for identifying and selecting options for responding and adapting to climate change.

The purpose of management in this context is to ensure the World Heritage site's resilience in the face of climate change

This guide helps site managers to analyse climate change threats and how they are likely to influence management objectives. It should enable site managers to factor climate change into management and action planning and feed into an existing management plan where one is already in place (e.g. as an appendix). Alternatively, it might provide the starting point for producing a site management plan. Other uses of such a plan might include making bids for funds and clarifying how those funds might be used, or taking opportunities to tap into funds from current programmes in national land planning, management planning or climate change.

Other guides, especially UNESCO World Heritage Centre's ***Enhancing our Heritage Toolkit***,[4] can be useful where climate change concerns need to be integrated into wider management considerations.

A key challenge in producing this guide was to define its scope – many of the suggested activities may not be obviously linked to climate change, and it is for the manager to make those links where appropriate. However most, if not all, protected area and natural resource management challenges can be linked to climatic factors. For example, conflicts over natural resources such as land, food, shelter and water can usually be linked to stresses caused by drought, flooding, erosion or disease, which are generally climate-driven. Therefore we have interpreted climate change adaptation in this guide quite broadly.

The purpose of management in this context is to ensure the World Heritage site's resilience in the face of climate change, and therefore to sustain its Outstanding Universal Value (OUV).

4 M. Hockings et al., 2008, *Enhancing our Heritage Toolkit: Assessing management effectiveness of natural World Heritage sites*, Paris, UNESCO World Heritage Centre. http://whc.unesco.org/en/series/23

1.2 Developing a plan – some practical considerations

Any planning process is costly in time and human resources, especially where a wide range of stakeholders is involved. Most of the elements described in this guide are identical to **management planning processes**, and they **should be used alongside the production of a management plan where possible**, to avoid unnecessary costs and duplication. Where an up-to-date management plan is in place, much of the data and thinking may already exist, and need not be repeated.

- **Delegate responsibility** to someone who has the authority to coordinate and drive the process forward, and **ensure support from the main stakeholders**, including communities that depend on the ecosystem services that the site provides.
- Think about the *kind* of strategy or plan that you intend to produce. You will need to **consider who will read it, and how it will be used**. This will determine its scope, format and style.
- Be prepared to **take some calculated risks** and **choose the best solutions** in the context of what is known and understood.
- **Do not underestimate the logistical implications** of carrying out this analysis and implementing actions.

The following ideas may also be useful:

Organizing yourself

- Assemble a team, say three to five colleagues who will collaborate in collating and assessing data, and in analysing options.
- Agree on responsibilities, including
  - Who will lead?
  - Who will be responsible for collecting and analysing data?
  - Who will lead on writing?
- Agree on deadlines.
- If you get stuck, consider these possibilities:
  - Try to break the problem down into smaller elements.

– Discuss your concerns with other team members and/or outside advisors.
– Start with the easiest parts.
– Look at examples from other sites.

Strategies for getting to work

- Do not try to study problems 'to death'. Investing too much time and resources in excessive data collecting may result in damage to the OUV of a site due to lack of timely action.
- Think in terms of a 'toolbox' of adaptation practices rather than single solutions. These should apply across a range of spatial and temporal scales.
- Work through a designated group which is charged with designing, implementing and evaluating actions.
- Encourage stakeholder participation. Raise awareness among surrounding communities that the site is of value to them and that climate change is *their* problem as well. Engage them in decision-making.
- Use graphics where possible to represent the issues and possible solutions. Problem/solution tree analysis (see Example 10, p. 52) is a particularly useful tool in helping people to visualize and understand problems.[5]
- Be creative in thinking about possible outcomes. Do not simply focus on what is likely or probable.
- Think about the funding implications. Some options may not be feasible due to the limitations on available funds. On the other hand, a convincing, evidence-based plan for adaptation will provide a strong case for funding.
- Ensure that all agreements, actions, delegated functions and support are **put in writing and circulated**.

A logical approach

While management planning is not necessarily a chronological process, it is important to work systematically, first by trying to understand **likely future climate change scenarios** and by understanding how the **OUV of a site might be affected by such conditions** – this will depend on **assessing vulnerability of the features** that contribute to its OUV, linked to the implications of a range of climate scenarios. Some features may be more vulnerable to certain climate change impacts than others.

Assessing the vulnerability of a site's features against a set of climate scenarios will help the manager to assess the degree of risk of climate change impacts to those features and hence to the site's OUV.

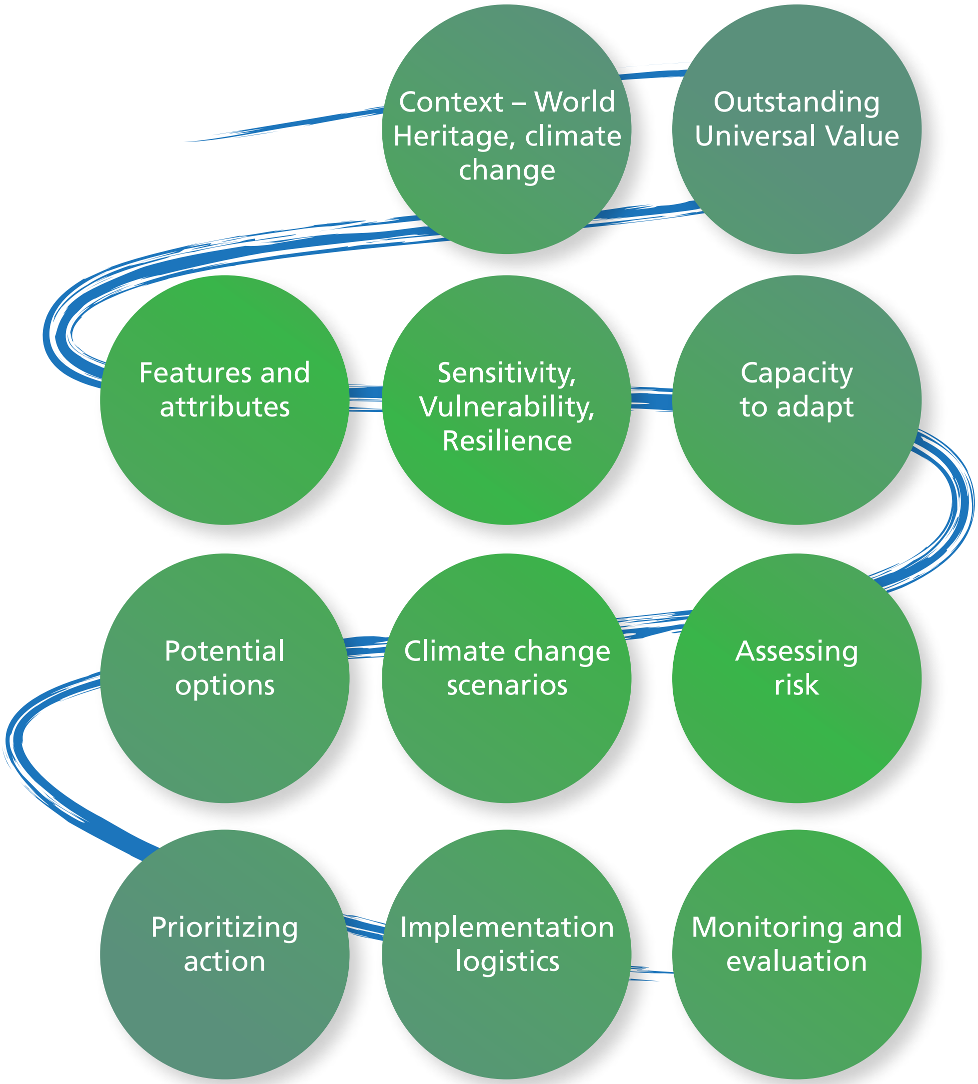
This in turn will enable the manager to **consider and prioritize various responses** against a range of criteria, which will provide a basis for **action** that can be **monitored and reviewed**.

Island ecosystems are extremely vulnerable to many climate-induced impacts, such as sea level rise and extreme weather events, affecting the coastal and marine biodiversity. East Rennell, Rennell Island (Solomon Islands). © OUR PLACE

5 For a guide to performing a problem tree analysis, see FAO, 2002, *Community-Based Forest Resource Conflict Management*, Training Package, Section 9.2, Exercise 8, Rome, Food and Agriculture Organization of the United Nations. ftp://ftp.fao.org/docrep/fao/005/y4301e/y4301e03.pdf

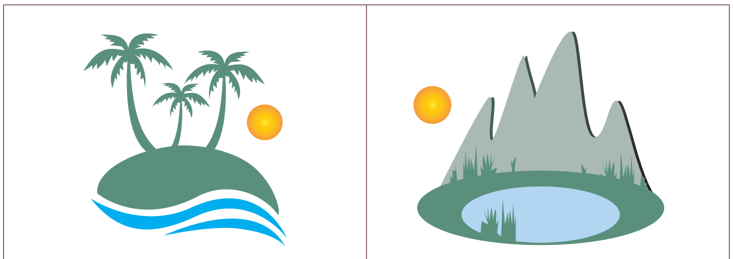
1.3 How the guide is structured

This guide is structured to reflect the general approach and thinking processes that a site manager would normally follow. As you work through the guide, we remind you how far you have progressed by summarizing the learning points and 'signposting' the next stage, by periodically referring to the diagram shown below. However, there is no need to follow every step unless you think it necessary.



Sample **worksheets** are included throughout the guide. These are intended to help structure thinking, and any of the sheets can be adapted or omitted as appropriate. More worksheets can be found in the *Enhancing our Heritage Toolkit*[6] and adapted to the needs of this guide.

Throughout the guide we refer to two theoretical sites, in order to help illustrate ideas in a simple way that avoids the complexities associated with many sites (Example 1).



Cloudey Island is a small island in a temperate zone.	The Snowey Mountains System is a high mountain landscape.

Example 1: Fictional examples used in this guide.

6 Hockings et al., 2008, op. cit. http://whc.unesco.org/en/series/23

1.4 Key terms – an explanation

It is important to clarify how we have interpreted the various terms used in the guide, especially those that may be unfamiliar. These interpretations are largely based on the *Operational Guidelines for the Implementation of the World Heritage Convention*.[7]

7 UNESCO World Heritage Centre, 2013, *Operational Guidelines for the Implementation of the World Heritage Convention*. http://whc.unesco.org/en/guidelines/

Table 1: Explanation of key terms

Term	Meaning	Example
Outstanding Universal Value (OUV)	A natural site is considered to have OUV when it: (i) meets one or more of the four natural heritage criteria (see p. 24), (ii) satisfies conditions of integrity and/or authenticity, and (iii) has an adequate protection and management system to ensure its safeguarding.	A site that contains a globally rare, endemic species, and thus provides it with the refuge, feeding and breeding conditions that sustain its population, could be said to have OUV provided its integrity can be maintained and it is effectively protected by legislation and effective management.
Features	Features are the physical, biological or geological components or manifestations of a site that together contribute to its OUV.	Wetlands may be a feature of a larger management area. But *within* a wetland there may be features such as pools, wet scrub, bogs, reed marsh and so on. Colonies of a particular bird species may be a feature of a cliff; communities of plants may be a feature of a grassland.
Values	Values refer to specific **manifestations or qualities of a site** that can be considered important to a particular stakeholder group. A site can have multiple values, both natural and cultural, for multiple stakeholder groups. Not all values will necessarily be considered relevant to the OUV.	An island ecosystem may contain a number of features that may be of value to different interests, such as fish, timber, non-forest timber products and even carbon stocks. While they may not in themselves be of OUV, the features that are of OUV may depend on them (e.g. rare and endemic seabirds rely on abundance of fish).
Attributes	Attributes are the **essential characteristics of a feature** that can be measured and monitored to provide evidence of its condition.	A woodland may have a number of attributes, such as dead standing timber, canopy, understorey and ground flora, associated fauna and so on. These can be monitored and measured.
Indicators	Indicators are **measures of the attributes** that allow us to determine the quality of a particular attribute, whether the condition of the attribute is within acceptable limits, and whether there are trends or changes such as uphill expansion, increased woodland mortality, etc.	Indicators in a woodland might include the proportion of dead to live timber; the amount of dead timber that is standing; the percentage of closed canopy, or its ratio to open canopy; the abundance of understorey; the abundance and variety of species.
Integrity	Integrity refers to how **intact and whole** a site is, how **resistant it is to threats**, **the condition of its pertinent features** and how well the features and processes express its OUV.	A large, remote and unoccupied site may have a high degree of integrity because of its natural condition.
Sensitivity	Sensitivity refers to **how easily the values of a site can be irreparably damaged**. A sensitive site is one whose features and their attributes can easily be transformed by a wide number of factors.	A small isolated habitat surrounded by intensive agriculture or development is likely to be sensitive, especially where it relies on external resources such as incoming water supplies. Low-lying mangrove forests are sensitive to sea level rise.

Term	Meaning	Example
Vulnerability	Vulnerability refers to a site's **sensitivity to changes in specific conditions**, e.g. a site may be vulnerable to flooding, but not vulnerable to overgrazing. It also refers to specific features or attributes that may be vulnerable or make the site vulnerable, whereas other attributes are resistant to threats.	An otherwise robust site such as a significant area of woodland might be vulnerable to timber extraction from local dwellers. Specific birds may be vulnerable to poaching for trade, whereas others are ignored.
Resilience	Resilience refers to the **ability of a site to survive impact and recover functioning to its original or desired state** after a disturbance. Often referred to as its 'elasticity'.	Where a forest suffers damage through fire or drought, it will be resilient when it is capable of restoring itself (as measured using appropriate indicators) after a period of time.
Monitoring	Monitoring is an **ongoing process** that records activity and observes changes on the ground in a highly systematic and repeatable way**.** Monitoring requires an identification of a site's features, their attributes and the indicators to be used to measure selected key attributes.	A fieldworker may be carrying out a number of observations and measures – quantitative and qualitative – and record them in real time. Monitoring usually entails the use of a range of tools, several measures, several timescales and a range of recording methods.
Evaluation or Assessment	Evaluation or assessment is **reflective measuring of the effectiveness** of the activities in achieving their intended goals.	At the end of a programme, or periodically, an organization might assess what activities have been carried out, what results have been achieved (outputs) and at what cost (inputs) in order to assess their effectiveness. Evaluation is also a review tool for management.

1.5 A note on local and indigenous peoples

Climate change exacerbates existing inequalities. Indigenous peoples and marginalized populations are particularly exposed and vulnerable to climate change impacts due to their resource-based livelihoods and the location of their homelands in marginal environments.

We recognize that cooperation with communities neighbouring World Heritage sites is crucial in the implementation of adaptation strategies. In this respect, those responsible for identifying and implementing these strategies should also consider their community and gender-related implications. Every effort should be made to ensure participation of local and indigenous communities in climate change decision-making so that adaptation strategies contribute to the well-being of the communities, including marginalized groups, and avoid strengthening existing inequalities. Knowledge possessed by indigenous peoples also contributes to climate change assessment and adaptation by offering observations and interpretations at a much finer spatial scale with considerable temporal depth and by highlighting elements that may not be considered by climate scientists.

For further information on climate change and indigenous peoples, see for example the following resources:

- A global forum for indigenous peoples, small islands and vulnerable communities, http://www.climatefrontlines.org/
- Nakashima, D. J., Galloway McLean, K., Thulstrup, H. D., Ramos Castillo, A. and Rubis, J. T. 2012. *Weathering Uncertainty: Traditional Knowledge for Climate Change Assessment and Adaptation*. Paris/Darwin, UNESCO/UNU. http://unesdoc.unesco.org/images/0021/002166/216613e.pdf

1.6 A note on gender

Women are disproportionately affected by climate change impacts, such as droughts, floods and other extreme weather events, because of women's limited access to resources, restricted rights, limited mobility and lack of voice in decision-making. However, women also play an important role in supporting households and communities to mitigate and adapt to climate change.

When designing adaptation strategies, it is crucial that climate change responses are gender aware, ensuring that women and men have an equal voice in decision-making on climate change and equal access to the resources necessary to respond to its negative effects.

There is a growing body of work on climate change and gender. A short list of useful resources is provided below:

- Gender Climate Change platform for information, knowledge, and networking on gender and climate change. http://www.gendercc.net/
- Global Gender and Climate Alliance – Incorporating a gender perspective in all climate change policies and initiatives. http://www.gender-climate.org/
- González, A. M. and Martin, A. S. 2007. *Gender in the Conservation of Protected Areas*. Parks in Peril, Innovations in Conservation Series. Arlington, Va., The Nature Conservancy. http://www.cbd.int/doc/pa/tools/Gender%20in%20the%20conservation%20of%20protected%20areas.pdf
- IUCN, UNDP, GWA, ENERGIA, UNESCO, FAO and WEDO as part of the Global Gender and Climate Alliance (GGCA). 2009. *Training Manual on Gender and Climate Change*. San José, Absoluto. https://portals.iucn.org/library/efiles/documents/2009-012.pdf
- UNDP. 2013. *Africa Adaptation Programme Experiences: Gender and Climate Change*. New York, United Nations Development Programme. http://www.undp.org/content/dam/aplaws/publication/en/publications/environment-energy/www-ee-library/climate-change/africa-adaptation-programme-experiences-gender-and-climate-change/AAP_Discussion_Paper1_English.pdf

Indigenous communities are often the first to witness climate change in different parts of the world. Virunga National Park (Democratic Republic of the Congo).
© Kim S. Gjerstad

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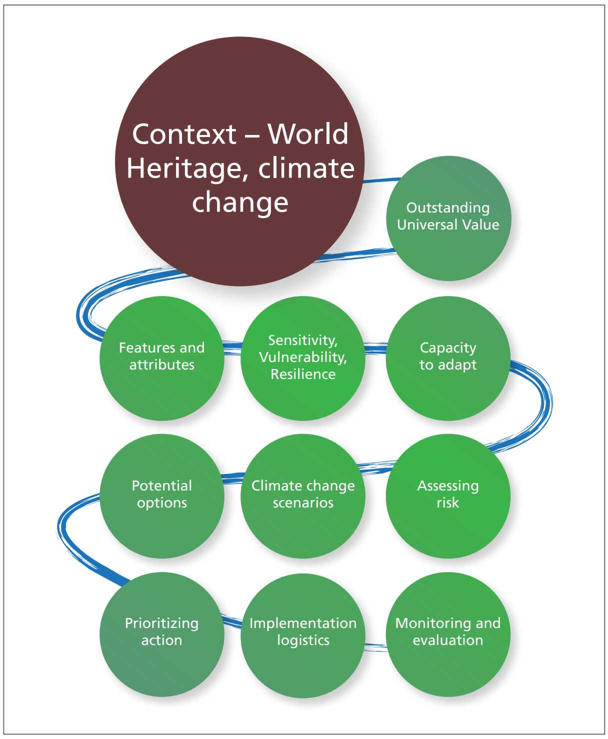
Understanding the context

Los Glaciares National Park (Argentina). © Pascal Gonzalez

2.1 World Heritage



The United Nations Educational, Scientific and Cultural Organization (UNESCO) seeks to encourage the identification, protection and preservation of cultural and natural heritage around the world considered to be of outstanding value to humanity. This is embodied in an international treaty called the *Convention concerning the Protection of the World Cultural and Natural Heritage*, adopted by UNESCO in 1972.

To be inscribed on the World Heritage List, a site must have **Outstanding Universal Value** (OUV). OUV implies 'cultural and/or natural significance which is so exceptional as to transcend national boundaries and to be of common importance for present and future generations of all humanity. As such, the permanent protection of this heritage is of the highest importance to the international community as a whole.' (UNESCO World Heritage Centre, 2013, para. 49).

States Parties to the World Heritage Convention have the responsibility to ensure the identification, nomination, protection, conservation, presentation, and transmission to future generations of the cultural and natural heritage found within their territory. All properties inscribed on the World Heritage List must have adequate long-term legislative, regulatory, institutional and/or traditional protection and management to ensure their safeguarding. This guide can help countries to carry out some of these obligations.

2.2 Climate change

The first World Climate Conference was held in 1979 because scientists had begun to notice the increase of carbon in the atmosphere caused by human activities which seemed to match with the global temperature increase. In 1988, the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP) set up the Intergovernmental Panel on Climate Change (IPCC) to provide the world with a clear scientific view on the current state of knowledge in climate change and its potential environmental and socio-economic impacts.

Organized two years after the release of the IPCC First Assessment Report, the United Nations Conference on Environment and Development in Rio de Janeiro in 1992 (the Earth Summit) resulted in the establishment of the UN Framework Convention on Climate Change (UNFCCC), in which nations agreed to explore further the causes and effects of global warming and how to limit and cope with its impacts. In 1995, the first Conference of the Parties (COP), the framework for the climate change negotiations, was

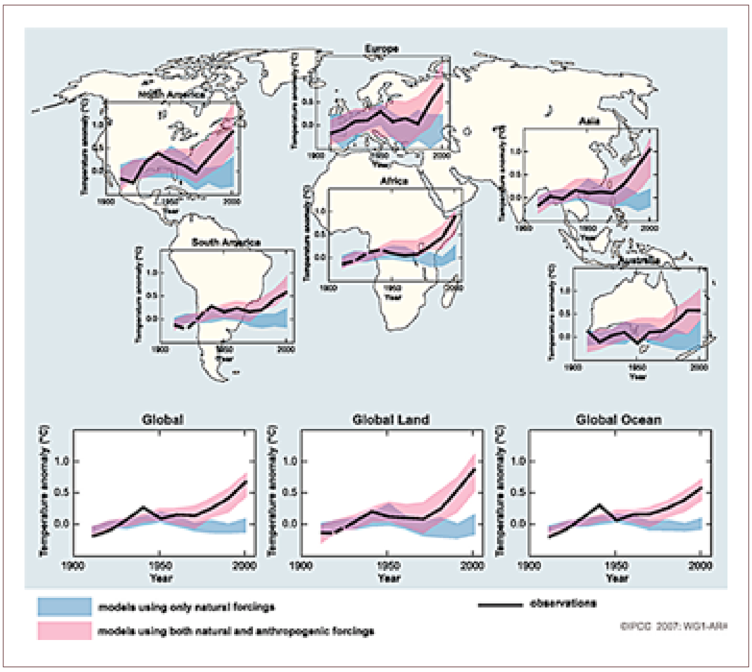


Figure 1: Global and continental temperature change. Source: IPCC (2007)

launched to strengthen the emission reduction provisions of the Convention. Two years later in 1997, the Kyoto Protocol was adopted which legally binds the developed countries to reduce carbon emissions. Since then, the Conference of the Parties (COP) has resulted in further provisions, but many of these are non-binding, and the climate change challenge remains.

In 2007 the IPCC presented its Fourth Assessment Report.[8] The report confirms that climate change is occurring now, mostly as a result of human activities (Figure 1). It illustrates the impacts of global warming already under way and to be expected in future, and describes the potential for adaptation of society to reduce its vulnerability. It also presents an analysis of costs, policies and technologies intended to limit the extent of future changes in the climate system. Some of this information has already been summarized in the previous climate change publications of the World Heritage Centre (see preface). The IPCC Fifth Assessment report will be completed in 2014.

The evidence of climate change is overwhelming, and there is considerable consensus among scientists that we are witnessing human-induced climate change, the outcomes of which may be catastrophic.

Climate change poses a major challenge to managers of protected areas. Its effects are ever-present and complicated, adding to stresses such as pollution, land-use change and habitat fragmentation. Mitigating and adapting to the impacts of climate change, through policies and on-site practices, is subject to extensive research. More than 4,000 scientific papers about climate change have been published to date, more than half of them in the last two or three years.

Despite this vast amount of research, protected area managers throughout the world can find it difficult to focus on adapting to climate change, even where they recognize the implications of failing to do so.

The reasons for this are complex. Some managers may lack the knowledge, and therefore the confidence, to analyse and anticipate the potential threats; others may be aware but may lack the resources or institutional structures that allow them to collaborate with other departments and communities in considering alternative options. In some cases, managers may simply feel that the difficulties are intractable and perhaps beyond their remit and lifetime.

Nonetheless, climate change is not a passing trend – it is here to stay, and it will impact all landscapes, including all natural World Heritage sites, fundamentally changing the way we understand and manage them. We are witnessing unpredictable weather patterns, floods, unseasonal drought, fires, extreme heat and cold, storms and sea level rise, glacial melting and altered movements in wildlife.

More information on climate change science is available on the websites of the IPCC[9] and the UNFCCC.[10]

8 IPCC, 2007, *Fourth Assessment Report: Climate Change 2007*. http://www.ipcc.ch/publications_and_data/publications_and_data_reports.shtml

9 http://www.ipcc.ch

10 http://unfccc.int/

2.3 Understanding the complexity of the problem

Before a site manager can begin to address the impacts of climate change, the complex nature of the problem needs to be appreciated. Such complexities are often resistant to easy resolution, and any attempt to solve one part of a problem may lead to new difficulties.

Complex problems may be said to have six central characteristics,[11] also relevant to understanding the complexity of the climate change challenge:

1) **The traditional approach – identify the problem and then seek the solution – does not apply.** Trying to understand *the problem* and then arriving at *the solution* may be impossible because different groups may see problems and solutions in different ways, and because there may be many unanticipated side effects resulting from different solutions. It is vital that in considering solutions, the natural World Heritage site manager critically analyses the possible ecosystem responses.

11 J. Conklin, 2005, Wicked problems and social complexity, in J. Conklin (ed.), *Dialogue Mapping: Building of Shared Understanding of Wicked Problems*, Wiley and Sons. http://cognexus.org/wpf/wickedproblems.pdf

2) **There is no stopping point.** All solutions are 'interim', and are driven by limits on political commitment, money, current understanding, human resources, time and energy. Managers must continually monitor the implications to their management interventions so that they can further improve or adapt them to changing environmental, social, economic or political realities.

3) **There are no 'perfect' solutions.** Problems may be 'critical', 'serious', 'potentially serious', 'less immediate' and so on. Likewise, solutions may be 'good', 'temporary', 'desirable but expensive' and so on. Solutions may need to be adjusted in the light of effects on the ecosystem and in response to opportunities, resources, acceptability and so on.

4) **Each problem is unique, and so is each set of solutions.** In the case of natural World Heritage sites, this means that because each site has its own unique characteristics, the 'cocktail' of problems and solutions will be unique to it, and unlikely to be applicable to other World Heritage sites. We are all 'learners' when it comes to the specifics of each site and its problems.

5) **Many solutions risk being expensive trials by error.** All attempts at management on the ecosystem scale are expensive, complex and prone to some degree of failure, and it may be impossible to go back and try again, because the underlying conditions such as temperature or precipitation patterns are also changing.

6) **There are no obviously recognizable alternative solutions that are better.** There may be many possible solutions, some already tried elsewhere, some not yet identified. By its nature, adaptation is about trial and error, using emerging knowledge, understanding, creativity and judgement based on experience.

Problems caused by climate change are particularly challenging because they can manifest themselves in highly complex ways, not simply by direct effects. As a simple example, responses such as the conversion of land from food to biofuels or major renewable energy projects can result in a reduction in available land for cereals or crops, and cause a rise in prices for those commodities, which can then become unaffordable for many living in poverty. This could result either in an increase in the number of people seeking to occupy new land for subsistence, or in government policies that aim to clear forest land to release it for food production, thus losing timber for construction, fuel and food, which might lead to encroachment on protected lands including World Heritage sites. Thus a policy decision, made perhaps in a distant part of the globe, can lead to difficulties at the doorstep of the site manager.

In seeking to address encroachment problems, it is important to understand their root causes. This requires careful analysis.

A slightly different version of the scenario described above is shown here (Figure 2). The reality can, of course, be much more complex.

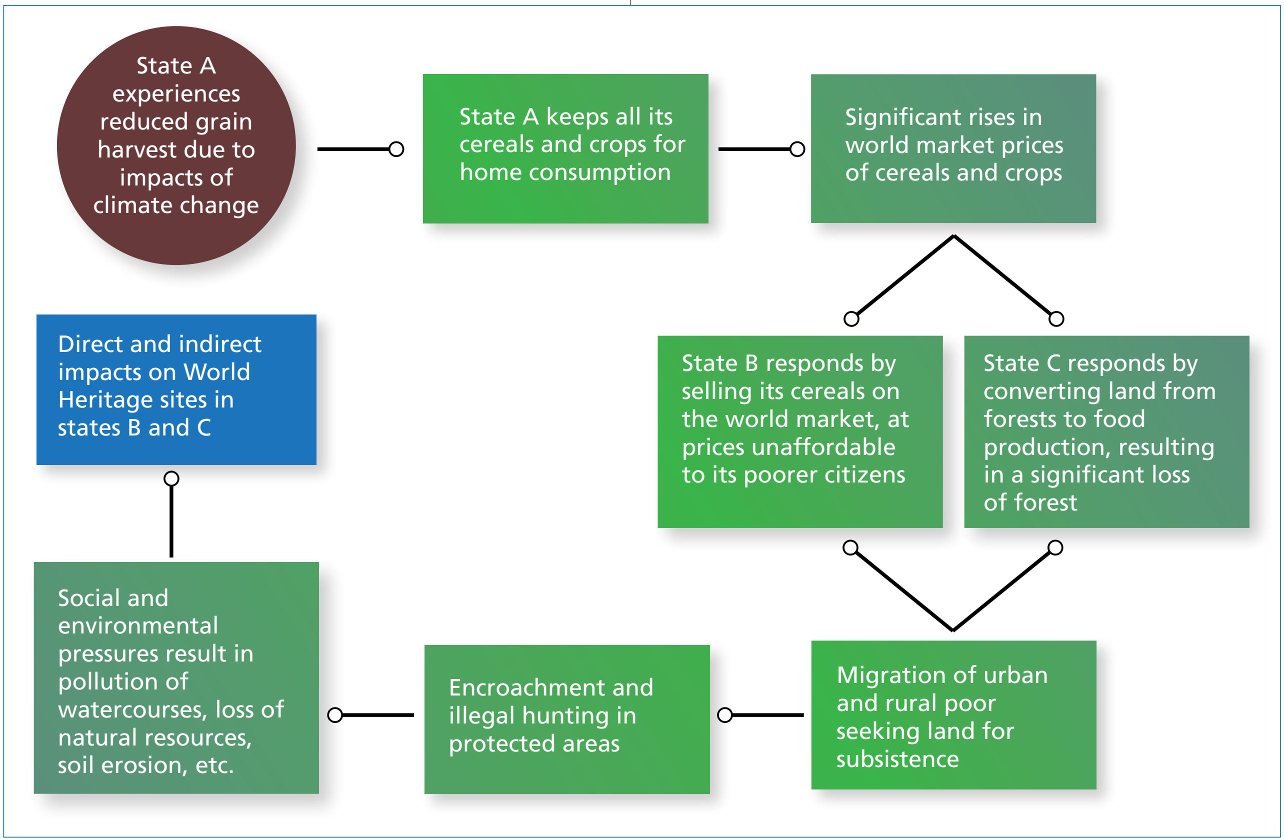


Figure 2: Example describing the complexity of problems related to climate change.

In this example, simply enforcing regulations may address the immediate problem, but will not address its underlying causes and may not be a sustainable or equitable option. The root causes of some problems may originate far from the site itself.

The task is to think creatively:[12]

- think beyond the spatial boundary of the site;
- think beyond the short term, and keep rethinking in the light of new information;
- think about problems at different levels, and how solutions will impact on people and ecosystems.

Think beyond the spatial boundary

Address the site in its broader landscape (Figure 3). The most successful climate change adaptation strategies view the site as an element of a larger landscape and then address the OUV on-site in the context of off-site practices that influence the OUV.

The capacity of World Heritage site management to adapt to climate change is determined by a number of activities taking place in the surrounding landscape. All protected areas have a spatial relationship with their surroundings, and exist within their wider ecosystems. A range of activities and requirements *beyond* the site will have a profound impact on its viability. Therefore, successful adaptation depends on the capacity of site managers to reconcile these different demands.

Think beyond the temporal boundary – monitor and adapt regularly

Think into the future. We cannot predict what will happen with certainty, but we can make some educated guesses. Climate change adaptation requires analysis of the current situation and the projected changes, measuring the results of actions taken, revising them and trying again. Adaptive management is based on this cycle of analysis, application, evaluation and revision (Figure 4).

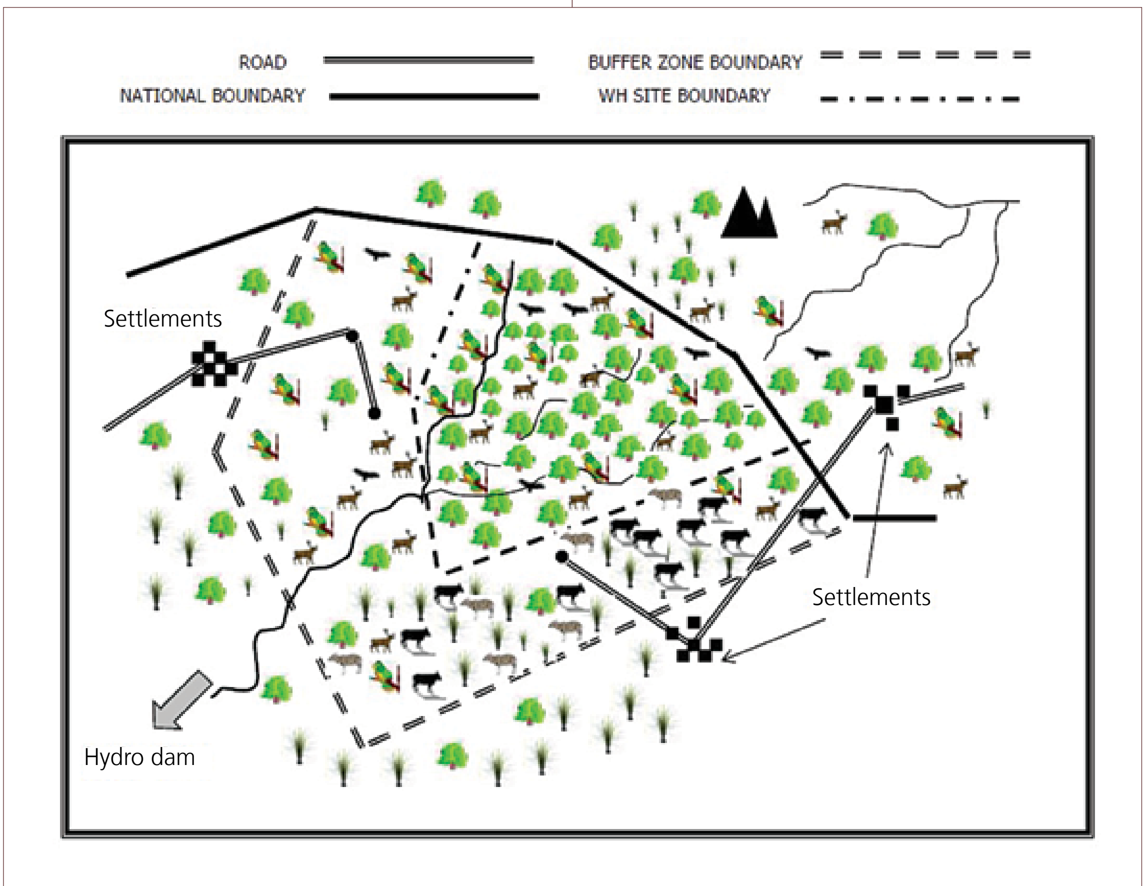


Figure 3: Understand the whole landscape where the site is situated.

12 Notes adapted from C. Falzon, 2004, *Protected Landscape Management*, M.Sc. Module 6, University of Aberystwyth, Wales, UK.

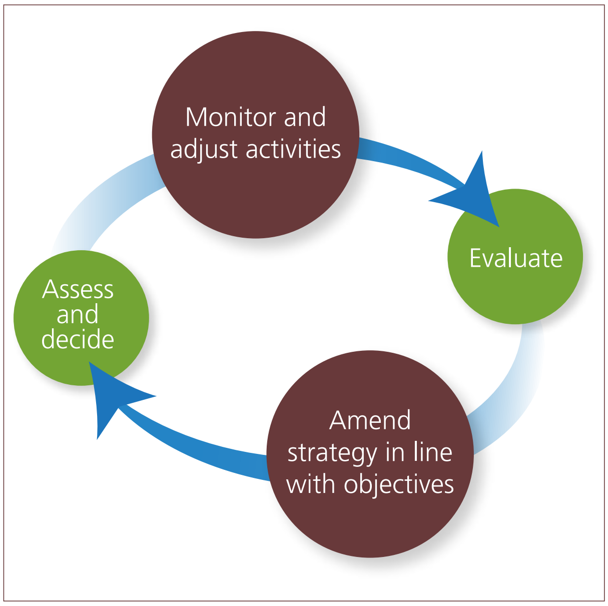


Figure 4: Adaptive management requires constant monitoring and adjustments.

Approach the problem at different levels using different methods

Adaptation responses take place at different levels. Small, site-specific, lower-level actions can be taken on most sites. Most if not all sites will also benefit from higher-level actions that involve different stakeholders, such as the surrounding community, policy-makers or energy and water companies. Some actions may entail infrastructural works, whereas others may be about education, legal enforcement or influencing others.

Approach all levels strategically, recognizing that working at lower levels is generally less expensive and provides quicker responses but may have more limited impact on protecting the OUV. Therefore, the most appropriate strategy is often to work simultaneously on both lower- and higher-level issues (Figure 5).

Practical action can be taken to micro-manage the critical habitats, perhaps by reducing erosion, diverting water, shading out, cutting, removing invasive species and so on. However, such actions on their own will do little to reduce impacts from the surrounding community, such as encroachment, disturbance or pollution. These will require a different, more strategic approach.

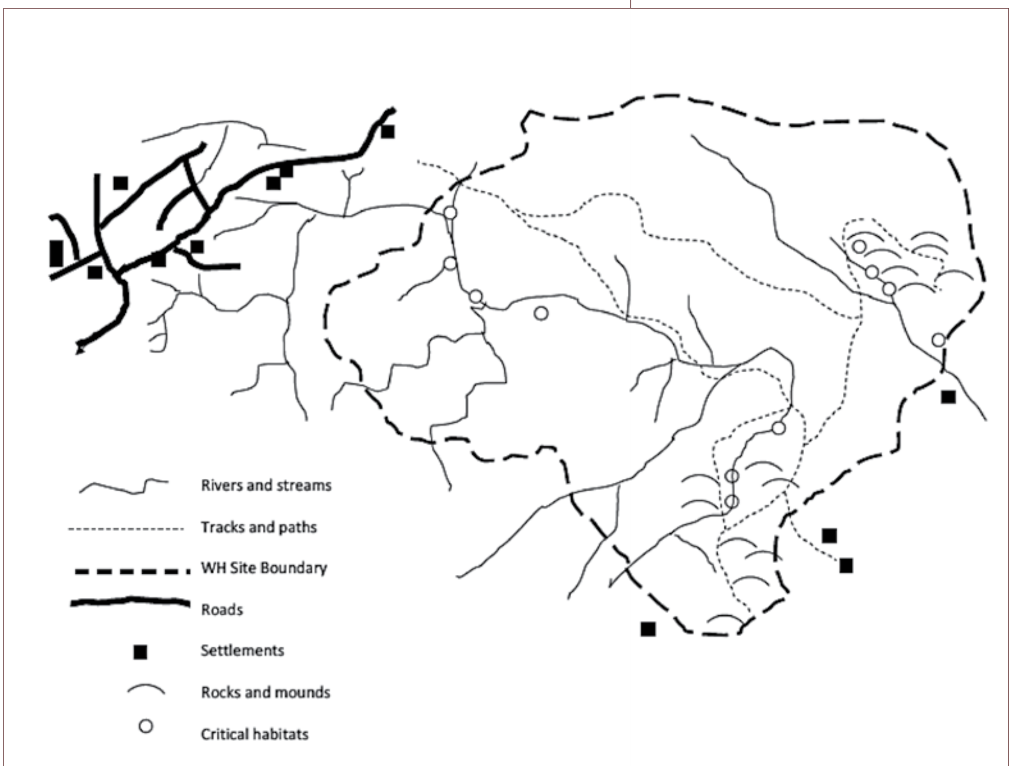


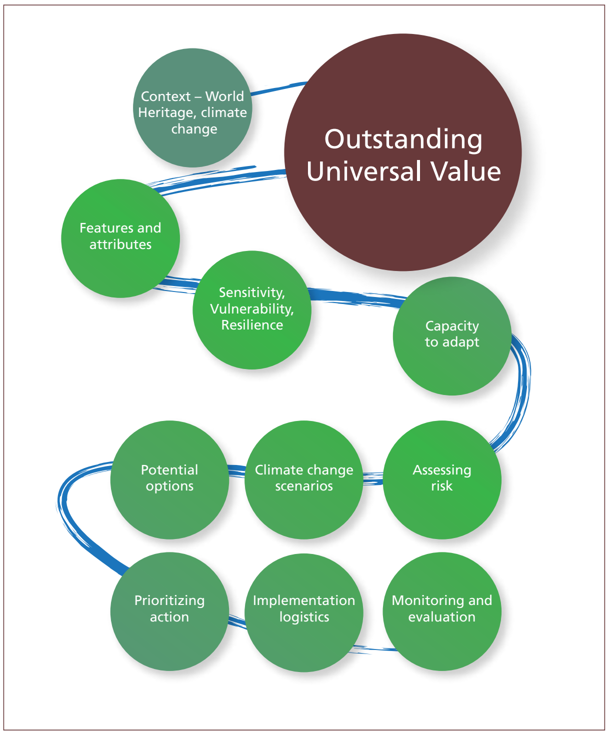
Figure 5: Work effectively at different spatial and temporal scales, and with different stakeholders using variety of methods.

3

Planning for adaptation

Yosemite National Park (United States).
© David Geldhof

3.1 Assess your site (1) – understand its OUV



'To be deemed of Outstanding Universal Value, a property must also meet the conditions of integrity and/or authenticity and must have an adequate protection and management system to ensure its safeguarding.'

Operational Guidelines (UNESCO World Heritage Centre, 2013, para. 78)

World Heritage sites are inscribed on the World Heritage List if they are considered as having Outstanding Universal Value (Figure 6). As such, they meet one or more of the ten criteria, of which criteria vii, viii, ix and x apply to natural World Heritage sites (see Example 2):

Criterion vii – 'contain superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance.'

Criterion viii – 'be outstanding examples representing major stages of earth's history, including the record of life, significant on-going geological processes in the development of landforms, or significant geomorphic or physiographic features.'

Criterion ix – 'be outstanding examples representing significant on-going ecological and biological processes in the evolution and development of terrestrial, fresh water, coastal and marine ecosystems and communities of plants and animals.'

Criterion x – 'contain the most important and significant natural habitats for *in situ* conservation of biological diversity, including those containing threatened species of Outstanding Universal Value from the point of view of science or conservation.'

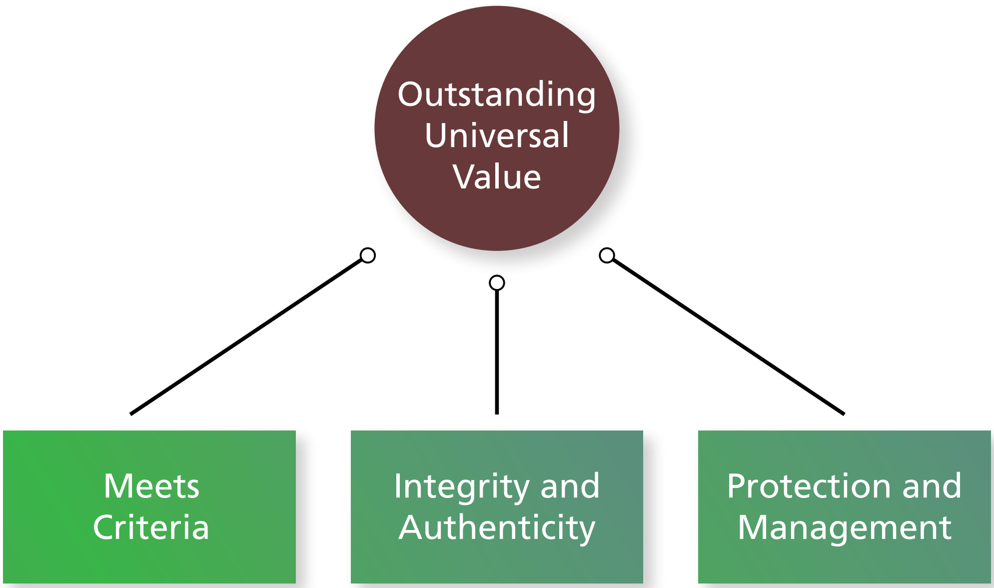
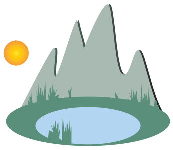


Figure 6: Illustration of the three pillars of Outstanding Universal Value (OUV). All three must be in place for a property to meet the requirements of the World Heritage List.

Example 2. Criteria used to inscribe the two theoretical sites in this guide.

Cloudey Island meets **criterion vii** – it contains superlative natural phenomena and areas of exceptional natural beauty and aesthetic importance. The island also meets **criterion x**, as it contains the most outstanding and significant natural habitats for *in situ* conservation of biological diversity, including threatened species of Outstanding Universal Value.



The Snowey Mountains System meets **criterion x** – it contains critical montane habitats and their associated plant and animal species that are representative of this region, a number of which are globally rare and endemic.

Worksheet 1: Understanding Outstanding Universal Value

Criterion	Description

A key area of concern for the World Heritage Convention is to ensure the integrity of the sites inscribed on the World Heritage List.

The following questions, adapted from the manual on *Preparing World Heritage Nominations*, highlight the required information needed for assessing integrity:[13]

- Are the site's key features and attributes related to the OUV whole and intact?
- Does the site include all the elements necessary to express its OUV?
- Is the site of adequate size to ensure complete representation of features/processes that convey its significance?
- What is the condition of the key features and attributes of the site?
- Are essential processes, relationships and dynamic functions maintained in good condition and at an appropriate scale?
- Does the site suffer from the adverse effects of development, neglect or any other degrading process?
- Do you have control over the processes causing deterioration? Who does? Have adaptation strategies been identified and implemented?
- Does the site have a buffer zone and, if so, is it under any threat?

Answering these questions honestly is essential in evaluating if and how different measures might help you to adapt to climate change impacts.

Integrity can be assessed in terms of wholeness and intactness of the natural and/or cultural heritage and its attributes (Example 3). The conditions of integrity are whereby the property:

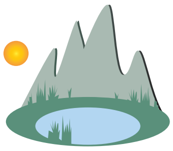
a) includes all elements necessary to express its Outstanding Universal Value (OUV)

b) is of adequate size to ensure the complete representation of the features and processes which convey the property's significance

c) is not threatened by adverse effects of development and/or neglect

Operational Guidelines
(UNESCO World Heritage Centre, 2013, paras 87–95)

13 UNESCO World Heritage Centre, 2011, *Preparing World Heritage Nominations, Resource Manual.* http://whc.unesco.org/en/activities/643/



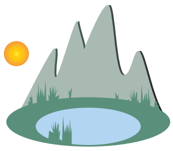
Example 3. Assessing the integrity of the Snowey Mountains System.

Key questions		Comments
Are the site's key features and attributes related to the OUV whole and intact?	Yes	*See comments below.*
Does the site include all the elements necessary to express its OUV?	Yes	*The mountain system contains the headwaters of the major rivers in this region; the second largest lake in the region (containing the highest biodiversity by abundance and by variety). 16 per cent of the vascular plants are endemic. It contains significant populations of snow leopard, and is therefore a crucial breeding and dispersal point for this endangered species.*
Is the site of adequate size to ensure complete representation of features/processes that convey its significance?	Yes	*The property contains five separate IUCN protected areas, and a biosphere reserve enclosing a Ramsar site. Its overall size is approximately 1.6 million ha, of which 0.8 million ha are strictly protected, and 0.4 million ha are protected.*
What is the condition of the key features and attributes of the site?		*Currently they are in pristine condition. Protection measures are strictly enforced in the core protection zones.*
Are processes, relationships and dynamic functions essential to features maintained in good condition and at an appropriate scale?	Yes	*Access to the strictly protected area is by permit only, and is subject to strict control. Grazing and other human activity is forbidden. The core is largely pristine.*
Does the site suffer from the adverse effects of development, neglect or any other degrading process?	Yes see comment	*A number of fires have occurred, which may have a local impact on vascular plants; although there is no encroachment, poaching in the less strictly protected zones has been problematic; overgrazing in some areas. Two lakes were stocked with non-native fish species in the 1940s.*
Do you have control over the processes causing deterioration? Have adaptation strategies been identified and implemented?	Yes, but see comment No	*The property is protected under various federal and state laws. However, federal policy in response to other overriding priorities may threaten the integrity of the property at a future date.*
Does the site have a buffer zone? If so, is it under any threat?	Yes No, but see comment	*The whole area is a biosphere reserve, of which 50 per cent is buffer zone – this is economic and recreational. There is some pressure for timber extraction, but currently this is for subsistence use only; overgrazing may threaten the flora of this zone*

Worksheet 2: Assessing integrity	
Key questions	**Comments**
Are the site's key features and attributes related to the OUV whole and intact?	
Does the site include all the elements necessary to express its OUV?	
Is the site of adequate size to ensure complete representation of features/processes that convey its significance?	
What is the condition of the key features and attributes of the site?	
Are processes, relationships and dynamic functions essential to features maintained in good condition and at an appropriate scale?	
Does the site suffer from the adverse effects of development, neglect or any other degrading process?	
Do you have control over the processes causing deterioration? Have adaptation strategies been identified and implemented?	
Does the site have a buffer zone? If so, is it under any threat?	

All World Heritage sites should have a Statement of Outstanding Universal Value (SOUV). Because it is impossible to list and describe every possible element of sites, these statements try to summarize those aspects that provide the foundation for World Heritage status (see Example 4).

Example 4. Extracts from the Statements of Outstanding Universal Value (SOUV) of the Cloudey Island and the Snowey Mountains System Sites.

	'Cloudey Island is one of the few islands in the world whose ecosystems can be said to be virtually untouched by humans. Its isolated location provides an ideal opportunity for studying the dynamics of insular evolution and natural selection – it is particularly notable for the ten plant and four landbirds species that are endemic to the island, including the highly endangered Cloudey Island petrel.'
	'The Snowey Mountains System forms the major mountain range in this biogeographic region and provides the source of its greatest rivers. Three separate areas are inscribed, in a total area of 1,612,000 ha. Five protected areas are designated. The property represents the most complete sequence of altitudinal vegetation zones in the region, from steppe, forest-steppe, mixed forest, subalpine vegetation to alpine vegetation. The site is also an important habitat for endangered animal species such as the snow leopard. In the eastern part of the system, a Buffer Zone encloses a Ramsar-designated lake, the second largest and most pristine in the region. The area is composed of upland taiga, a glacial zone, mountain meadows, and high-altitude tundra and steppes. More than 1,400 vascular plants are found here, and of these 16 per cent are endemic. The area supports a diverse fauna, including over 40 mammal species and 300 bird species.'

Because SOUVs were made a requirement for nominating World Heritage sites only in 2008, efforts are currently under way to retrospectively develop SOUVs for those sites that do not yet have them. If your site does not have a SOUV, you are encouraged to refer back to the site's nomination file, and to the inscription decision of the World Heritage Committee to identify the features that contribute to the site's OUV.

As well as stating their OUV, all natural World Heritage sites have some description of their biodiversity and landscape features and their attributes developed at the time of nomination. These are the foundation for the justification of the OUV.

Many resources are available for support in documenting natural conditions. *Enhancing our Heritage Toolkit*,[14] especially Tool 1, 'Identifying site values and management objectives', is particularly useful in understanding this step.

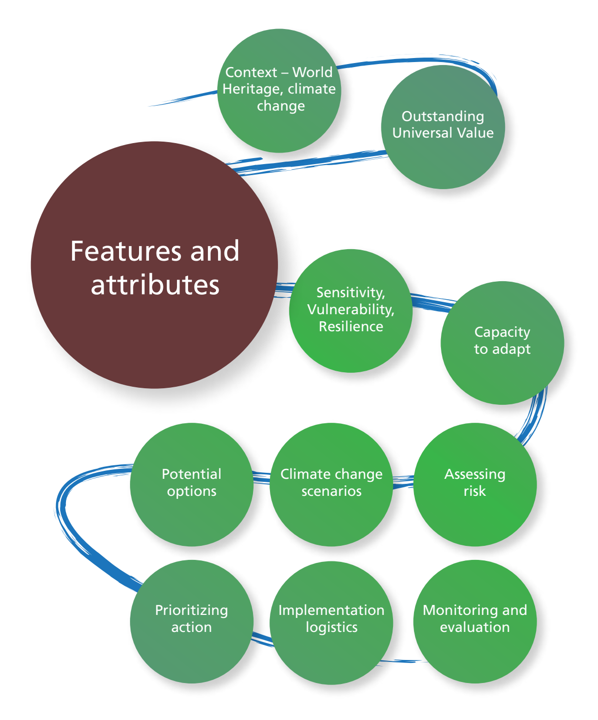
The *Operational Guidelines,*[15] IUCN's Resource Manuals on *Management Planning for Natural World Heritage Properties*[16] and *Outstanding Universal Value: Standards for Natural World Heritage*[17] specify in depth the attributes that contribute to OUV.

For natural sites, the biophysical components of the OUV commonly consist of features, and include such characteristics as visual or aesthetic significance, scale of physical features or habitats, intactness of ecological processes, naturalness of a system, viability of populations of rare species, and/or rarity of the ecological or physical conditions.

For some useful examples of OUV, criteria and integrity see the descriptions of the following World Heritage sites: Sagarmatha National Park in Nepal,[18] Great Barrier Reef in Australia[19] and Ichkeul National Park in Tunisia.[20]

14 Hockings et al., 2008, op. cit. http://whc.unesco.org/en/series/23
15 UNESCO World Heritage Centre, 2013, *Operational Guidelines for the Implementation of the World Heritage Convention*. http://whc.unesco.org/en/guidelines
16 IUCN Protected Areas Programme, 2008, *Management Planning for Natural World Heritage Properties. A Resource Manual for Practitioners.* https://portals.iucn.org/library/efiles/documents/2008-077.pdf
17 T. Badman et al., 2008, *Outstanding Universal Value: Standards for Natural World Heritage*, Gland, Switzerland, International Union for Conservation of Nature. https://portals.iucn.org/library/efiles/documents/2008-036.pdf
18 http://whc.unesco.org/en/list/120
19 http://whc.unesco.org/en/list/154
20 http://whc.unesco.org/en/list/8

3.2 Assess your site (2) – understand its features and attributes; set objectives



While the OUV provides a framework, on its own it does not offer enough detail for monitoring and providing evidence of climate change or its effects. In order to set objectives for site management, it is necessary to:

- identify those features of a site that contribute to its OUV;
- carefully analyse the attributes for each feature, and
- assess the condition of each feature based on its measurable attributes.

It is important to recognize that **World Heritage designation is granted on the basis of OUV alone**, and not all of a site's features contribute to the OUV. Managers should therefore try to understand the site's OUV and the condition of the variables (features and attributes) that sustain it (see Examples 5 and 6).

A consistent approach to documenting, recording and reporting the attributes of your site's key features will provide the basis for future impact assessment, as well as the basis for designing and implementing adaptation strategies.

This section offers a systematic approach to monitoring and analysing the effects of climate change, and is a standard approach to managing and monitoring the condition of habitats and species.

This can be a difficult concept to grasp, but it is central to effective site management. What counts as a feature depends on the spatial scale of a site. Some large areas may have few features, while other areas may have many. The best way to consider **features** is to simply list those things that are considered most important. The OUV statement will help you to identify them.

Features of natural sites can be important physical, geological or ecological components such as habitats, species, populations, processes or formations.

Attributes are characteristics of a feature that can be monitored to provide evidence about the condition of the feature.

Operational Guidelines (UNESCO World Heritage Centre, 2013)

Example 5. Features of Cloudey Island.

1) Fossil raised reef
2) Karst cliffs, caves and pinnacles
3) Reef fish species
4) Natural scrub forest
5) Ten species of endemic vascular plants (1–10 listed)
6) Invertebrate species
7) Reptiles/turtles
8) Seabirds
9) Four species of landbird including the Cloudey Island petrel (1–4 listed)

These are fairly general, and in the case of Cloudey Island only one specific species was named as a feature in the site's Statement of OUV – the Cloudey Island petrel. Good management dictates that as far as possible all species that constitute a key feature are listed, but this depends on the capacity of the management staff.

In order to monitor these features, each of their **attributes** must be understood (see Example 6). Attributes are what any feature needs to make it function, and which can be observed. These include feeding, sheltering, breeding, predation, migration patterns, and other factors such as hunting, pollution, etc. They might include extent, variety, age, extraction and regrowth rates for forests, or abstraction and recharging, biological and chemical composition in watercourses. All these attributes can be **directly measured and observed**, and will provide the evidence for managing change and responding to it.

Example 6. Attributes of some of the features of Cloudey Island.

Site feature 4	Attributes
Natural scrub forest	**Extent and distribution**
	Canopy cover – percentage of closed/open canopy
	Species composition – relationship between different indigenous species/indigenous-introduced species
	Regeneration – rate of regeneration/growth/death for each species
	Dead wood – abundance of standing and fallen dead wood
	Understorey and ground flora – abundance and composition of species at different levels
	Precipitation, temperature, frequency of storm events, wind conditions

Site feature 5	Attributes
(for each endemic vascular plant) Plant 1, 2, 3, etc.	**Extent and distribution of each species**
	Reproduction rates and processes
	Grazers/browsers – species and distribution
	Presence of competing vascular species – rates of encroachment and loss
	Precipitation, temperature

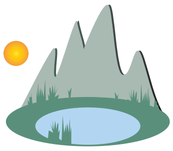
Site feature 9	Attributes
(for each endemic landbird) Cloudey Island petrel	**Population size – numbers of pairs – dispersal**
	Breeding sites – location, number
	Breeding rates – how often, how many
	Predation rates – native and non-native predators
	Competitors – native and non-native competitors
	Death rates – ageing, accidental death, exposure to disease
	Frequency of storm events/wind conditions
	Temperature, precipitation
	Feeding – locations, food species, habitats

The above attributes should be monitored because they provide the basis for evidence of any changes that may be linked to climate factors, and therefore how the OUV might be negatively impacted. The managing team needs to consider **how to consistently measure these attributes and how to present the results**, in order to assess the condition of each feature and whether it is declining, stable or improving**.** The *Operational Guidelines* recommend site managers to identify 'key indicators for measuring its state of conservation'.

As well as providing the basis for monitoring pressures and trends, this systematic approach allows the manager to **set clear objectives** that can be monitored. The aim of managing any natural World Heritage site is to maintain and enhance its OUV, but this is meaningless unless clear objectives and management targets can be set (see Example 7 and Worksheet 3).

Objectives, as well as their indicators, should be '**SMART**'. There are different ways of developing objectives, but they should support the aim by identifying **Specific, Measurable** targets that can be met by the plan, and these should reflect the attributes you have identified above. Importantly, they should also be **Achievable** and **Realistic** within the timescale or resources available within the plan. The objectives must also be **Timebound**, with set deadlines.

In the case of extensive, remote natural sites exposed to few anthropogenic threats, the objectives may be relatively straightforward – perhaps no more than monitoring the attributes and reporting. Smaller more sensitive sites may require more intervention to maintain their integrity, and the objectives may need to reflect this. Some sites may include specific cultural and economic, as well as natural objectives, under different headings – you will need to ensure these do not conflict.



Example 7. The case of the Snowey Mountains System demonstrates the link between aims, features, attributes and management objectives.

Aim

'To maintain and enhance the diversity, abundance and ecological integrity of all physical and biological resources in the park area, so that they may be enjoyed and used productively by present and future generations.'

Feature

SNOW LEOPARD

Attributes

- Population size and dispersal
- Birth/death ratios
- Prey species – population size and dispersal
- Climate factors – frequency of storm events, temperature, precipitation
- Habitat – response to glacial conditions/seasonal change
- Anthropogenic causes of injury and death

Objectives linked to OUV

1) Increase the population of snow leopards by 10 per cent.
2) Reduce poaching incidents by 20 per cent.
3) Remove invasive plant species from 30 per cent of mountain meadows to protect the pika, a snow leopard prey mammal.
4) Carry out twelve community outreach programmes per year to raise awareness.
5) Ensure that all staff members have been trained in taxonomy within three years.
6) Contribute to fifteen university field visits per year.

Worksheet 3: Features and attributes – objectives

Features	Attributes	Objectives
FEATURE	A	
	B	
	C	
	D	
FEATURE	A	
	B	
	C	
	D	
FEATURE	A	
	B	
	C	
	D	

3.3 Assess your site (3) – understand its sensitivity and vulnerability

It is important to remember that **your site may contribute significantly to mitigating the effects of climate change** – tropical forests, salt marshes and mangroves, sea grasses and peat uplands store large quantities of carbon, and most of them also serve as refuges and pockets of biodiversity that retain metapopulations, and in some cases act as natural protective barriers to climate-related physical impacts and other effects such as diseases. Moreover, as World Heritage sites are usually the largest, and often among the best-conserved within a local or regional network of protected areas, they can act as a centre of species dispersal to smaller protected areas, contributing to biodiversity conservation throughout a broader landscape. In this way, your site can play an important climate change adaptation role for the larger protected areas network.

World Heritage sites can also contribute to the health and well-being of people by providing ecosystem services, such as water for drinking, agriculture and industry, absorbing atmospheric and aquatic pollution, capturing carbon, and providing clean air, as well as a source of fresh food.

For these reasons it is in everyone's interest to protect and enhance such sites. In this guide, sensitivity and vulnerability are seen as separate but linked concepts. A site may be **sensitive** for many reasons. It may be too small to resist a number of pressures; key species populations might be at critical levels with little room to manoeuvre, or its

Value of protected areas for climate change mitigation and adaptation

Protected areas play a major role in reducing climate-changing carbon dioxide emissions in the atmosphere. Of the world's terrestrial carbon stock, 15 per cent – 312 gigatonnes – is stored in protected areas around the world. In Canada, over 4 billion tonnes of carbon dioxide are sequestered in thirty-nine national parks, estimated to be worth US$39–87 billion in carbon credits. In the Brazilian Amazon, protected lands are expected to prevent 670,000 km^2 of deforestation by 2050, representing 8 billion tonnes of avoided carbon emissions.

Protected areas also serve as natural buffers against climate impacts and other disasters, providing space for floodwaters to disperse, stabilizing soil against landslides and blocking storm surges. It has been estimated that coastal wetlands in the United States provide US$23.2 billion a year in protection against flooding from hurricanes.

Protected areas can keep natural resources healthy and productive so that they can withstand the impacts of climate change and continue to provide the food, clean water, shelter and income communities rely upon for survival. Thirty-three of the world's hundred largest cities derive their drinking water from catchments within forest-protected areas.

Natural Solutions: Protected areas helping people cope with climate change (Dudley et al., 2010)

Emerald Lake, Canadian Rocky Mountain Parks (Canada). © Maureen Flynn boundaries may be too porous to maintain integrity in the face of encroachments of many kinds – extraction, pollution, settlements, poaching and so on. A site may be particularly sensitive if it is a rare or unique type of habitat, or if it is isolated from similar sites. In Section 3.4 we ask *'how resilient is your site?'* A sensitive site may be the opposite of a resilient site, as demonstrated by the examples given.

For the purposes of this guide, **vulnerability** is seen as the level of risk of damage by a specific threat, or sets of threats. Some sites are generally robust, but might be vulnerable to specific threats such as flooding or fire, and some species might be vulnerable specifically to predation, disease or hunting. Our concern has to do with **vulnerability to the effects of climate change**, and **a sensitive site might be particularly vulnerable to this particular threat.**

Climate change impacts rarely happen in isolation. It is not always easy to establish clear cause and effect relationships between climate change and visible changes at a World Heritage site. What may seem as a new alien species to address may in fact be closely linked to higher temperatures, facilitating the spread of that species, or the reproductive failures of a key species may be linked to a disease that thrives in more humid conditions.

Some climate change impacts will be **cumulative**, where each effect may seem to be minimal, but taken together a number of apparently minor effects may be significant. Other effects could be **'threshold'**, whereby a habitat seems to sustain impacts up to a certain point before collapsing. Some of the effects may be **'upstream'**, originating from distant regions. For example, migratory species that feed or breed in your area may be under severe drought stress in another country, resulting in changes in species interaction at your site, and potentially reducing its OUV.

A few general examples of possible threats posed by climate change are shown in Table 2 (there are of course many more). Many of these threats result from indirect pressures, perhaps over a long period of time or originating far away. Such pressures might derive from changes in policy, land-use patterns, demography or other factors.

Giant leaf frog, Amazon National Park – many amphibians have very specific climatic requirements and their populations change rapidly as climatic conditions change. Therefore, amphibians are often sensitive indicators of climate change. © Dawn Tanner and Jim Perry

Table 2: Possible threats posed by climate change in different habitats/landscape types

Habitat/ landscape type	Possible threats
High mountain range	▶ Glacial melt leads to inundation of valley habitats and communities. ▶ Land losses beyond World Heritage sites reduce livelihood alternatives of rural populations, resulting in encroachment and poaching of key species. ▶ Increases in temperature extremes, precipitation or extraction lead to a loss of fragile and rare flora.
Wetland	▶ Climate-induced crop loss results in intensification of farmland use, which in turn leads to erosion, pollution from fertilizers and increased pressure to drain wetlands for agricultural uses. ▶ Changes in seasonal rainfall, upstream diversion, irrigation or reservoir impounding result in drying out or periodic flooding. ▶ Changes in agricultural practices lead to increased salinization. ▶ Human migration in response to drought or flood, results in pollution from human waste.
Lake	▶ Pollution from upstream industrial, agricultural or housing development as a result of relocation, leads to eutrophication, species losses, changes in habitat.
Tropical forest	▶ Policy changes in response to climate-induced resource needs lead to increases in extraction or land-use changes, with consequent losses of important tree species and habitats. ▶ Loss of fauna and flora through poaching by climate change refugees. ▶ Changes in forest structure as a direct result of extreme weather patterns. ▶ Loss of soils as a result of erosive forces upstream.
Reef	▶ Climate change induced warming, cooling or changes in chemistry lead to changes in numbers/varieties of fish species and changes in reef populations and structure. ▶ Reef mortality as a result of temperature changes, increases in carbon or acidity.
Mangrove	▶ Changes in water levels result in tidal effects, increased erosion and loss of mangrove. ▶ Increases in precipitation result in higher levels of silt deposits or 'scouring' mangrove soils, as well as freshwater incursion. ▶ Introduction of invasive species, in response to changes in climatic conditions.
Shoreline	▶ Coastal inundation or erosion as a result of higher sea levels. ▶ Changes in longshore drift patterns as a result of increased river and estuary flows, or development/shoreline infrastructure elsewhere.

For specific examples of the effects of climate change on World Heritage sites, consult the UNESCO World Heritage Centre publication *Case Studies on Climate Change and World Heritage*.[21]

A number of factors can undermine the integrity of a site and make it vulnerable to threats associated with climate change (see the 'integrity test' questions in Section 3.1, also Example 8). These might include:

- Any fragmentation and/or modification of landscape, which **undermines intactness.**
- Any threat to populations or hydrology can result in ecological loss or erosion, or an increase in pest-borne diseases, thus **losing some of the necessary OUV elements.**
- Any loss of habitat or reduction in size that results in a **lack of capacity to support representative communities or processes.**
- Any loss of attributes such as prey species, migration routes or breeding grounds that **reduces the condition of features** and **leads to their losses.**
- Any threat to ecosystem function or interrelationships that **undermines the viability of features to function adequately.**
- Encroachment, land conversion, human migration, intensification of water use, diversion of catchments and erosion can all result in **adverse effects** and **degrading processes.**
- Lack of control over any of the above can result in changes to vegetation patterns, increases in fire incidents, drought or poaching, leading to a **loss of features** and **ecosystem breakdown.**
- Lack of corridors and buffer zones results in the inability of species to migrate and find new breeding and feeding grounds, and can result in **loss of key species** and ultimately a **breakdown in habitat.**

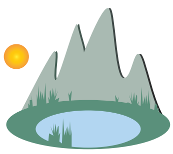
21 UNESCO World Heritage Centre, 2007*a*, *Case Studies on Climate Change and World Heritage*. http://whc.unesco.org/en/activities/473

Example 8. Monitoring the attributes of the endemic Cloudey Island petrel.

The observations provide clear evidence of the poor condition of this key feature and its vulnerability to a number of threats. A combination of increased storm events and high winds, together with an invasive rat population, may spell doom for this species and undermine the site's OUV. Moreover, the increasing presence of fishing vessels may pose a significant threat to the integrity of the surrounding marine ecosystem.

As well as monitoring and recording features and their attributes, **a narrative that describes their condition is required**. Furthermore, **evidence** to support the assessment is essential.

Site Feature 9	Attributes	Comments
Cloudey island petrel	Population size – numbers of pairs – dispersal	*About 26,000. Throughout the island. Global base of this endangered species.*
	Breeding sites – location, number	Mainly on island plateau. Moist subtropical scrub vegetation – globally rare habitat.
	Breeding rates – how often, how many	5–20 per cent. Low breeding rate, limited prospect of immigrant populations.
	Predation rates – native and non-native predators	*Invasive rats predate on the chicks and eggs (estimated at 25,000 per annum). Some predation by marine mammals and skuas.*
	Competition – native and non-native competitors	*Increased presence of fishing trawlers results in capture of prey species in significant quantities.*
	Death rates – ageing, accidental death, exposure to disease	*Possible losses due to accidental snagging in fishing equipment.*
	Frequency of storm events/wind conditions	*No discernible pattern, but increase in frequency of reported category 4/5 storms since the 1990s.*
	Temperature, precipitation	*Rainfall 1,300–1,500 mm. Average temperatures 1.5 °C above average for previous decade.*
	Feeding – locations, food species, habitats	Squid/krill/carcasses. Limited knowledge. Rise in sea temperatures may result in habitat changes.



Meanwhile, the Snowey Mountain System team have identified poaching, encroachment and extraction of scrub and plants as problems.

Human-induced fires are having an impact on important flora. Two of the lakes were stocked with non-native fish about seventy years ago, which may pose a threat to the native species, although the trends are not known.

In conclusion, **climate change vulnerability indicates the extent to which changes in climatic conditions are likely to cause a negative impact to the site's OUV**. This is determined by:

- off-site stresses (e.g. future climate projections, surrounding landscape scale influences);
- on-site conditions (e.g. current state of conservation of rare species); and
- adaptive capacity (e.g. ability of management to take action to prevent negative outcomes).

Invasive alien species:
World Heritage case study – Galápagos

There is widespread agreement that invasive alien species represent the greatest single threat to the Galápagos National Park (GNP) ecosystem, causing a burden to native species. More than 1,300 alien non-native species have been reported, including feral pigs, goats, rats and pigeons. Staff from the Galápagos National Park and the Charles Darwin Foundation have successfully eradicated several alien species (such as pigs, goats, tilapia, donkeys) from some islands. Such projects require extensive advance planning, capacity-building, funding and political support. However, there are also risks and high costs associated with any large-scale ecosystem manipulation. In one case, for example, all members of an endangered raptor species were captured and held in captivity while invasive rats were exterminated. Nevertheless, as a result of efforts to remove invasive alien species, the islands' ecosystem is now more resilient to climate change impacts.

http://whc.unesco.org/en/activities/615/

Galápagos Islands, Equador.
top: © UNESCO / Marc Patry; bottom: © Evergreen

3.4 How resilient is your site?

A natural site might be compared with the human body. The stronger and healthier it is, the more likely it is able to recover from illness, that is, the more resilient it is.

A more resilient site will be less likely to suffer negative impacts to its OUV. Protected areas are ecologically resilient where they are:

- relatively undisturbed – meaning they are under low stress and better equipped to resist new threats;
- relatively large, giving them the ability to self-restore if smaller parts of the protected area have been damaged by disease, fire or other such factors;
- ecologically well connected to the broader landscape – genetic pools remain healthy from the unobstructed movement of species in and out; temporary extirpations of rare species can be overcome by immigration; and gradual shifts in community make-up can occur as temperature and moisture gradients shift;
- relatively stable – they are not subjected to rapid and dramatic anthropogenic changes.

Humans have a large influence on all ecosystems; **resilience is also largely socio-ecological, not purely ecological**, even in the context of natural World Heritage sites.[22] It is the relationship between the broader landscape and human activity that determines the degree of resilience of the larger area in which a site is located. On a large (ecoregional) scale, resilience tends to be particularly strong when there is sufficient variability to allow a wide range of organisms to accommodate and compensate for changes.

22 A. C. Newton, 2011, *Socio-ecological resilience and biodiversity conservation in a 900-year-old protected area. Ecology and Society*, Vol. 16, No. 4, Article 13. http://www.ecologyandsociety.org/vol16/iss4/art13/

Resilience can be described as elasticity: it refers to the ability of a system to survive impact and recover functioning to its original or desired state after a disturbance. A resilient system can absorb shocks such as flood, drought or major fire, without any significant long-term disturbances to its functioning.

Building Resilience to Climate Change (Andrade Pérez et al., 2010)

Two processes are linked to resilience:
- Resistance – the ability of an ecosystem to absorb disturbance without structural change;
- Recovery – the speed of return to the pre-disturbance ecosystem structure.

Rethinking ecosystem resilience in the face of climate change (Côté and Darling, 2010)

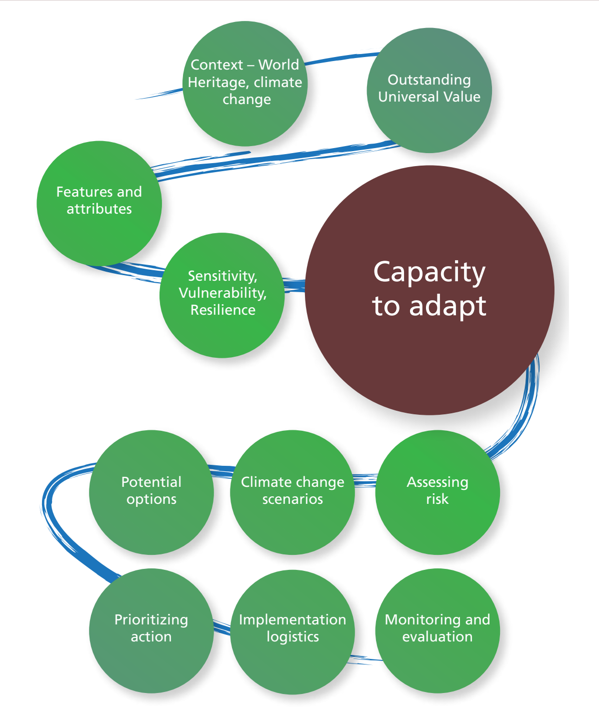
Resilience: World Heritage case studies

Very large sites contain a higher diversity of ecological conditions and human activities than smaller areas. Such sites are likely to be more resilient. On the other hand, some sites may be less resilient because of their size, the specific needs of their communities and their poor connectivity. For example:

Manú National Park in Peru is a 1.5 million ha park with tiers of vegetation rising from 150 m to 4,200 m above sea level, and contains the highest biological diversity on Earth, including some 850 species of bird, 200 species of mammal, thousands of vascular plants and hundreds of tree species. The size and wide range of altitude provides considerable scope for movement in response to climatic changes, and also high capacity to cope with extreme events such as storm conditions. Beyond its own qualities, Manú National Park is also surrounded by several other large protected areas – further contributing to its resilience.
http://whc.unesco.org/en/list/402

Vallée de Mai Nature Reserve in Seychelles, an area of palm forest on the densely populated island of Praslin, is an outstanding example of biological evolution, shaped by geological processes that took place millions of years ago. Although surrounded by the 300 ha Praslin National Park, the site itself is just 19.5 ha, and is extremely vulnerable to fire and to the illegal taking of the coco de mer nut as well as to invasive species and upstream activities. It is currently too small to sustain its values, and requires interventions such as replanting to maintain its unique ecosystem components. The area is at risk from changes in seasonal patterns of rainfall, with torrential rains affecting breeding and feeding patterns and causing significant erosion. Periods of drought have also increased the risk of fire.
http://whc.unesco.org/en/list/261

3.5 Assess your capacity to adapt



A number of factors influence the capacity of a management system to adapt to climate change. **If your adaptive capacity is limited, the choice of options available to address climate change will also be limited, and the site may be more vulnerable.**

You **must** take the following factors into account in calculating your options. More detailed guidance is provided in the *Enhancing our Heritage Toolkit,*[23] and is therefore not repeated here.

23 Hockings et al., 2008, op. cit. http://whc.unesco.org/en/series/23

Tajik National Park (Mountains of the Pamirs) (Tajikistan). © Nomination file

Management systems

The questions in Worksheet 4, adapted from the resource manual on *Preparing World Heritage Nominations*,[24] relate to management systems, and should be helpful in assessing vulnerability to climate change linked to site management.

24 UNESCO World Heritage Centre, 2011, *Preparing World Heritage Nominations*, Resource Manual. http://whc.unesco.org/en/activities/643/

It is essential to go beyond biophysical attributes to document **the human capital** (staff size, capabilities) of the site management team, and to **include off-site resources** that might be available. Human resources will strongly influence the degree to which a site manager is able to develop and implement an adaptation plan. NGOs, government institutions and universities all have a staff capability that might be available to complement World Heritage staff skills.

Worksheet 4: Management systems

Issue	For example ...	
Does the management system specify how the OUV will be sustained?	▶ *Does your management system include a small number of scenarios of future climate conditions?* ▶ *Does it include a process for monitoring and reporting the condition of your features?* ▶ *Does it include a process for monitoring and reporting by local communities?* ▶ *Does it include indicators that could serve as action triggers?* ▶ *Does it provide guidance on action when a trigger is encountered?*	
Is the management system explicitly practical?	▶ *Does it define specific and clear options in response to scenarios, or is it open-ended?* ▶ *Does it tell you who you should communicate with, when and how?*	
Does the management system include cycles of thought and review?	▶ *Are these cycles defined (e.g. for different options/actions)?* ▶ *Who carries out the review, and how is it done?* ▶ *Do you carry out regular briefings and discussions?*	
Does the management system recognize the capacity needs of staff?	▶ *Do staff have the skills to measure, analyse and interpret variables?* ▶ *Are they aware of the requirements of the management system?* ▶ *Do they have the necessary resources?* ▶ *Are they given time to carry out monitoring and reporting?*	
Does the management system include an assessment of risk and how to respond to it?	▶ *Does the system say how to respond to extreme events such as more frequent/intense flooding, drought, cold or hot spells?* ▶ *Does it say who makes decisions about what action to take?* ▶ *Is there a protocol for government support should the need arise in the case of critical events?*	

Stakeholders

Adaptive capacity includes your **relationship to the communities around you**, without whose support effective responses to the threat of climate change would be impossible. You also need to understand your other **partners and stakeholders** – what motivates them, how they relate to the site, and their negotiating positions (see Worksheet 5). Different people and groups need different kinds of approaches – some will be less confident in large meetings, or may be unable to express their concerns. Some may be hostile to World Heritage site management for complex reasons that are important to recognize. For a complementary worksheet on engagement of stakeholders, please see *Enhancing Our Heritage Toolkit*.

Worksheet 5: Profiling stakeholders

<table>
<tr><td>Name of stakeholder/community group/ partner/individual</td><td colspan="11"></td></tr>
<tr><td>How the World Heritage site relates to them, and how they relate to the site</td><td colspan="11">For example, physically, economically, socially, spiritually, legally, etc.; levels of use, historic attachment, culture, economic need, rights, etc.</td></tr>
<tr><td>Level and type of power</td><td colspan="11">Political support, economic, social leadership/status, threat, education, knowledge, religion, etc. Where does power come from? How is it used? How important to the site is the stakeholder?</td></tr>
<tr><td>General level of knowledge of the site</td><td colspan="2">Extensive</td><td colspan="2">Good</td><td colspan="3">Some knowledge</td><td colspan="2">Limited</td><td colspan="2">None</td></tr>
<tr><td rowspan="2">General level of support for the site and its aims</td><td colspan="5">Negative</td><td></td><td colspan="5">Positive</td></tr>
<tr><td>-5</td><td>-4</td><td>-3</td><td>-2</td><td>-1</td><td>0</td><td>+1</td><td>+2</td><td>+3</td><td>+4</td><td>+5</td></tr>
<tr><td>Particular areas of concern (if any) or opportunities for engagement</td><td colspan="11">Lack of trust? Past problems? Open antagonism? Breakdown in communication? Disagreements over rights? Etc.</td></tr>
</table>

Legal and policy context

The ability to manage any World Heritage site (and to adapt to climate change impacts) will depend on the **legal and policy support** given by government, especially in relation to legal and policy issues that may potentially impact on a site's integrity, as well as the documentation that establishes its legal status. Additionally, many countries also have national strategies, policies and other legislation on climate change of which the site management should be aware.

It is therefore important to review how the government influences site management, by analysing its commitment through national laws, through the policies it promotes, and through the international laws, treaties and conventions it actively supports (see Worksheet 6).

This can be a challenging process, but needs to be honestly considered so that a realistic assessment can be made.

Worksheet 6: Legal and policy context

International legislation	**Relevance to OUV**
World Heritage Convention	
Convention on Biological Diversity	
Treaty x Key section 1 Key section 2 Etc.	
Title y Key section 1 Etc.	
National legislation	**Relevance to OUV**
Title Key section 1 Key section 2 Key section 3 Etc.	
Title	
Policies	**Relevance to OUV**
Title Statement/reference	

Site design

Site boundaries are defined under the terms of the World Heritage inscription. However, they may not reflect the ecological patterns and systems that support ecosystem functions such as prevailing rainfall patterns, migration, hydrological systems, variations in habitat types, and so on. Documenting the ecological connectivity of the site should be a central part of its assessment, especially the movement of resident species whose home range might extend into other areas, migratory species moving through the site, or the movement of pollutants, invasive species or people across site boundaries.

Many natural World Heritage sites are surrounded by a buffer zone that may be more or less under the control of the site management agency, and/or for which there may be specific land-use policies in place designed to support the integrity of the site. The existence, the size and design, and the actual management implications of buffer zones vary widely among sites. Ecological connectivity within the buffer zone and beyond is a crucial factor in the site's resilience – particularly for smaller sites (e.g. less than 10,000 ha).

Therefore the **shape, size and location** of the site, the **fluidity of its boundaries**, and the **relationship of its ecosystems to one another,** are all key factors in determining adaptive capacity, as are **surrounding land uses** such as settlement and the use of natural resources (see Worksheet 7). The reliance of key species on feeding, breeding and resting grounds beyond the site's boundaries is crucial. The ability to manage for drought, flooding, fires, migrations and habitat change is influenced by the design of the site and its relationship to its surroundings.

Worksheet 7: Site design

Overall size	*Is the site large enough to allow for viable core and meta populations, predator/prey relationships, feeding/breeding sites, migrations, etc.?*
Proportion of major habitat types	*To what extent does the **amount** of each habitat type influence the site's integrity and its susceptibility to climate factors?*
Shape and topography Brief description + sketch plan	*How might the site's **shape** influence its integrity, management, migration patterns, vulnerability, etc.?*
Boundaries	*Is the site bounded by **roads**, **railways**, **rivers**, **mountain tops**, **valleys**, **forest zones**, etc.? How will these influence future management?*
Buffer zone	*Is a buffer zone present? Do you have any management authority there? Who does? Can they help? Is the buffer zone viable? How might it help/hinder the reshaping of the site if necessary? Does it allow for migrations?*
Significant development	*How might this influence natural features such as water, atmosphere, waste, invasive species, erosion, human encroachment, etc.?*
Wider setting	*Beyond the buffer zone, is the site set within a landscape that might allow for reshaping it if necessary? Does it offer the potential for establishing corridors?*

3.6 Adaptation options

There are no 'quick fixes' or easy solutions to the problem. However, the following broad options will help to ensure that your site is as resilient as possible, and to reduce the negative effects of climate change as far as possible. Each manager and team will have to decide for themselves how feasible some of these options are for a given site, and should develop an inventory of strategic options and necessary actions linked to each option.

A hierarchy of options is available both at the discrete level of particular sites and in the wider landscape and political and social context. Some of these options entail interventions in terms of **infrastructure**, such as diverting roads or rivers, shoring up banks or coastlines, building tunnels or bridges, **managing habitats** by burning, managing coastal retreat, planting or removing species, or **protecting and enhancing species** by improving or providing access to water, shelter or food.

Other options may include **establishing buffer zones, corridors, and different types of protected areas.**

On their own, such interventions may not prove successful, and a raft of other initiatives may need to be taken. Some of these may entail **paying or compensating surrounding communities** to do or to avoid doing something that might influence the resilience of the site; **optimizing people's interests** in supporting the protection of wildlife and ecosystems by **raising awareness** of their values and by **giving people a stake** in their protection; **persuading politicians or the private sector** of the importance and expediency of protecting the OUV of World Heritage sites; and **generating the support of the global community** in the protection of such sites.

In general, adaptation practices should conserve the geophysical stage, protect refugia, and promote connectivity within the greater landscape. Some interventions require hard engineering, such as artificial reefs, breakwaters, roads, canals, removing invasive species, re-vegetation, managing dunes, restoring wetlands, or burning. Others focus on changing human behaviour, such as education, zoning, taxation, legislation, or social programmes.[25] Significant engagement with stakeholders in the surrounding land/seascape when such practices are being designed will increase understanding and protection of the OUV. Most site teams will have a working relationship with local and regional governments and NGOs, offering an opportunity to develop a dynamic conservation plan for designing such practices.

In all cases, it is essential that monitoring is carried out regularly and accurately. Here are examples of possible options:

- **Reduce existing stressors**, such as illegal hunting, encroachment or extraction. If enforcement is a strategy, try to focus on the root causes and see if you can contribute to managing them as well. Be aware that some of these stressors may already be linked to climate issues, such as refugees from civil conflicts over water, or from drought, flooding or storm events.

- **Remove/control invasive species** if physically and financially possible. Costs can be considerable, including human resources, capture equipment, vehicles and transport; sighting and monitoring equipment; training in taxonomy and veterinary skills; tracking, trapping and capture skills; cutting equipment; the use of chemicals and their effects; safety and maintenance; monitoring skills; and general awareness about methods of elimination. Even if it is logistically possible, there might not be the political or public support necessary for such a programme.

Invasive alien species: Case of *Mikania micrantha*

Mikania micrantha is a fast-growing creeper, commonly known as 'mile a minute weed'. Its native range is in the tropical and subtropical zones of central and South America, where its impact is relatively insignificant. However, it is capable of spreading rapidly and smothering even large trees, resulting in major impacts on natural forests, grasslands, plantations and agricultural systems. It is the main invasive plant in **Chitwan National Park** in **Nepal** where it poses a threat to the rare one-horned rhino, as it has the potential to destroy plant species on which the rhino is dependent, as well as habitats and species that are rare in their own right.
http://whc.unesco.org/en/list/284; http://www.forestrynepal.org/publications/biblio/4029

25 See for example, A. Travers et al., 2012, *Ecosystem-based Adaptation Guidance – Moving from Principles to Practice,* Nairobi, United Nations Environment Programme.
http://www.unep.org/climatechange/adaptation/Portals/133/documents/Ecosystem-Based%20Adaptation/Decision%20Support%20Framework/EBA%20Guidance_WORKING%20DOCUMENT%2030032012.pdf

- **Raise awareness among partner communities, visitors and colleagues**. The more aware people are, the more prepared they will be for change, and the more resistant to 'shock' should it occur. Encourage local people to review their use of resources, as well as their practices, in the light of climate change. Rephrase your visitor interpretation in order to highlight climate issues. Keep people informed.

- **Build alliances with NGOs, businesses and landowners**. Work with them to raise awareness of climate change. Work with adjoining landowners to enhance positive management and minimize negative impacts – encourage the control of pesticides, herbicides and fertilizers, especially where your site is 'downstream' of such land; encourage the naturalization of waterways and their shorelines.

Engaging local communities: Case of the Sundarbans

The Sundarbans mangrove forest, one of the largest mangrove forests in the world (140,000 ha), lies in the delta of the Ganges, Brahmaputra and Meghna rivers on the Bay of Bengal in Bangladesh. The Sundarbans World Heritage site is intersected by a complex network of tidal waterways, mudflats and small islands of salt-tolerant mangrove forests, and presents an excellent example of ongoing ecological processes. Various NGOs are working with farming communities surrounding Sundarbans National Park to reduce the amount of fertilizer and pesticide entering watercourses, and to develop organic systems and manage rainwater more efficiently. It is hoped that such practices will help to retain soils and encourage the growth of mangrove, thus reducing the potential impact of storm events and sea surges.
http://www.indiawaterportal.org/; http://whc.unesco.org/en/list/798

- **Expand the effective size of the site**, by introducing a buffer zone if possible, in order to allow for movement and population growth. Encourage sustainable use/alternative livelihoods with surrounding communities in the area, so as to minimize impacts on adjoining ecosystems. Where feasible, secure formal agreements for co-management of resources.

- **Encourage, lead/participate in the design and designation of new protected areas** where they form part of the same eco-region and perform functions similar to those of your site, to allow species the opportunity to take advantage of new climatic conditions.

- **Work with national planning and development agencies** to include conservation and enhancement of OUV in all policies and plans, including sustainable development strategies, spatial plans, requests for funding, action plans, district and regional development plans, poverty reduction strategies, etc.

Integrated protection of World Heritage

The Canadian Government has integrated protection of World Heritage properties into comprehensive planning programmes. Where World Heritage sites are administered by Parks Canada, site authorities participate in land- and resource-use planning processes beyond the site's boundaries to ensure that the World Heritage values are recognized in spatial strategies. Where sites are owned by the provinces, municipal planning activities must take into account the values of the sites. Environmental assessment legislation is also widely used to ensure that alternatives and mitigation of threats are applied when considering proposals.
http://www.pc.gc.ca/eng/docs/pm-wh/rspm-whsr/sec1/sec1c.aspx

The **United Kingdom's Jurassic Coast** (Dorset and East Devon Coast) World Heritage site is particularly complex, as it is heavily populated and much of the land is privately owned. Furthermore, the territory covers a number of public administration areas. Given that the site is also subject to coastal erosion, it is particularly important that clear, agreed national and local policies are harmonized and rigorously applied in order to protect its OUV in the context of the wider landscape. Various planning, coastal protection, agriculture, floodwater and access laws are used to regulate activities and to establish and enforce protective policies.
http://www.jurassiccoast.com/downloads/spatial_planning_research_project_-_luc.pdf

South Africa has a national climate change response strategy (2004) containing twenty-two key actions including 'Develop protection plans for plant, animal and marine biodiversity'.
http://unfccc.int/files/meetings/seminar/application/pdf/sem_sup3_south_africa.pdf

- **Form alliances with managers of other natural World Heritage sites and protected areas** within the area of influence of your site if possible, to ensure effective communication about migratory species such as birds, butterflies or large mammals.

Working beyond boundaries: Case of Peninsula Valdés

The endangered southern right whales are central to the OUV of **Peninsula Valdés** World Heritage site in Argentina. These whales come to calve at the site, but spend a good part of the year elsewhere. Site managers assess the climate change risks to whales not only at the site but throughout its range and determine if there is anything that can be done to reduce the risks.
http://whc.unesco.org/en/list/937

- **Carry out interventions, such as planting, clearing and fire setting** in order to manage the balance of habitats, optimize colonization and reduce the risk of climate-linked calamities. Such interventions may differ considerably in scale, and can be expensive if maintained. You may decide to expand the amount of critical habitat for refuge, breeding or feeding purposes; or you may decide to increase the patchwork of a range of habitats in a landscape, which provide for flexibility or offer nesting and feeding opportunities. You may also need to develop corridors or migratory 'stepping stones' within your site. This may be particularly appropriate where a critical species contributes to your site's OUV, and assist either its translocation, or the translocation of its prey species.

Managing with fire

The plant and animal communities of many arid and semi-arid landscapes have evolved to depend on fire. In these landscapes, fire removes or controls invasive plants, releases nutrients and opens certain kinds of seeds. Fires have been a natural part of ecosystem function for millions of years and part of human-induced management for thousands. The fire-adapted landscapes of South Africa, including **Cape Floral Region** (http://whc.unesco.org/en/list/1007) and **Vredefort Dome** (http://whc.unesco.org/en/list/1162) World Heritage sites, are examples of such landscapes. Intentional fire management through controlled burns can serve to protect the OUV of these fire-dependent areas.

- Use **fire as a technique in adjoining sites** to prevent climate-induced uncontrollable fires that may impact your site. Work with landowners to carry out appropriate programmes of controlled burning.

- Rarely, **large engineering projects such as water or road diversions may be appropriate**. Such projects are expensive, and while they may benefit the World Heritage site, they may be controversial in other ways. For example, communities may resent a road diversion that has an impact on their settlement; truckers may be against increases in distance and therefore fuel costs; local politicians may not support a diversion that reduces access to their communities.

Hard engineering: Case of Keoladeo National Park

India's Keoladeo National Park is a 29 km^2 site on the edge of the Gangetic Plain, constructed between the mid-1700s and the late 1800s when the natural drainage was blocked, creating a number of wetland habitats. Originally built as a hunting reserve for the local maharaja, it has long since evolved into an important migratory bird over-wintering area, with over 350 species. Given the local hydrology, and the increasing demands on water from agriculture, the wetlands need more water than could naturally be supplied. Major water diversion works built in the last few years are intended to ensure a constant water supply, especially during poor monsoon years, thus maintaining the critical habitat and sustaining the site's OUV.
http://whc.unesco.org/en/list/340

- Where off-site ecosystem disruptions have impaired your site's integrity, you may need to **use 'hard engineering' to restore** it. Examples include large bridges over motorways to assist migrations; coastal infrastructure to protect sensitive sites by preventing build-up of silts as a result of longshore drift; and diversion of watercourses to retain wetland integrity. Wherever possible, engage (or encourage strategic partners to engage) with forums that make decisions about infrastructure. Influence planners to consider the impacts of roads, reservoirs and coastal defences on the integrity of your site. Influence thinking on whether changes in infrastructure are necessary compared with other options; if so whether they are appropriately located and of the right scale; what materials are used and where they are sourced; the potential for enhancements such as wildlife corridors/tunnels/bridges; fish ladders; seasonal regulations to optimize breeding, feeding and movement, and so on. Focus on preserving and strengthening existing biological corridors.

Hard engineering: Case of Mount Kenya

Mount Kenya National Park hosts significant numbers of elephants, but much of the surrounding landscape is farmed. Kenya Wildlife Service, with the support of many partners including Kisima Farm, the Bill Woodley Mount Kenya Trust, the Ngare Ndare Forest Trust and the Lewa Wildlife Conservancy is increasing options for elephant movement in response to changing conditions. The most ambitious project has been a wildlife underpass, allowing animals to cross highways in safety. The underpass opened in January 2011 and has already proved to be beneficial to wildlife and in increasing connectivity to improve ecosystem resilience.
http://whc.unesco.org/en/list/800
http://lewawildlifeconservancy.createsend.com/T/ViewEmail/r/58CF27AC0B66826B)

- **Identify appropriate sites that can be protected and enhanced** to provide migratory stopping points, or corridors to enable wildlife to move into new areas. Provide funding and support to retain or convert these sites from inappropriate land uses, using management agreements. Establish community reserves. Consider engaging in payment for ecosystem services (PESs) programmes, including REDD+ initiatives (see page 76), as a means of securing financing and local support for activities that will require concerted, landscape level participation.

Greater Yellowstone Co-ordinating Committee

Three federal agencies are represented on **Greater Yellowstone Co-ordinating Committee** (**GYCC**, http://fedgycc.org/), responsible for nearly 53,000 km^2 of protected and managed land, including Yellowstone National Park. The GYCC has developed a range of climate change mitigation strategies and practices to be implemented by its state and federal members, and a wide range of adaptation strategies, mainly focused on large wildlife and ecosystem function. Cooperative agreements have led to co-management of very large areas of land, ensuring the sustainability of large, migratory and charismatic species such as American bison and elk. In some states, legal instruments exist which allow landowners to voluntarily cede the right to use their land in certain ways, in exchange for property tax reductions or other forms of recognition. The conservation easement can be temporary or permanent.

- Where important species are in severe danger of extinction, and where feasible, it may be necessary to **relocate** them to a new area, or to a controlled environment, where their population can be protected and their numbers increased before longer-term solutions are identified.

3.7 Key issues in adaptation planning

1. **Ensure that you take into account the dynamics of climate change when developing management plans.** You will need to consider the possible effects of sea level rise, increased storm incidents, flood events, drought, glacial retreat, etc. These may include change in land cover, habitats and species; erosion and silting up; or changes in migration patterns. You may therefore need to plan for coastal realignment; diversion or blocking of watercourses; expansion or reshaping of your site; or relocation of any settlements away from threatened valleys or coasts. Your plan should demonstrate that you have thought about these things and considered a range of options. Do not produce plans as if there will be no changes to your site over the next decades.

Rezoning the Great Barrier Reef

In 2004 the Australian Government rezoned the Great Barrier Reef to increase protection to a range of species and resources. For example, the 'no take' areas were increased from 5 to 33 per cent, and 'no trawl' areas from 15 to 28 per cent of the park. One of the main reasons was the protection of the marine turtle, which had suffered from various impacts including fishing. Overall, the area that provided increased protection for the three marine turtle species from trawling rose from 30 to 70 per cent.
http://www.gbrmpa.gov.au/zoning-permits-and-plans/zoning

2. **Review the zoning system for your site.** You may need to carry out interventions on parts of it, and allow for new patterns of movement and colonization by both humans and wildlife in and around the site. If applicable, review the management of visitors to reduce erosion, waste, disruption, litter and other impacts.

Indigenous peoples: Case of Manú National Park[26]

Manú National Park in Peru, like many large forested World Heritage sites, is home to resident indigenous communities, who carry out a wide range of subsistence activities within the park including hunting. With new technology come new practices, in this case changing a bow and arrow to a shotgun has taken its toll on game populations. This is mitigated in Manú by a policy that bans firearms inside the site, alongside targeted development activities to encourage people to support conservation. There is, however, evidence that outside interests may pose a threat to the indigenous communities and continuity of their traditional lifestyles.
Ohl-Schacherer et al., 2007, http://www.utm.utoronto.ca/~w3bio/bio464/lectures/lectures_assets/sustainability_of_indigenous_hunting.pdf;
T. Moore, 2010, http://www.culturalsurvival.org/publications/cultural-survival-quarterly/peru/peru-people-parks-and-petroleum

3. **Review the laws and regulations that may have an impact on the effectiveness of your management and ability to adapt.** Consider how social and economic programmes are influencing decisions about land, water and energy use in the landscape within which your site is located.

Finally, you need to bear in mind the following:

- **Attempting to solve a problem for one feature of the site's OUV may create new problems for other features**. It may therefore be useful to think in terms of so-called *Limits of Acceptable Change* (LAC).[27] Some degree of change is always certain, and we should focus our management efforts where they will have the greatest impact on sustaining the OUV while mitigating the unwanted changes. Therefore, we need to calculate how much loss is acceptable within certain limits. Some changes (e.g. a 10 per cent reduction in the population of an umbrella species) may be acceptable because addressing the causes of that reduction would increase the probability of more dramatic changes to another population. In contrast, a manager may decide that a 20 per cent reduction in the same population is threatening to the OUV and requires attention.

- **Risks to a natural World Heritage site can come from several sources**, for example on-shore and upland land uses that degrade water quality or cause silting at a coastal or marine site. This may be beyond the capacity of natural World Heritage site managers to address alone, and they should consider the logistical implications of trying to do so, including engaging concerned government departments to take on broader climate change issues that may affect their site.

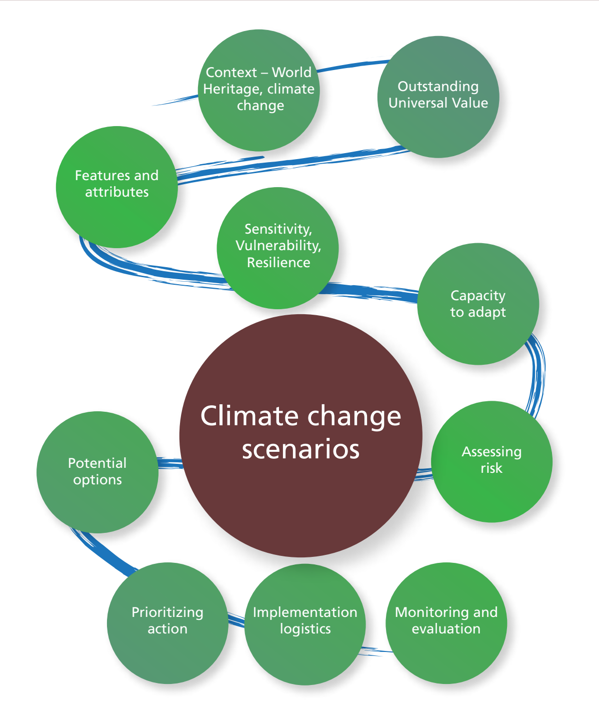
Thinking beyond borders: Case of Monarch Butterfly Biosphere Reserve

The Monarch Butterfly Biosphere Reserve in Mexico, where protecting the OUV relates to the migratory phenomenon, requires management interventions not only at the site, but throughout the butterfly's migratory range, which includes Canada and the United States. Although site managers cannot engage with governmental bodies outside their country, they can ensure that appropriate national government agencies are informed of issues that might require international coordination.
http://whc.unesco.org/en/list/1290

Monarch butterflies at Monarch Butterfly Biosphere Reserve (Mexico). © Dawn Tanner and Jim Perry

26 J. Ohl-Schacherer et al., 2007, *The sustainability of subsistence hunting by Matsigenka native communities in Manu National Park*, Peru, Conservation Biology, Vol. 21, No. 5, pp. 1174–85.
27 G. H. Stankey et al., 1985, *The Limits of Acceptable Change (LAC) System for Wilderness Planning*, US Department of Agriculture, Ogden Forest Service.

3.8 Analyse different climate change scenarios



It is not the job of a World Heritage site manager to predict future climate change. Expert advice can be obtained from national meteorological offices and academic institutions. However, it is worth being aware of how climate is predicted by climatologists and other scientists.

Projecting climate change is a highly complex endeavour, which has evolved rapidly over the last twenty years. Climatologists have expanded their range of tools, such as satellite monitoring, supercomputer modelling and networks of land- and sea-based remote monitoring stations, to bring planet-wide information together into real-time climate indicators. This information is used to develop climate prediction models.

There are approximately twenty-five parallel, global modelling efforts under way, each involving a team of climatologists, physicists and modellers. Each of these teams has developed its own climate prediction model (typically called a **General Circulation Model** (GCM)). GCMs are the principal tool used to understand coarse-scale/low resolution (e.g. global, continental/sub-continental) patterns in climate and to predict future climatic conditions. GCMs have a cell size of several thousand km^2 (which is one or two orders of magnitude greater than most World Heritage sites, although several sites are of this size class).

GCMs use knowledge of atmospheric physics and historical climates to model temperature and precipitation. Each GCM operates with different assumptions and internal relationships. Because no single GCM is universally correct, most climatologists and other scientists consider it good practice to use several models and express predicted future conditions as the mean of those predictions. However, it is also essential to incorporate variance among the models as a measure of uncertainty.[28]

GCMs are useful in understanding broad climate patterns and in describing the potential, coarse-scale future conditions to which a site might be exposed. However, they are not useful for predicting the specific conditions that might be experienced by plant, animal or human communities in and around a World Heritage site. Also, our ability to precisely predict future climates is currently limited to a few decades and is better for temperature than precipitation. The lack of precision for precipitation and long-term predictions is a significant limitation in planning management strategies for a site.

GCMs can be 'downscaled' (i.e. fine-tuned) to provide climate modelling at a finer spatial resolution. Downscaling is based on the addition of local climate-influencing factors such as the presence of mountain ranges, large water bodies (e.g. coast lines, lakes), and altitudinal gradients. Finer-scale **Regional Circulation Models** (RCM) may offer much more precise predictions for future conditions. For example, a GCM cell might be 100 km on a side, while an RCM cell might be 10–15 km on a side. However, downscaling is very data- and resource-intensive. RCMs are available for limited areas that are data rich (e.g. much of North America and Europe) but should soon be available for most other parts of the world.

Where available, RCMs will give a site manager a better understanding of probable future conditions, but still will not provide predictions at a level of detail that allows precise planning. As a result, regardless of the level of detail available from existing GCMs and RCMs, managers will have to work in an environment of uncertainty, always requiring monitoring and the capacity to adapt responses to changing conditions. But this does not mean that the GCMs and RCMs are of no use. The models should provide a useful range of possible climate scenarios for at least a few decades. Such future climate scenarios can also be updated every few years, as input data for models improve, and as models become more powerful.

28 J. A. Perry, 2011*a*, *Literature review on climate change adaptation and natural World Heritage sites*, prepared for UNESCO World Heritage Centre; J. A. Perry, 2011*b*, World Heritage hot spots: a global model identifies the 16 natural heritage properties on the World Heritage list most at risk from climate change, *International Journal of Heritage Studies*, Vol. 17, No. 5, pp. 426–41.

Climate predictions for a specific site should be seen as a way to develop a context, or as a way to understand how significant the issue might be. Although we do not have the capability to change future climatic conditions, being forewarned gives a context for scenario-building, which in turn allows possible responses to be planned.

While future climate conditions are very difficult to predict precisely, even rough predictions will help a manager to think about the ways in which the attributes of the OUV may be expected to respond to future climate conditions. This allows at least some form of risk analysis as the basis for designing an adaptation plan. Such a plan should provide a range of prioritized actions, both within and beyond the site itself.

Before considering risk, we look at some scenarios at site level, and think about their possible effects. While climate futures are unpredictable, we can perhaps guess that some scenarios are less likely than others, so it would be useful to eliminate the least likely ones, and spend more time thinking about:

- scenarios that you can envisage will have a direct impact on your site;
- scenarios that might impact your region generally, and might therefore have a knock-on effect on your site.

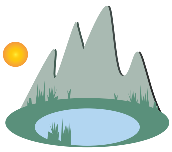
A useful way to analyse this is to think *'what if …'*. For example, *'What if my site began to experience increases in sustained storms?' 'What if my site experienced drier summers?'*

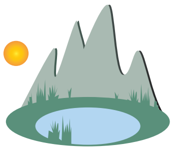
The IPCC's Fourth Assessment Report[29] (2007) predicted a number of global future scenarios with high degrees of certainty. Some of these are particularly relevant to our two theoretical sites, shown in Example 9. Any of these climate effects might result in a range of impacts that will undermine a site's OUV.

29 http://www.ipcc.ch/publications_and_data/ar4/syr/en/contents.html

Glaciers are melting worldwide and the appearance of some mountainous sites, sometimes inscribed because of their exceptional aesthetic beauty, could change dramatically. Tongariro National Park (New Zealand). © OUR PLACE

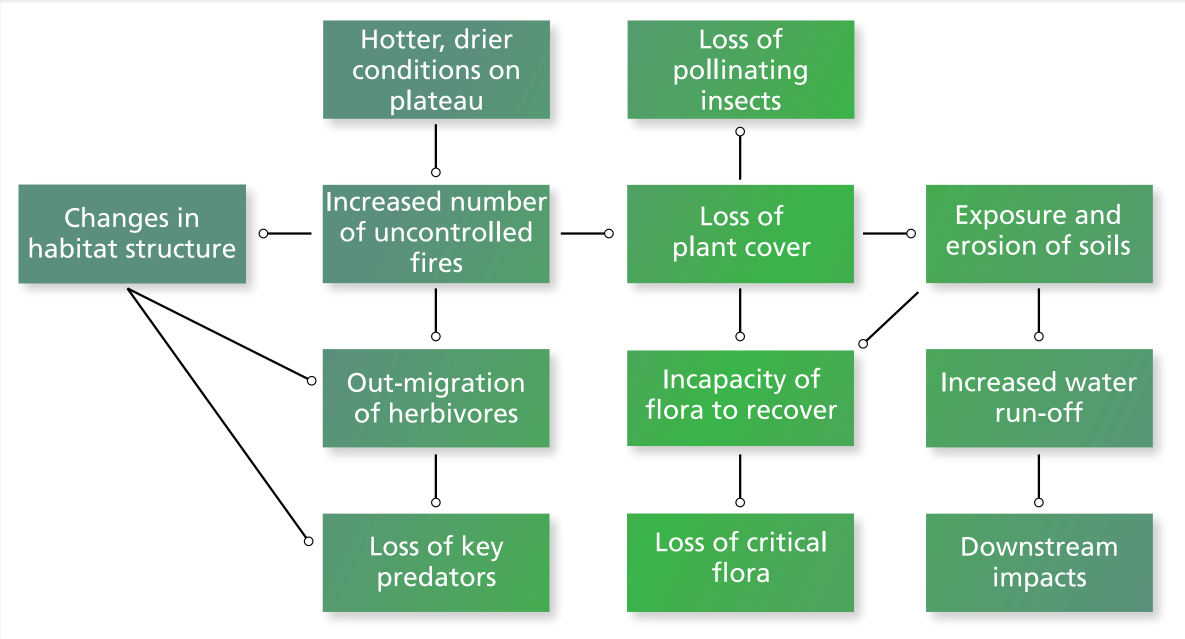
Example 9. Possible climate change impacts at the Cloudey Island and the Snowey Mountains System sites.

	IPCC statements	Which could mean ...	Resulting in ...
	'Coasts will be exposed to increasing risks such as coastal erosion due to climate change and sea-level rise' 'Increases in sea-surface temperature of about 1–3 °C (will) result in more frequent coral bleaching events and widespread mortality unless there is thermal adaptation or acclimatization by corals'	▶ Increased exposure to higher turbulence from the sea ▶ Changes to marine biology ▶ Increased exposure of plateau scrub to salt spray ▶ Changes to reef pattern ▶ Increased exposure of beach to rising sea levels and turbulence ▶ Increase in tropical storm events	▶ Accelerated undermining of cliffs and caves ▶ Loss of prey species ▶ Loss of endemic invertebrates ▶ Coral bleaching ▶ Disruption to turtles nesting on the beach ▶ Loss of habitat and associated species
	'More and larger glacial lakes' 'Increasing rock avalanches ...' 'Increased run-off and earlier spring peak discharge in many glacier and snow-fed rivers' 'Changes affecting algae ... fish and zooplankton because of rising water temperatures and changes in: ice cover, oxygen levels, water circulation' 'Dry regions will get drier, and wet regions will get wetter' 'Spring events such as the unfolding of leaves, laying of eggs and migration are happening earlier' '...pole-ward and upward (to higher altitude) shifts in ranges of plants and animal species'	▶ Shorter periods of freezing ▶ Increased avalanche events ▶ Wetter conditions in some areas ▶ Changes to lake biology, as a result of increased eutrophication ▶ Drier, hotter conditions in high plateau areas	▶ Changes in habitat – loss or migration of some plant communities ▶ Increased silting downstream ▶ Catastrophic flooding as a result of glacial dam bursts ▶ New lakes formed from avalanche debris ▶ Increases in algal blooms ▶ Disruption to feeding/ breeding habits of key mammal species ▶ Loss of feeding grounds/ refuge sites for migrating birds ▶ Migration of prey species ▶ Increases in uncontrolled fire events



Example 10. Problem tree analysis.

A useful way to analyse the effects of climate change on your site is to use a 'problem tree' to consider the potential effects of a problem. The Snowey Mountains System team analysed the ways that the structure of the plateau grassland habitat might change, shown below.



Rough predictions such as the above will help a manager to think about the ways that the attributes of the OUV may be expected to respond to future climate conditions (i.e. a risk analysis). The risk analysis forms the basis for designing an adaptation plan, which should relate to a spatial hierarchy of actions, both within and beyond the site itself (see Section 3.10 on adaptive actions).

A considerable amount of literature is now available online, which provides valuable background information on future climate scenarios at regional levels. See for example:

IPCC Fourth Assessment Report: Climate Change 2007
http://www.ipcc.ch/publications_and_data/publications_and_data_reports.shtml
The IPCC Fifth Assessment Report containing updated information is due in 2014.

Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation (IPCC)
http://www.ipcc-wg2.gov/SREX/images/uploads/SREX-All_FINAL.pdf

Pacific Climate Futures (Government of Australia)
http://www.pacificclimatefutures.net/

USA Climate Futures (United States Government)
http://epa.gov/climatechange/science/future.html

Visualizing Future Climate in Latin America: Results from the application of the Earth Simulator (World Bank)
http://siteresources.worldbank.org/INTLAC/Resources/SDWP_Future_Climate.pdf

PRECIS (Providing Regional Climates for Impacts Studies) Regional Climate Modeling System

PRECIS, developed and maintained by the UK Hadley Centre, is the most widely used, fine-scale, user-driven climate modelling system currently available. It is also appropriate for local application at a natural World Heritage site. PRECIS is available free of charge, but its use requires attending a training workshop, which are organized worldwide.

http://www.metoffice.gov.uk/precis/

3.9 Understand likely OUV responses – analyse the risks

Obviously the less resilient a site is, and therefore the more vulnerable it is to climate change, the higher the risk that it will suffer negative impacts from changes in climate. For the manager, the task is first to identify the sources of those risks, then to determine:

– How likely are they to occur?

– How significant are they likely to be?

Some events might be highly likely, but not significant to the OUV of a site. Others might be highly unlikely but disastrous if they do occur. A risk analysis is designed to help to identify outcomes that would be both **relatively likely and relatively significant**, and would therefore demand priority management attention.

A useful way of analysing the risk to a site's OUV is to look at its key features and their attributes and assess the probability and significance posed by threats. For example:

OUV feature	Description of impact
Reptile community of the site is among the most diverse in the world, with more than thirty-five species, 90 per cent of which are endemic	Invasive predator damages populations
	Increased fire frequency changes vegetation, reducing habitat
	Reduced precipitation results in loss of wetland habitat
	Increased storm frequency and intensity results in eroded and sediment-laden habitats
	Phenology of spring grasses alters food for major prey during breeding season

OUV feature	Description of impact	Probability	Significance
Reptile community	Invasive predation on reptiles		
	Fire frequency degrades habitat		
	Precipitation frequency causes loss of wetlands		
	Storm frequency and intensity damages habitats		
	Phenology of spring grasses alters food for major prey during breeding season		

Improbable (low)	Insignificant (low)
Possible (medium)	Significant (medium)
Probable (high)	Highly significant (high)

In this example the site manager will focus efforts on improving capacity to manage fire in specific areas where damage to reptile habitat is most likely, while establishing a rigorous monitoring programme for the presence of invasive species.

An analysis of this sort allows the manager to identify key actions to sustain the OUV. Risk assessment is not a perfect science – it is informed guesswork based on the intuition, insights and expertise of the management team and colleagues, but it does provide a basis for focusing on issues that might otherwise be missed. This kind of assessment is therefore always most effective when carried out by a team that understands socio-economic as well as ecological dimensions.

Worksheet 8: Features and attributes – climate change risk analysis

Features	Attributes	Description of climate change impact(s) on the features and attributes	Risk of impact – probability (high / medium / low)			Risk of impact – significance (high / medium / low)		
Feature			H	M	L	H	M	L
			H	M	L	H	M	L
			H	M	L	H	M	L
			H	M	L	H	M	L
Feature			H	M	L	H	M	L
			H	M	L	H	M	L
			H	M	L	H	M	L
			H	M	L	H	M	L
Feature			H	M	L	H	M	L
			H	M	L	H	M	L
			H	M	L	H	M	L
			H	M	L	H	M	L

3.10 Select and prioritize your actions

While most action responses should be obvious, as in Example 10 above, it is worth making the following points:

- There may often need to be a number of action responses, not only to a range of risks that may be identified, but even to a single risk.
- It is possible that some actions in the case of a particular feature may inadvertently or unavoidably undermine other features or some of their attributes, and thus threaten the OUV.
- Possible responses may be neither obvious nor immediately acceptable to politicians, higher-level decision-makers or communities with an interest in the site.
- Some actions may not be feasible, either immediately or in the medium term.
- It is always necessary to prioritize actions.
- For these reasons, adopting simple reflexive responses will rarely be the best approach.

Example 11. Prioritizing management actions at Cloudey Island.

The Cloudey Island management team has assessed the risks to two of the features that contribute to their OUV, and then considered their possible responses against a set of criteria. They have also considered whether there are likely to be any conflicts between their responses and other features and attributes that contribute to the OUV.

Key feature	Impact	Probability	Significance
(1) Natural scrub forest	Increased storm events remove soils		
	Increased salt spray increases soil salinity		
	Encroachment by climate refugees seeking alternative land		
	Wind-/sea-borne invasives impact on vegetation		
(2) Endemic landbirds	Increased storm events impact on breeding cycles		
	Predation by invasives		
	Loss of vegetation through increased salinity/exposure		
	Loss of water through increased salinity		

Possible response actions	Criteria						PRIORITY ACTIONS
	Impact on other OUV features	Technical expertise	Logistics	Human resources	Time	Finance	
No action	Hn	-	-	-	-	-	-
Monitor soil amount and condition	-	H	M	M	H	L	C
Buffer soils against prevailing winds	?	H	H	H	H	H	-
Monitor soil salinity	-	H	M	M	H	L	C
Manage for colonization of less-exposed areas	M		M	L	H	L	-
Work with partners to minimize risk of encroachment	-	H	H	H	H	H	D
Patrol and enforce regulations	M	M	H	H	H	H	D
Monitor for wind-/sea-borne invasives	-	H	H	H	H	M	C
Remove/control invasive predator	Hp	H	H	H	H	H	A
Create artificial nest sites in unexposed areas	?	H	H	M	M	H	D
Monitor vegetation changes	-	H	M	M	H	H	C
Establish rain-fed watering points	?	M	M	M	L	M	B
Monitor bird numbers, dispersal, nests, etc.	Hp	H	H	H	H	M	A

Note: in the first column, there are high impacts on OUV features that are both positive **(Hp)** and negative **(Hn)**.

It is important to justify the scoring, providing as much information/evidence as possible to support it. In this example, the team has decided that 'do nothing' is not an option, as it will eventually result in loss of OUV. Some intervention will be necessary.

Although the overall costs are high, removing or controlling invasive predators is also seen as a priority, as this poses the greatest single threat to the landbird population, and will also benefit other features, such as seabirds and other small mammals and reptiles.

Establishing rain-fed watering points for birds is also seen as a useful option, as there is little fresh water available in this karst ecosystem, and it is likely to be threatened by increased salinity. Providing the landbird population with a reliable source of water will help to sustain it. The conditions may not support managing for colonization of new areas by the plateau scrub, and it may in any case impact on other important habitats, and is therefore not seen as a priority. Buffering the soils against prevailing winds is untested and may not be feasible on this scale.

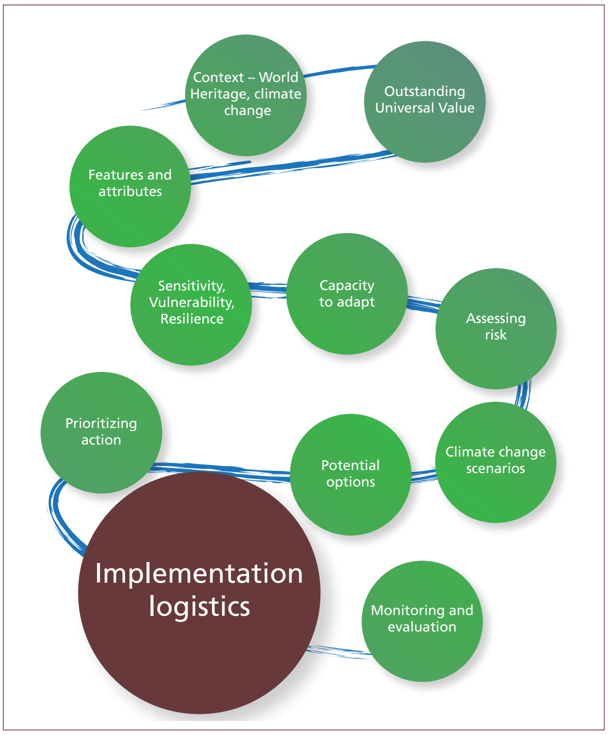
However, placing nest boxes may be an option should the landbird population not be seen to recover from invasive predation, as climatic conditions may be a complicating factor in their recovery.

The risk from climate refugees is not seen as an immediate threat, but it is a possibility, and work needs to be done to minimize this risk.

Worksheet 9: Prioritizing action against criteria

Possible response actions	Criteria						Priority actions

3.11 Implement your plan



This section deals with some of the practicalities of implementing your responses. Much of this should be familiar in the context of management and action planning.

As a result of the above analysis, you will have prioritized your actions, remembering that **these relate first and foremost to protecting your site's OUV in the most effective and efficient way possible.** This is the desired outcome.

Having identified the necessary skills and resources needed, you may need to consider whether any new skills can be brought in or whether you will need to train your own staff. There are a number of other considerations that a manager must bear in mind; a few examples are offered below. The agreed actions will need to be broken down into distinct tasks:

- If you intend to use external skills such as NGOs to remove or control invasive species, how will they be managed?
- If you intend to carry out the work in-house, who will need training, how and when?
- What equipment will you need for the different tasks? Will you buy it or hire it? How will you transport it and store/maintain it if necessary?
- What will be monitored? Over what timescales? What are the logistics? How will records be maintained?

Example 12. Action plan and related tasks at Cloudey Island.

A

Monitor and remove invasive predators

1 Literature review/case studies
2 Database for recording/reporting
3 Training programme – taxonomy, trapping/dispatch techniques, monitoring/recording
4 Recruit specialist staff
5 Purchase equipment
6 Initial field trial
7 Review
8 Carry out removal programme
9 Monitor/record presence/absence/locations

Monitor bird numbers, dispersal, nests, etc.

10 Training – monitoring/recording skills
11 Database as above
12 Monitoring equipment
13 Carry out monitoring/recording programme

B

Establish rain-fed watering points

1 Literature review/case studies
2 Identify and produce or purchase necessary materials
3 Monitoring equipment
4 Monitor/record

C

Monitor soil amount and condition

Monitor soil salinity

Monitor for wind-/sea-borne invasives

Monitor vegetation changes

1 Training in necessary skills
2 Equipment as necessary
3 Database as above
4 Carry out periodic monitoring/recording programme

D

Create artificial nest sites in unexposed areas

1 Literature review/case studies
2 Identify appropriate locations
3 Carry out pilot programme
4 Evaluate
5 Carry out full programme based on assessment of need
6 Carry out monitoring/recording programme

Patrol and enforce regulations

7 Training - knowledge of the law, interpersonal skills
8 Record/report incidents

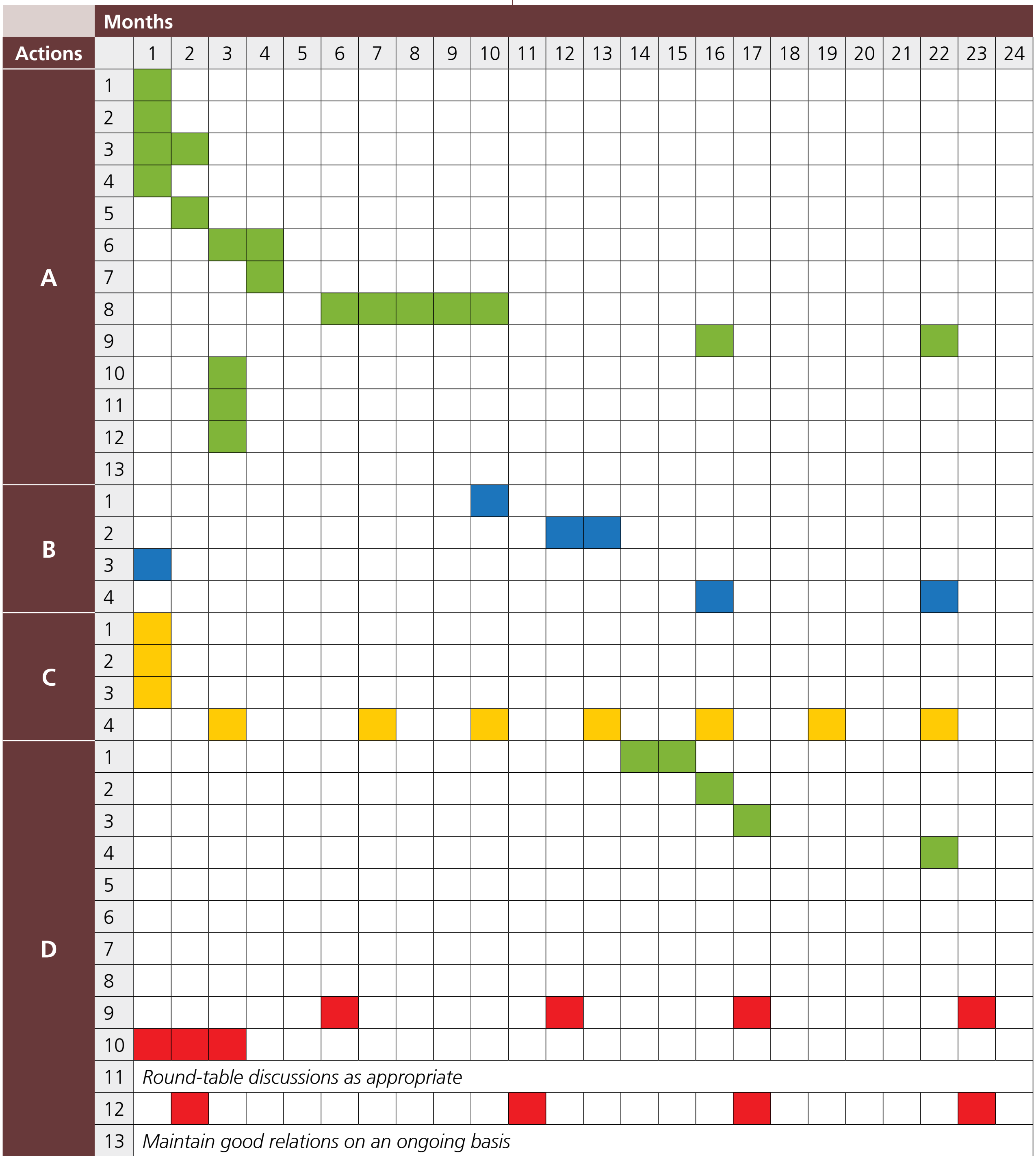
Work with partners to minimize risk of encroachment

9 Literature review/examples/incidence of events
10 Develop contacts list
11 Participate in round-table discussions
12 Raise awareness of issues
13 Maintain good relations

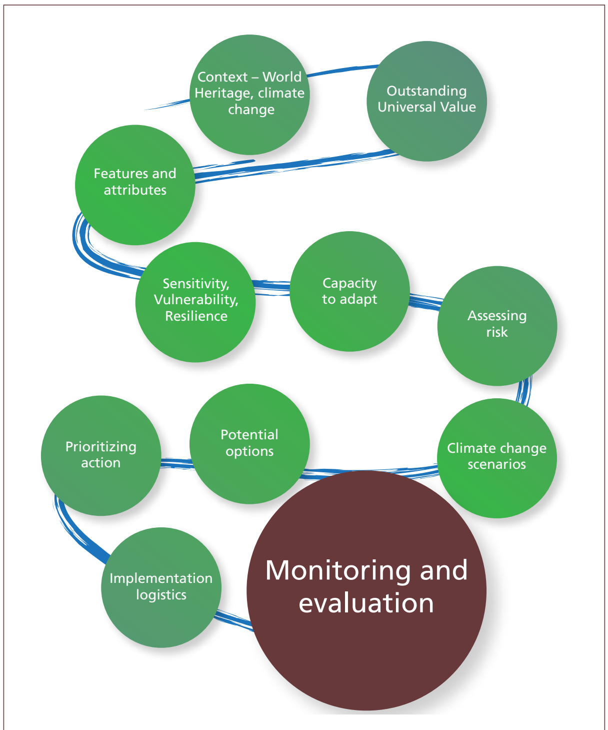
The site management team recognizes the need to be as well informed as possible, so literature reviews, web searches, consultations with other managers, UNESCO, IUCN and other key organizations, and reviews of policy and law are all helpful. Strategic partnerships with universities or NGOs can often go a long way towards sharing some of this knowledge.

The team has also recognized the need to organize and test data storage and use before the programme gets under way – acquiring appropriate software and hardware, setting up a workable database, and training staff in its use are all important practical requirements.

Having listed the tasks linked to each option, the management team has now agreed on a logistical plan for implementing the tasks. It recognizes the need to start a training programme and to set up the system early on, and has timed its activities to coincide with appropriate seasonal factors such as breeding and rearing, different weather events, and optimal trapping times. It appreciates the need to minimize human presence on the island, and has timed monitoring activities to coincide with each other where possible, as this will also optimize logistics and minimize impact. It also recognizes that some activities go beyond the twenty-four-month horizon of this initial programme.


Months
Actions
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
A
1 2 3 4 5 6 7 8 9 10 11 12 13
B
1 2 3 4
C
1 2 3 4
D
1 2 3 4 5 6 7 8 9 10 11 12 13
Round-table discussions as appropriate
Maintain good relations on an ongoing basis

3.12 Monitoring and evaluation



A wealth of research has demonstrated that well-designed monitoring of World Heritage habitats and species both on site and during off-site migration, as well as of key geology and hydrology indicators, will serve as an early warning, allowing managers to be proactive in reducing negative impacts where possible.

Monitoring small isolated ecosystems such as pools, wetlands, wooded areas and scrubland will assist in assessing ecosystem-scale impacts. These small systems contribute disproportionately to regional landscape diversity, have easily assessed communities and physical structure, and serve as stepping stones in the landscape, facilitating plant and animal movements.[30]

At the community and ecosystem scale, climate monitoring has also demonstrated rapid recent changes across a landscape. For example, alpine streams in Switzerland have warmed, shown reduced nitrogen concentrations and reduced taxa richness and density of zooplankton in only a few decades.[31]

30 L. de Meester et al., 2005, Ponds and pools and model systems in conservation biology, ecology and end evolutionary biology *Aquatic Conservation: Marine and Freshwater Ecosystems*, Vol. 15, pp. 715–25.
31 C. T. Robinson and B. Oerlti, 2009, Long-term biomonitoring of alpine waters in the Swiss national park, *Eco. Mont*, Vol. 1, No. 1, pp. 23–34.

Monitoring plant and animal communities at World Heritage sites provides evidence of change, allowing a manager to take adaptive action proactively. The physiology and behaviour of many groups of plants and animals is modified as climate changes. Those modifications can be useful in guiding the selection of variables that might be monitored on site. A great variety of taxa (e.g. plants, birds, butterflies) have altered community distribution poleward in the past few decades.[32]

Plant communities across a wide elevation gradient in France have been shown to move upward at an average of 29 m per decade.[33] Many species of migratory bird have tended to arrive earlier in the spring in the last few decades although the evidence varies widely among species, and reasons for the change are poorly understood.

The timing with which biological events recur is known as **phenology**. The phenology of plant and animal properties, such as migration, flowering or breeding, is closely linked to biophysical conditions, and is therefore highly subject to climate change, which makes phenological observation a valuable climate monitoring-system.

Organizing volunteer phenology monitoring can be an effective way to engage stakeholders in a World Heritage site.

The National Phenology Network in the United States is one example of how phenology can be used.[34]

Data collection from a phenological analysis can be presented graphically, such as in Figure 7, for a simple presentation to stakeholders.

Migratory species provide useful statistical information on responses to climate factors. However, our information on the dates when species leave their wintering grounds is limited, especially for species that winter in Africa.[35] Organizations such as the British Trust for Ornithology[36] and Birdlife International[37] provide useful data on bird migration (as do many locally based NGOs), but the general lack of information, as well as its dissemination, is problematic.

32 R. Hickling, D. B. Roy, J. K. Hill, R. Fox and C. D. Thomas, 2006, The distributions of a wide range of taxonomic groups are expanding polewards, *Global Change Biology*, Vol. 12, pp. 450–55.
33 J. Lenoir et al., 2008, A significant upward shift in plant species optimum elevation during the 20th century, *Science*, Vol. 320, pp. 1768–71.
34 B. P. Haggerty and S. J. Mazer, 2008, *The Phenology Handbook: A guide to phenological monitoring for teachers, students, families, and nature enthusiasts*. University of California, Santa Barbara. http://www.usanpn.org/files/shared/files/Haggerty&Mazer_ThePhenologyHandbook_v3Aug2009.pdf
35 E. Knudsen et al., 2011, Challenging claims in the study of migratory birds and climate change, *Biological Reviews*, Vol. 86, pp. 928–46.
36 http://www.bto.org/science/international/out-africa
37 http://www.birdlife.org/africa

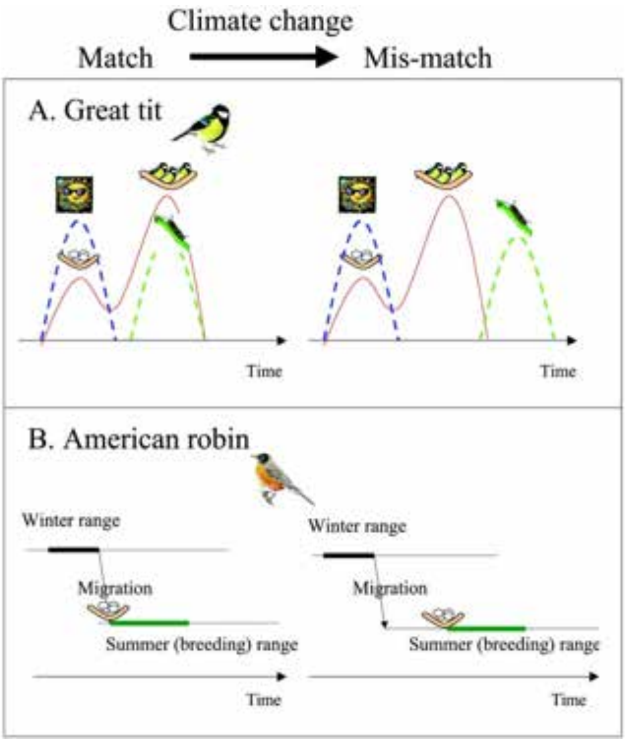


Figure 7: Climate change impacts on phenology. Source: National Academy of Sciences (2002), http://www.pnas.org/content/99/21/13379

Where appropriate, managers of African World Heritage sites might focus on such migrations as indicators of climate change, partly because of the contribution such observations would make to global research but also because these data are not well known, so careful data collection might be especially informative. Likewise, larger migratory animals provide essential information on changes in seasonal vegetation patterns. Scientists have successfully associated animal migrations and insect emergences with fine-scale climatic patterns.[38]

Amphibian communities in particular have shown the most dramatic climate change responses to date.[39] In one study, autumn breeding amphibian populations are breeding later and winter breeding species are breeding earlier, with changes ranging from 5.9 to 37.2 days per decade.[40]

38 D. Senepathi et al., 2011, Climate change and the risks associated with delayed breeding in a tropical wild bird population, *Proceedings of the Royal Society Part B – Biological Sciences*, Vol. 278, pp. 3184–90.

39 E. A. Chadwick et al., 2006, Inter- and intraspecific differences in climatically mediate phonological changes in coexisting *Triturus species, Global Change Biology*, Vol. 12, pp. 1069–78.

40 B. D. Todd et al., 2011, Climate change correlates with rapid delays and advancements in reproductive timing in an amphibian community population, *Proceedings of the Royal Society Part B – Biological Sciences*, Vol. 278, pp. 2191–97.

Butterflies have been shown to be very responsive to climatic changes over relatively short time frames (a few decades), and their responses are highly correlated with data on degree-days in the landscape.[41] Those changes are important to World Heritage sites known for their biodiversity because IUCN's Red List may not adequately represent the risk that climate change poses to amphibian or dragonfly communities or to other small animals.

Achieving your adaptation goals

How do you know whether your plan for climate change adaptation is effective in achieving the goals established for it?

As described in Tool 11 of *Enhancing our Heritage Toolkit*, monitoring and assessment can help the site team to clarify its perception of climate change risks, its adaptive strategy, and the effectiveness of the adaptation actions it has decided to implement. As part of designing an effective assessment, the team will need to develop a range of indicators to measure the key outcomes from the adaptation plan; these should be directly related to the attributes of the site OUV. Monitoring relies on the use of **indicators**, measures that reflect the condition of attributes that contribute to the OUV and that respond proportionally as the quality of those attributes changes.

For example, the up-slope movement of a plant community might indicate a response to climate change, while annual counts of a major grazer might serve as an indicator of the health and diversity of a grassland ecosystem. Guidance for developing indicators is offered in Tool 11 of *Enhancing our Heritage Toolkit*:

> **'The art to developing a monitoring system is to select a few indicators that capture as much information as possible about the values – such as different aspects of biodiversity and ecosystem functioning – without costing too much time or money to monitor. In the context of biodiversity monitoring, indicators need to give information about biodiversity (e.g. species, genetic richness, population dynamics and trophic structure) and ecosystem functioning (e.g. succession, vegetation age-class distributions, productivity and decomposition). ... social, cultural and economic issues should also be considered.'**
>
> ***Enhancing our Heritage Toolkit***
> **(Hockings et al., 2008)**

41 J. A. Hodgson et al., 2011, Predicting insect phenology across space and time, *Global Change Biology*, Vol. 17, pp. 1289–1300.

Monitoring is always limited by available resources, so the results and interpretations of a monitoring programme should be framed appropriately. For example, the experimental design (i.e. kinds and numbers of samples collected at various places and times) will dictate how well the site team understands the natural variance and the effects of an intervention such as an adaptation practice. Monitoring results might be phrased as statistically significant differences or as differences observed and recorded anecdotally. It will usually be valuable to consult a statistician, perhaps through a local university or ministry office, to assist with design and interpretation of monitoring results.

There are many kinds of questions to consider when designing a monitoring strategy, such as:

- When is the best time to carry out monitoring?
- How many times? How frequently?
- Where are the most likely locations?
- Have you chosen a representative number and variety?
- Are the methods and equipment appropriate?
- Are the resources adequate?
- Are the methods effective without being too costly?
- Is the data recording consistent?
- How can you avoid bias, or over-/underestimating?

Monitoring follows a logical (not always linear) path of data collection, analysis and interpretation (Figure 8).

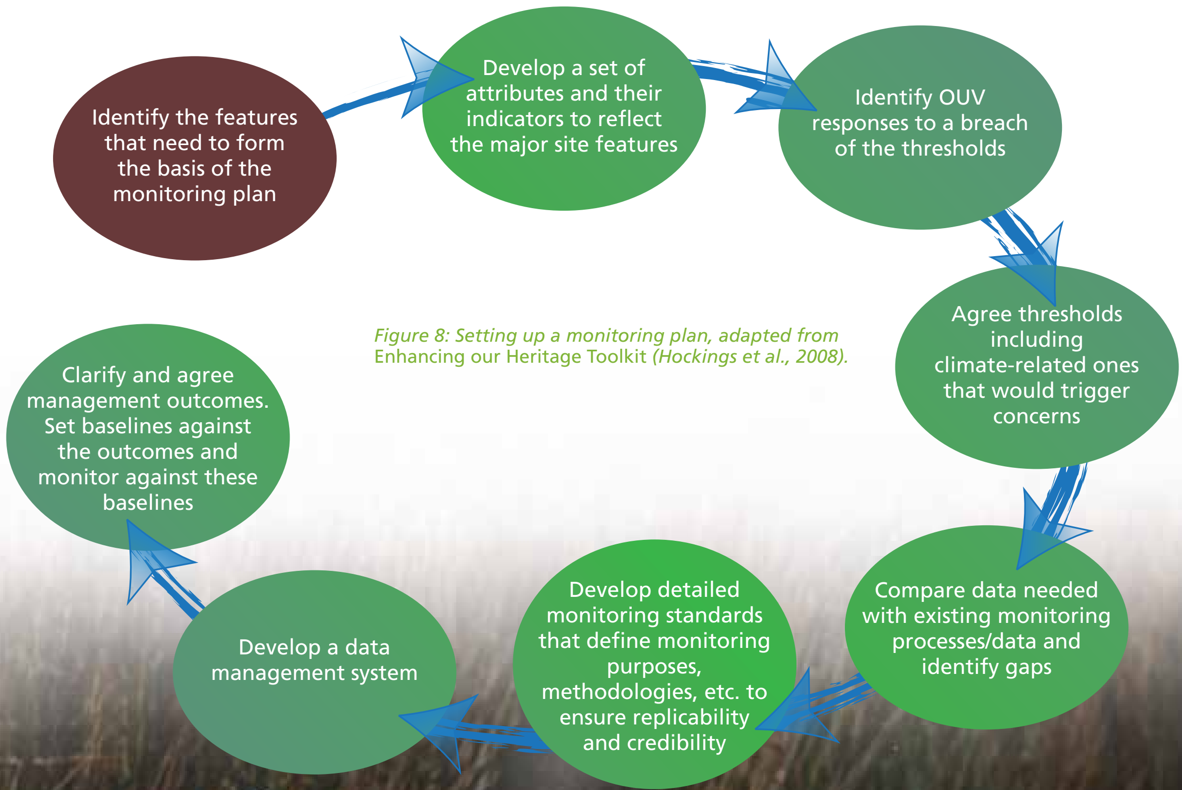
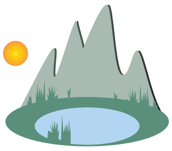


Figure 8: Setting up a monitoring plan, adapted from Enhancing our Heritage Toolkit *(Hockings et al., 2008).*

Srebarna Nature Reserve (Bulgaria).
© Ivo Hadjimishev



Example 13. Monitoring the population of snow leopards at the Snowey Mountains System.

Prior to carrying out the monitoring programme, the management team has reviewed the amount and location of appropriate habitat, and identified a representative number of monitoring sites. It has decided to carry out its work in mid-March, to allow for a build-up of scats and scrapes at the end of the mating season, while preserving tracks in the snow where it has built up between cliff bottoms and slopes, and along ravine edges, favoured snow leopard sites. This means that humans and livestock have yet to be active in the area. On the other hand, some areas will be inaccessible because glacial melt-water has swollen the rivers.

Attribute	Indicator
Population and dispersal	**Presence/absence** Scats, scrapes, scent marking, claw marking, tracks – locations, descriptions/GIS Sightings – locations, descriptions Reported sightings – descriptions Corpses – causes of death, locations
Key prey species	**Presence/absence** Abundance of each variety – locations/counts Droppings – locations/descriptions Prints – locations/descriptions Reported sightings Sightings
Climate factors	Precipitation – frequency, amount Seasonal snow melt – evidence by date Glaciation – area/GIS; evidence of retreat Storm events – reported by communities; calendar; severity and type Temperature – daily measures during field visit Avalanche/rockfall events – reported incidents; field observations
Habitat factors	Upward migration of flora – yes/no; rate indicated by presence/GIS Habitat for prey species – abundance of types – mapped estimates/GIS Water – availability, abundance, locations/GIS
Human factors	Conflict incidents – reported by communities Poaching incidents – snow leopard – reported by communities; seizures Poaching incidents – prey species – reported by communities; seizures Presence of livestock – type, numbers, locations

It is worth bearing in mind that while a high incidence of some indicators would lead to the obvious conclusion of presence, the lack of signs and reports is not necessarily an indication of absence of the species.

GIS is a particularly useful tool in identifying and monitoring distribution and migration patterns, habitat change, metapopulations, communities, precipitation, mean temperatures, hydrology and so on.

This section has discussed monitoring in terms of the options and actions in relation to climate change adaptation, but of course monitoring is a continuous aspect of protected area management generally and World Heritage site management in particular. Bearing in mind the dynamics of climate change, and the need for constant adjustments, there is no end point.

However, at regular timepoints during a programme, the management team should periodically pause and reflect on how effectively the site is being managed as well as how clearly the team understands the effects of its management. This entails an assessment of the state of the site, the monitoring programme **and the management system**. In order to sustain a site's OUV *despite* climate change, a manager needs to evaluate both the processes through which management is achieved as well as the specific attributes that contribute to the OUV. Lessons learned will help the team to refine the adaptive strategy, increasing the probability that the OUV will be sustained.

The purpose of evaluation is to give feedback and information in order to adjust future activities, such as redirecting them elsewhere, reducing or intensifying them, allocating more or fewer resources, measuring new indicators or amending techniques. It is an opportunity to analyse previously unforeseen impacts, both positive and negative, that have occurred during the period and process in question.

Worksheet 10 presents a useful way of evaluating the state of a site's features as a result of any adaptation programme.

Worksheet 10: Condition of features

Features (list)	Attributes (list)	Condition (comment)	Overall assessment of feature – condition and trend (symbol)	Sources of information

- Significant concern
- Some concern
- Good condition at this time

The key symbols provide an overall assessment of condition. By overlaying the relevant symbol with the appropriate arrow, it is possible to assess whether the condition is stable, improving or deteriorating, i.e. 'significant concern but improving' might be symbolized thus, ⇧ whereas 'some concern but stable' might look like this: ⇔

It is beyond the remit of this guide to instruct on the production and maintenance of monitoring and evaluation records. However, it is important to ensure that these are consistent, accessible, understood by a variety of audiences and invite a response.

Evaluation should at least refer back to the questions asked at the beginning about the site's integrity:

- Are the site's key features and attributes related to the OUV whole and intact?
- Does the site include all the elements necessary to express its OUV?
- Is the site of adequate size to ensure complete representation of features/processes that convey its significance?
- What is the condition of the key features and attributes of the site?
- Are processes, relationships and dynamic functions essential to features maintained in good condition and at an appropriate scale?
- Does the site suffer from the adverse effects of development, neglect or any other degrading process?
- Do you have control over the processes causing deterioration? Have adaptation strategies been identified and implemented?
- Does the site have a buffer zone and, if so, is it under any threat?

It is hoped that the answers will be positive, but as climate dynamics change, the World Heritage site manager will need to maintain a proactive and adaptive approach.

As well as evaluating the effects of any climate change adaptation strategy, it is important to recognize the need to **evaluate the monitoring programme itself**. Managers need to ensure that monitoring has been systematic, objectively verifiable, appropriately timescaled, adequately resourced, efficiently carried out and targeted at measurable and relevant indicators.

3.13 Monitoring weather and climate patterns and their effects

One of the most difficult steps is gathering evidence of climate trends and their effects. Given the increasing concerns about climate change and uncertainties, any monitoring should include a systematic record of prevailing local weather conditions and trends. In order to sustain any medium- to long-term record, site managers should begin to accumulate as much regional and local information as possible.

Worksheet 11 summarizes a range of climatic factors and approaches to recording them. It is generic, not comprehensive, and requires adaptation to local circumstances, but may be a useful starting point in recording climate patterns and effects over the following decades.

The Bay of Bengal where the rivers Ganges, Brahmaputra and Meghna meet the sea, otherwise known as the Sundarbans. If the sea level was to rise by 45 cm worldwide as a consequence of climate change, 75 per cent of the Sundarbans mangroves could be destroyed and many species and millions of people would be affected. © NASA image created by Jesse Allen, Earth Observatory, using data obtained from the University of Maryland's Global Land Cover Facility

Worksheet 11: Monitoring weather / climate patterns and effects		
	Metrics / comment	**Evidence / source**
Weather/climate factors		
Precipitation	Days Amounts	
Sunny days	Days of rain / cloud-free weather	
Temperature	Days of highest / lowest mean temperatures	
Blizzard/storm incidents (i.e. snow/rain with storm force winds)	Dates Narrative	
Events		
Fire incidents	Dates Narrative	
Flooding incidents	Dates Narrative	
Drought	Days in which demand for water exceeds supply	
Presence of sea ice	Extent Volume	
Loss of river banks	Lengths Amounts Rates	
Rockfall/mudslide incidents	Dates Severity Narrative	
Silting	Increases in silting volumes	
Avalanche incidents	Dates Severity Narrative – known sites/new sites, etc.	
Melting	Dates Rates	
Habitats		
Changes in vegetation patterns	Dispersal – new species present Dominance	
Flowering/seeding patterns	Dates	
Crop yields	Increases/decreases of types Loss to weather patterns Loss to pest species	
Species		
Pests	Increases/decreases in pest species New species present New patterns of predation/feeding	
Invasive species	Increases/decreases in species New species present	
Insects	Increases/decreases Hatching patterns – dates	
Birds	Increases/decreases Hatching patterns – dates Nesting/feeding patterns – increases/decreases, new sites Migration dates	
Mammals	Migration patterns – new sites, timescales Feeding patterns Birth rates Predation patterns	
Fish	Non-native species Deaths caused resulting from algal blooms Migration and breeding patterns Availability of foods	

4

Conclusion

The Sundarbans (Bangladesh).
© UNESCO/Marc Patry

Climate change is an issue that has become more prominent as a management concern. Increasingly, protected area managers and other authorities recognize that a 'do-nothing' option is not viable. We hope that this guide will provide the tools you will need to carry out your own climate change adaptation strategy that can be integrated into an overall management plan.

While we believe that the approach highlighted in this guide is sound, it is important to adapt the contents to suit your own needs and purposes once the principles and ideas are understood.

You should not underestimate the demands of time and resources in developing an adaptation strategy, and it might be appropriate to carry out this work while revising or producing your management plan, or in conjunction with the development of wider land management strategies and plans.

It is likely that a number of focused workshops will be required to enable all those with an interest in your site to gain awareness and understanding of the issues, and to gain ownership of the process. Any strategy such as this requires the shared knowledge, advice and support of a wide range of interests.

For any strategy to work, it must be relevant to its users, and above all practical. Too many well-intended strategies fail simply because they are unusable.

Expertise in climate change adaptation is growing among the protected area management community, and it is important to keep up to date by reviewing UNESCO World Heritage Centre and IUCN websites, as well as those of international and national NGOs. An increasing number of case studies and examples of strategies is available on the internet, including those referred to here, and they are a valuable source of information.

We particularly commend UNESCO World Heritage Centre's *Enhancing our Heritage Toolkit* as it provides the basis of the management approach highlighted in this guide.

In conclusion, the following points are worth reiterating:

- Climate change is a highly complex process, and we cannot predict in detail what future climate conditions might be. However, we can develop some consensus on likely scenarios based on observation, knowledge and expertise, and professional intuition. What is clear is that change is on the way.

- The focus of natural World Heritage management is the protection of its Outstanding Universal Value (OUV). It is important that everyone knows what this is and understands what it means. The purpose is to protect and to enhance your site's OUV.
- An useful approach to understanding your site's OUV is to consider its features – the qualifying features are what led to its inscription. Protecting these features and their attributes (such as breeding, feeding, migrating patterns, life cycles, extent, scale, interactions and so on) will effectively protect the OUV of a site. It is therefore important to analyse your site's features and their attributes.
- There may be various measures available to you, some of which are likely to be more costly, time-consuming and logistically demanding than others. While it is important to be realistic about what can be achieved, you need to bear in mind that the cheapest 'quick fixes' may not be the best option. Provided you can justify particular measures on the basis of the best available evidence, you should not ignore challenging options where necessary. In any case, you may need to work on a range of measures at different levels. Monitoring and evaluation are essential, as you may need to adjust your activities in response to changing conditions. Ensure well-targeted monitoring which will supply the answers you need – do not spend time and money on monitoring irrelevant aspects. You will need to evaluate your actions from time to time to ensure that they are an appropriate response to evolving climate conditions.

Climate change is an issue that has become more prominent as a management concern. Increasingly, protected area managers and other authorities recognize that a 'do-nothing' option is not viable. We hope that this guide will provide the tools you will need to carry out your own climate change adaptation strategy that can be integrated into an overall management plan.

Pirin National Park (Bulgaria). © Ivo Hadjimishev

5

References

Spinner dolphins – these acrobatic and charismatic animals are characteristic of shallow marine waters, areas subject to interacting forces of climate change and aggressive land use. © Dawn Tanner and Jim Perry

Andrade Pérez, A., Herrera Fernandez, B. and Cazzolla Gatti, R. (eds). 2010. *Building Resilience to Climate Change: Ecosystem-based adaptation and lessons from the field.* Gland, Switzerland: IUCN. https://portals.iucn.org/library/sites/library/files/documents/CEM-009.pdf

Badman, T., Bomhard, B., Fincke, A., Langley, J., Rosabal, P. and Sheppard, D. 2008. *Outstanding Universal Value: Standards for Natural World Heritage*. Gland, Switzerland, International Union for Conservation of Nature. https://portals.iucn.org/library/efiles/documents/2008-036.pdf

Boer, H. 2010. Policy options for, and constraints on, effective adaptation for rivers and wetlands in northeast Queensland. *Australian Journal of Environmental Management*, Vol. 17, pp. 154–64.

Chadwick, E. A., Slater, F. M. and Omerod, S. J. 2006. Inter- and intraspecific differences in climatically mediate phonological changes in coexisting *Triturus* species. *Global Change Biology*, Vol. 12, pp. 1069–78.

Conklin, J. 2005. Wicked problems and social complexity. In: J. Conklin (ed.), *Dialogue Mapping: Building of Shared Understanding of Wicked Problems.* Wiley and Sons. http://cognexus.org/wpf/wickedproblems.pdf

Côté, I. M. and Darling, E. S. 2010. Rethinking ecosystem resilience in the face of climate change. *PLoS Biology*, Vol. 8, No. 7, e1000438. doi:10.1371/journal.pbio.1000438.

De Meester, L., Declerck, S., Stokes, R., Louette, G., van de Meutter, F., de Bie, T., Michels, E. and Brendonck, L. 2005. Ponds and pools and model systems in conservation biology, ecology and end evolutionary biology. *Aquatic Conservation: Marine and Freshwater Ecosystems*, Vol. 15, pp. 715–25.

Dudley, N., Stolton, S., Belokurov, A., Krueger, L., Lopoukhine, N., MacKinnon, K., Sandwith, T. and Sekhran, N. (eds). 2010. *Natural Solutions: Protected areas helping people cope with climate change.* IUCN-WCPA, TNC, UNDP, WCS, World Bank, WWF/ Gland, Switzerland, Washington DC, New York. http://cmsdata.iucn.org/downloads/natural_solutions.pdf

Falzon, C. 2004. *Protected Landscape Management*. M.Sc. Module 6. University of Aberystwyth, Wales, UK.

FAO. 2002. *Community-Based Forest Resource Conflict Management*. Training Package. Rome, Food and Agriculture Organization of the United Nations. ftp://ftp.fao.org/docrep/fao/005/y4301e/y4301e03.pdf

Gender Climate Change platform for information, knowledge, and networking on gender and climate change. http://www.gendercc.net/

Global Gender and Climate Alliance – Incorporating a gender perspective in all climate change policies and initiatives. http://www.gender-climate.org/

González, A. M. and Martin, A. S. 2007. *Gender in the Conservation of Protected Areas*. Parks in Peril, Innovations in Conservation Series. Arlington, Va., The Nature Conservancy. http://www.cbd.int/doc/pa/tools/Gender%20in%20the%20conservation%20of%20protected%20areas.pdf

Government of Australia. 2011. *Pacific Climate Change Science Program. Climate Futures*. http://www.pacificclimatefutures.net/

Government of South Africa. 2004. *A National Climate Change Response Strategy for South Africa.* Pretoria, Department of Environmental Affairs and Tourism. http://unfccc.int/files/meetings/seminar/application/pdf/sem_sup3_south_africa.pdf

Great Barrier Reef Marine Park Authority. http://www.gbrmpa.gov.au/

Greater Yellowstone Coordinating Committee. http://fedgycc.org/

Haggerty, B. P and Mazer, S. J. 2008. *The Phenology Handbook: A guide to phenological monitoring for teachers, students, families, and nature enthusiasts*. University of California, Santa Barbara. http://www.usanpn.org/files/shared/files/Haggerty&Mazer_ThePhenologyHandbook_v3Aug2009.pdf

Hickling, R., Roy, D. B., Hill, J. K., Fox, R. and Thomas, C. D. 2006. The distributions of a wide range of taxonomic groups are expanding polewards. *Global Change Biology*, Vol. 12, pp. 450–55.

Hockings, M., James, R., Stolton, S., Dudley, N., Mathur, V., Makombo, J., Courrau, J. and Parrish, J. 2008. *Enhancing our Heritage Toolkit: Assessing management effectiveness of natural World Heritage sites*. Paris, UNESCO World Heritage Centre. (World Heritage Papers 23.) http:whc.unesco.org/en/series/23/

Hodgson, J. A., Thomas, C. D., Oliver, T. H., Anderson, B. J., Brereton T. M. and Crone, E. E. 2011. Predicting insect phenology across space and time. *Global Change Biology*, Vol. 17, pp. 1289–1300.

India Water Portal home website. http://www.indiawaterportal.org/

Intergovernmental Panel on Climate Change (IPCC). http://www.ipcc.ch

IPCC. 2007. Fourth Assessment Report: Climate Change 2007. http://www.ipcc.ch/publications_and_data/publications_and_data_reports.shtml

IPCC. 2012. *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation.* A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change. C. B. Field, V. Barros, T. F. Stocker, D. Qin, D. J. Dokken, K. L. Ebi, M. D. Mastrandrea, K. J. Mach, G.-K. Plattner, S. K. Allen, M. Tignor and P. M. Midgley (eds). Cambridge University Press, Cambridge, UK/New York. 582 pp. http://www.ipcc-wg2.gov/SREX/images/uploads/SREX-All_FINAL.pdf

IUCN. 2008. *Protected Area Programme, Management Planning for Natural World Heritage Properties. A Resource Manual for Practitioners*. http://cmsdata.iucn.org/downloads/whmanagement.pdf

IUCN, UNDP, GWA, ENERGIA, UNESCO, FAO and WEDO as part of the Global Gender and Climate Alliance (GGCA). 2009. *Training Manual on Gender and Climate Change*. San José, Absoluto. https://portals.iucn.org/library/efiles/documents/2009-012.pdf

Knudsen, E., Lindén, A., Both, C., Jonzén, N., Pulido, F., Saino, N. et al. 2011. Challenging claims in the study of migratory birds and climate change. *Biological Reviews*, Vol. 86, pp. 928–46.

Land Use Consultants/Dorset County Council. 2011. Jurassic Coast Pathfinder Spatial Research Project. http://www.jurassiccoast.com/downloads/spatial_planning_research_project_-_luc.pdf

Lenoir, J., Gégout, J. C. Marquet, P. A., de Ruffray, P. and Brisse, H. 2008. A significant upward shift in plant species optimum elevation during the 20th century. *Science*, Vol. 320, pp. 1768–71.

Moore, T. 2010. *Peru. People, Parks and Petroleum. Cultural Survival*. http://www.culturalsurvival.org/publications/cultural-survival-quarterly/peru/peru-people-parks-and-petroleum

Nakashima, D. J., Galloway McLean, K., Thulstrup, H. D., Ramos Castillo, A. and Rubis, J. T. 2012. *Weathering Uncertainty: Traditional Knowledge for Climate Change Assessment and Adaptation*. Paris/Darwin, UNESCO/UNU. http://unesdoc.unesco.org/images/0021/002166/216613e.pdf

Newton, A. C. 2011. Socio-ecological resilience and biodiversity conservation in a 900-year-old protected area. *Ecology and Society*, Vol. 16, No. 4, Article 13. http://www.ecologyandsociety.org/vol16/iss4/art13/

Ohl-Schacherer, J., Shepard Jr, G. H., Kaplan, H., Aplan, Carlos, A., Peres, C. A., Levi, T. and Yu, D. W. 2007. The sustainability of subsistence hunting by Matsigenka native communities in Manu National Park, Peru. *Conservation Biology*, Vol. 21, No. 5, pp. 1174–85. C#2007 Society for Conservation Biology. http://www.utm.utoronto.ca/~w3bio/bio464/lectures/lectures_assets/sustainability_of_indigenous_hunting.pdf

Plitvice Lakes National Park (Croatia). © OUR PLACE

Parks Canada. 2006. *Periodic Report on the Application of the World Heritage Convention*. http://www.pc.gc.ca/eng/docs/pm-wh/rspm-whsr/sec1/sec1c.aspx

Perry, J. A. 2011*a*. *Literature review on climate change adaptation and natural World Heritage sites Prepared for UNESCO World Heritage Centre.*

PRECIS Regional Climate Modelling System. http://www.metoffice.gov.uk/precis/

Perry, J. A. 2011*b*. World Heritage hot spots: A global model identifies the 16 natural heritage properties on the World Heritage list most at risk from climate change. *International Journal of Heritage Studies*, Vol. 17, No. 5, pp. 426–41.

Robinson, C. T. and Oerlti, B. 2009. Long-term biomonitoring of alpine waters in the Swiss national park. *Eco. Mont.*, Vol. 1, No. 1, pp. 23–34.

Sapkota, L. and Banko Janakari. 2007. Ecology and management issues of Mikania micrantha in Chitwan National Park, Nepal. *Forestry Nepal*, Vol. 17, No. 2, Kathmandu Nepal, pp. 27–39. http://www.forestrynepal.org/biblio/author/1784

Senepathi, D., Nicoll, M. A. C., Teplitsky, C., Jones, C. G. and Norris, K. 2011. Climate change and the risks associated with delayed breeding in a tropical wild bird population. *Proceedings of the Royal Society Part B – Biological Sciences,* Vol. 278, pp. 3184–90.

Stankey, G. H., Cole, D. N., Lucas, R. C., Petersen, M. E. and Frissell, S. S. 1985. *The Limits of Acceptable Change (LAC) System for Wilderness Planning*. US Department of Agriculture, Ogden Forest Service. (General Technical Report – USDA**,** No. INT-176.)

Todd, B. D., Scott, D. E., Pechmann, J. H. K. and Gibbons, J. W. 2011. Climate change correlates with rapid delays and advancements in reproductive timing in an amphibian community population. *Proceedings of the Royal Society Part B – Biological Sciences*, Vol. 278, pp. 2191–97.

Travers, A., Elrick, C., Kay, R., Vestergaard, O. et al. 2012. *Ecosystem-based Adaptation Guidance – Moving from Principles to Practice.* Nairobi, United Nations Environment Programme. http://www.unep.org/climatechange/adaptation/Portals/133/documents/Ecosystem-Based%20Adaptation/Decision%20Support%20Framework/EBA%20Guidance_WORKING%20DOCUMENT%2030032012.pdf

UNDP. 2013. *Africa Adaptation Programme Experiences: Gender and Climate Change*. New York, United Nations Development Programme. http://www.undp.org/content/dam/aplaws/publication/en/publications/environment-energy/www-ee-library/climate-change/africa-adaptation-programme-experiences-gender-and-climate-change/AAP_Discussion_Paper1_English.pdf

UNESCO World Heritage Centre. 2007*a*. *Case Studies on Climate Change and World Heritage.* http://whc.unesco.org/en/activities/473/

UNESCO World Heritage Centre, 2007*b*, *Climate Change and World Heritage – Report on predicting and managing the impacts of climate change on World Heritage and Strategy to assist States Parties to implement appropriate management responses*. http://whc.unesco.org/en/activities/474

UNESCO World Heritage Centre, 2008, *Policy Document on the Impacts of Climate Change on World Heritage Properties*. http://whc.unesco.org/en/CC-policy-document/

UNESCO World Heritage Centre. 2011. *Preparing World Heritage Nominations*. Resource Manual. http://whc.unesco.org/en/activities/643/

UNESCO World Heritage Centre. 2013. *Operational Guidelines for the Implementation of the World Heritage Convention*. http://whc.unesco.org/en/guidelines

UNESCO World Heritage List
Península Valdés (Argentina)
http://whc.unesco.org/en/list/937
Great Barrier Reef (Australia)
http://whc.unesco.org/en/list/154
The Sundarbans (Bangladesh)
http://whc.unesco.org/en/list/798
Galápagos Islands (Ecuador)
http://whc.unesco.org/en/activities/615/
Keoladeo National Park (India)
http://whc.unesco.org/en/list/340
Mount Kenya National Park/Natural Forest (Kenya)
http://whc.unesco.org/en/list/800
Chitwan National Park (Nepal)
http://whc.unesco.org/en/list/284
Sagarmatha National Park (Nepal)
http://whc.unesco.org/en/list/120
Vallée de Mai Nature Reserve (Seychelles)
http://whc.unesco.org/en/list/261
Cape Floral Region Protected Areas (South Africa)
http://whc.unesco.org/en/list/1007
Vredefort Dome (South Africa)
http://whc.unesco.org/en/list/1162
Ichkeul National Park (Tunisia)
http://whc.unesco.org/en/list/8

United Nations Framework Convention on Climate Change. https://unfccc.int/

United States Environmental Protection Agency (2013): Climate Change Futures. http://epa.gov/climatechange/science/future.html

World Bank, Visualizing Future Climate in Latin America: Results from the application of the Earth Simulator. http://siteresources.worldbank.org/INTLAC/Resources/SDWP_Future_Climate.pdf

6

Appendices

A wide range of indigenous cultures have formed over thousands of years along Peru's western Andes, with elevation and climate-specific practices. As climate changes, many of these practices are being threatened. Traditional weaver, Sacred Valley near Ollantaytambo, Peru. @ Dawn Tanner and Jim Perry

Appendix I. Funding opportunities

A wide range of funding is potentially available to assist with climate change adaptation; some of it appropriate also to a natural World Heritage site. The sources most likely to apply to World Heritage sites are REDD+ (Reducing Emissions from Deforestation and Forest Degradation), the Special Climate Change Fund and the Adaptation Fund.

REDD+ is a multilateral funding programme targeted to reduce emissions and sequester carbon in developing countries. The REDD+ Voluntary Database (http://reddplusdatabase.org/) is a linkage mechanism that attempts to coordinate partnerships between funding sources and projects on the ground.

The Special Climate Fund and the Adaptation Fund are international funding mechanisms designed to support adaptation in developing countries. Access to funding from these sources is through the National Adaptation Programs of Actions (NAPA). Fifty countries have developed and submitted NAPAs (to November 2013). Any World Heritage site manager interested in pursuing this route for funding should approach their national government, probably through the ministry of finance or environment or their equivalent, to ensure that climate change adaptation at World Heritage site advances national goals.

The following table on different funding sources, developed by Damaris Kyonki, UNEP Nairobi, is reprinted with permission.

Available Environment Funding Opportunities

World Bank Climate Investment Funds	
Clean Technology Fund (CTF)	
Eligibility	To be eligible for CTF funding a country must: ▶ be ODA eligible ▶ have an active MDB country program **What kind of programs does the CTF promote?** ▶ **Power Sector**: Renewable energy and highly efficient technologies to reduce carbon intensity ▶ **Transport Sector**: Efficiency and modal shifts ▶ **Energy Efficiency**: Buildings, industry, and agriculture
Application Deadline	Varied
Amount	Varied
URL Link	http://www.climateinvestmentfunds.org/cif/node/2
Strategic Climate Fund (SCF)	
Eligibility	Targeted programs under the SCF include: ▶ **The Forest Investment Program (FIP)**, approved in May 2009, aims to support developing countries' efforts to reduce emissions from deforestation and forest degradation by providing scaled-up financing for readiness reforms and public and private investments. It will finance programmatic efforts to address the underlying causes of deforestation and forest degradation and to overcome barriers that have hindered past efforts to do so. ▶ **The Pilot Program for Climate Resilience (PPCR)**, approved in November 2008, was the first program under the SCF to become operational. Its objective is to pilot and demonstrate ways to integrate climate risk and resilience into core development planning, while complementing other ongoing activities. ▶ **The Program for Scaling-Up Renewable Energy in Low Income Countries (SREP)**, approved in May 2009, is aimed at demonstrating the social, economic, and environmental viability of low carbon development pathways in the energy sector. It seeks to create new economic opportunities and increase energy access through the production and use of renewable energy.
Application Deadline	Varied
Amount	Varied
URL Link	http://www.climateinvestmentfunds.org/cif/node/3

World Bank Climate Investment Funds	
The Global Environmental Facility	
Eligibility	The GEF funds a broad array of project types that vary depending on the scale of GEF resources, the project needs and the issue addressed. In order to be approved, each project follows a specific project cycle. Each GEF country member has designated an officer responsible for GEF activities, known as GEF Operational Focal Point, who plays a key role in assuring that GEF projects are aligned to meet the needs and priorities of the respective country. Any eligible individual or group may propose a project. However, to be taken into consideration, a project proposal has to fulfill the following criteria: ▶ It is undertaken in an eligible country. It is consistent with national priorities and programs. ▶ It addresses one or more of the GEF Focal Areas, improving the global environment or advance the prospect of reducing risks to it. ▶ It is consistent with the GEF operational strategy. ▶ It seeks GEF financing only for the agreed-on incremental costs on measures to achieve global environmental benefits ▶ It involves the public in project design and implementation. ▶ It is endorsed by the government(s) of the country/ies in which it will be implemented.
Application Deadline	Varied
Amount	Varied
URL Link	http://www.thegef.org/gef/
The Adaptation Fund	
Eligibility	**Country Eligibility** Developing country Parties to the Kyoto Protocol that are particularly vulnerable to the adverse effects of climate change including low-lying and other small island countries, countries with low-lying coastal, arid and semi-arid areas or areas liable to floods, drought and desertification, and developing countries with fragile mountainous ecosystems. A cap in resource allocation per eligible host country, project and programme will be agreed by the Board based on a periodic assessment of the overall status of resources in the Adaptation Fund and with a view to ensuring equitable distribution. **Implementing and Executing Entities** Eligible Parties who seek financial resources from the Adaptation Fund shall submit proposals directly through their nominated National Implementing Entity (NIE). They may, if they so wish, use the services of Multilateral Implementing Entities (MIE). The implementing entities shall obtain an endorsement from the government. National Implementing Entities (NIE) are those national legal entities nominated by Parties that are recognized by the Board as meeting the fiduciary standards established by the Board. The NIEs will bear the full responsibility for the overall management of the projects and programmes financed by the Adaptation Fund, and will bear all financial, monitoring, and reporting responsibilities. A group of Parties may also nominate regional and sub-regional entities as implementing entities. Multilateral Implementing Entities (MIE) are those Multilateral Institutions and Regional Banks that meet the fiduciary standards provided by the Board. The MIEs, chosen by eligible Parties to submit proposals to the Board, will bear the full responsibility for the overall management of the projects and programmes financed by the Adaptation Fund, and will bear all financial, monitoring, and reporting responsibilities.

World Bank Climate Investment Funds	
	In the case of regional (i.e. multi-country) projects and programmes, the proposal submitted to the Board should be endorsed by the designated authority of each participating Party. Executing Entities are organizations that execute adaptation projects and programmes supported by the Fund under the oversight of the Implementing Entities.
Application Deadline	The deadline for project submissions for the fourteenth Board meeting was July 13, 2011. The next to be announced later.
Amount	Varied
URL Link	http://www.adaptation-fund.org/
Clean Development Mechanism	
Eligibility	▶ Be approved by the host country, i.e. the Designated National Authority (DNA); ▶ Reduce GHG emissions relative to a baseline that has to be defined according to the CDM modalities and procedures. ▶ Contribute to the sustainable development goals of the host country (as defined by the host country); ▶ Define exact, physical boundaries of project activities and consider leakage, i.e. emissions occurring outside the project boundaries, related to the project activity ▶ Provide for stakeholder participation; ▶ Exclude-nuclear and large hydro technology; ▶ Prove that no resources are diverted from official development assistance (ODA); and ▶ Be carried out only by those countries that have ratified the Kyoto Protocol.
Application Deadline	Varied
Amount	Varied
URL Link	http://cdm.unfccc.int/index.html
Clean Energy for Development Investment Framework	
Eligibility	The same as the adaptation fund.
Application Deadline	Varied
Amount	Varied
URL Link	http://go.worldbank.org/7W3DZHKNF0
Carbon Finance	
Eligibility	
Application Deadline	
Amount	
URL Link	http://carbonfinance.org/
USAID Environment: Climate Change Funding	
Eligibility	
Application Deadline	
Amount	
URL Link	http://www.usaid.gov/our_work/environment/climate/funding.html
UN-REDD Programme Fund	
Eligibility	Countries were selected for phase I (the pilot phase) according to the following criteria: 1) Request for quick start action 2) Existing collaboration with UN partners in related areas for rapid progress 3) Emission reduction potential 4) Degree of REDD readiness potential 5) Regional, biome and socio-economic representation 6) Coordination with international REDD initiatives

World Bank Climate Investment Funds	
	7) Leadership potential in sub-regional experience sharing 8) Ability to contribute experiences to UNFCCC negotiations and development of REDD mechanisms Guidance on how each criterion was judged, and how REDD readiness potential was assessed, is not publicly available. During the sixth Policy Board meeting, the following criteria were proposed for prioritizing funding allocations for new National Programmes, though as of May 2011 had not been formally approved: 1) Being a partner country of the UN-REDD Programme; 2) Achieving regional balance; 3) Enhanced coordination with other initiatives; 4) Ability of UN agencies to assist the country; 4) Ability to demonstrate progress results in a short term based on REDD+ early action; 5) REDD+ potential; and 6) Commitment to applying the principles of the UN-REDD Programme
Application Deadline	Varied
Amount	Varied
URL Link	http://www.climatefundsupdate.org/listing/un-redd-programme
Swedish International Development Cooperation Agency	
Eligibility	Sida seeks to contribute to projects that the partner countries have identified as important. With its 1,500 (usually Swedish) partners, Sida provides funding, skills, and other resources to accomplish this goal. The primary opportunities for cooperation with Sida are the following: ▶ 1. **NGOs:** Most of Sida's funding is channeled through Swedish NGOs. Sida is currently working in cooperation with over 300 of them. ▶ 2. **Multilateral Cooperation**: Approximately 1/3 of Swedish development funds is given to international organizations including the UN, the World Bank, and several regional development banks. These funds are available either through partnerships with the countries themselves or through the international body. Some funds are also donated to the EU. ▶ 3. **Grant and Credit Aid**: This type of funding goes directly to partners in the developing country requesting the funds. ▶ 4. **Contract-Financed Development Cooperation**: Sida arranges for the creation of a partnership between a Swedish organization with technical skills and a developing country at that country's request. Sida finances and oversees the project. ▶ 5. **International Training Programs**: Swedish companies, universities, and government agencies arrange training programs with partner countries for the exchange of knowledge, experience and skills. These take place in Sweden and are evaluated three years after their conclusion. ▶ 6. **Research Cooperation**: Swedish researchers are given Sida grants for work in development through one of the following programs: programs for bilateral research cooperation with developing countries (1/3 of funds), regional programs (1/3 of funds), international research programs including those of the WHO and CGIAR are funded (1/4 of funds), research work on developing countries conducted in Sweden (1/10 of funds). ▶ 7. **Consultant Trust Fund Programme**: 10 consultant funds with regional or global operations are funding through international development banks and organizations.
Application Deadline	
Amount	
URL Link	http://web.mit.edu/urbanupgrading/upgrading/resources/organizations/Sida.html

World Bank Climate Investment Funds	
European Commission Funds	
Eligibility	EC funds projects in the following key areas. More information for eligibility for each area is in the respective link. ▶ Agriculture and Rural Development ▶ Audiovisual and Media ▶ Communication ▶ Consumers ▶ Culture ▶ Economic and financial affairs ▶ Education, training and youth ▶ Employment and social affairs ▶ Energy ▶ Enlargement ▶ Enterprise ▶ Environment ▶ External Aid ▶ External Relations ▶ External Trade ▶ Fisheries ▶ Freedom, Security and Justice ▶ Humanitarian Aid ▶ Regional Policy ▶ Research and Innovation ▶ Transport
Application Deadline	Varied
Amount	Varied
URL Link	http://ec.europa.eu/grants/beneficiaries_en.htm
European Commission – LIFE+ for climate action Programme	
Eligibility	LIFE is the EU's financial instrument supporting environmental and nature conservation projects throughout the EU, as well as in some candidate, acceding and neighbouring countries. Since 1992, LIFE has co-financed some 3115 projects, contributing approximately €2 billion to the protection of the environment. The European Commission has approved funding for 183 new projects under the fourth call for the LIFE+ programme (2007-2013). The projects are from across the EU and cover actions in the fields of nature conservation, environmental policy, and information and communication. Overall, they represent a total investment of €530 million, of which the EU will provide €244million. Projects financed by LIFE+ must satisfy the following criteria: ▶ Projects must be of EU interest, making a significant contribution to the achievement of the general objective of LIFE+; ▶ They must be technically and financially coherent and feasible and provide value for money; ▶ Where possible, projects financed by LIFE+ should promote synergies between different priorities under the 6th Environmental Action Programme, and integration. In addition, to ensure European added value and avoid financing recurring activities, projects should satisfy at least one of the following criteria: ▶ Best-practice or demonstration projects, for the implementation of the Birds and Habitats Directives; ▶ Innovative or demonstration projects, relating to EU environmental objectives, including the development or dissemination of best practice techniques, know-how or technologies;

World Bank Climate Investment Funds	
	▶ Awareness-raising campaigns and special training for agents involved in forest fire prevention; ▶ Projects for the development and implementation of EU objectives relating to the broad-based, harmonised, comprehensive and long-term monitoring of forests and environmental interactions.
Application Deadline	Closed in July 2011. The next application will be announced in the website provided below.
Amount	Varied
URL Link	http://ec.europa.eu/clima/funding/lifeplus/index_en.htm
European Commission - NER 300 call climate action Programme	
Eligibility	In order for a Project to be eligible for Funding, the Project must satisfy the following criteria: 1) It must fall into one of the technology Categories or sub-categories set out in Annex 1 of the Decision and reproduced in Annexes 2 and 3 of the Call. A Project cannot be submitted under more than one Category or Sub-category; 2) It must comply with the requirements as set out in Section 5.1.3 below; 3) CCS Projects must satisfy the CCS Project requirements, as set out in CCS project requirements below; and 4. RES Projects must be innovative in nature. Existing, proven technologies are ineligible. **CCS project requirements** CCS projects must meet the following specific constraints: 1) Each CCS project has to implement the full chain (capture, transport and storage); 2) Each project must implement heat integration for the capture component of the process; a) For power generation applications, the Project Sponsor must demonstrate that it has aimed to maximise heat integration between the Power Plant and the capture facility, taking into consideration operational and economic constraints. There is no minimum integration threshold; b) For industrial applications of CCS and including CCS on refineries, cement kilns, primary production routes in iron and steel or aluminium production, the Project Sponsor must demonstrate that heat integration between the CO_2 source and the capture facilities has been considered and justify the approach taken. There is no minimum integration threshold.
Application Deadline	The last announcement was in October 2010. The next application will be announced in the website provided below.
Amount	Varied
URL Link	http://ec.europa.eu/clima/funding/ner300/index_en.htm

Appendix II: Examples of climate change adaptation management actions

Marc Patry, World Heritage Centre

Strengthening connectivity: Mount Kenya National Park / Natural Forest (Kenya)

In 2010, the Kenya Wildlife Service began working on the nomination file for the extension of the Mount Kenya National Park/Natural Forest (inscribed 1997) to include the Lewa Wildlife Conservancy and the Ngare Ndare Forest protected lands to the north.

Lewa and Ngare Ndare Forest are connected to Mount Kenya via a pioneering elephant corridor that serves as a route for landscape connectivity, stretching from Mount Kenya through Lewa and onwards north into the wide expanse of Samburu National Reserve. The groundbreaking corridor was made famous two years ago when a bull elephant was the first of his species to use a man-made highway underpass. Now this underpass is used every year by hundreds of pachyderms, along with a range of other species of Kenyan wildlife, as they follow the corridor along this historical migration route.

Establishing wildlife corridors facilitates the movement of animals over the wider landscape, ensuring they can access food and water in times of need, while reducing the potential for conflict with surrounding communities. Of course, corridors have to lead to suitable habitat, such as the Lew Wildlife Conservancy and the Ngare Ndare Forest in this case.

Climate change scenarios for the region point to longer periods of drought – which would compel many animals to roam over wider ranges in search of food. Facilitating connectivity between protected areas is an often recommended strategy to helping adapt to such eventualities. In this respect, both the extension of the World Heritage site in 2013 and the installation of infrastructure to facilitate this movement were two excellent steps towards increasing the site's resilience to climate change.

Removing existing threats: Galápagos Islands (Ecuador)

Galápagos Islands is an iconic World Heritage site (inscribed 1978, extension 2001), known for its array of endemic species and how they graphically illustrate evolutionary processes. This oceanic island ecosystem evolved with very little influence from continental life forms. Only occasionally have species from the continent been able to traverse the 1,000 km of ocean and establish themselves in the islands. This relative isolation has led to processes of speciation, resulting in unique communities of plants and animals.

One of the forces driving evolutionary processes in Galápagos is the occasional apparition of the El Niño phenomenon, the last major one having been recorded in 1997–98. A severe El Niño in Galápagos means very warm and wet conditions

Traversing the wildlife corridor from Mount Kenya (in the background) to the Lewa Wildlife Conservancy.
© Lewa Wildlife Conservancy

A Galápagos penguin searches for prey (Equador).
© Rich Mendola

on land, and very warm ocean waters. These tend to be devastating for marine life, including all animals dependent on healthy marine ecosystems – such as the Galápagos penguin.

There are relatively few Galápagos penguins even at the best of times – the latest surveys indicating a total population of fewer than 2,000, although numbers have been estimated to have reached 3,400 in 1971. Population declines of as much as 77 per cent have been recorded after severe El Niños, followed by gradual increases.

The Galápagos penguin has survived for thousands of years under the typical Galápagos conditions – indeed, these conditions have no doubt led to the evolution of the original arrivals into this endemic species. However, climate change in Galápagos is expected to be manifested through more frequent and more severe El Niño events. Given the huge effect of a severe El Niño on penguin populations, there is an increased risk that the penguin may disappear altogether.

The Galápagos National Park Service (GNPS) has recognized the precariousness of the penguin population. Given its vulnerability to El Niño events and the projected increase in frequency and severity of such events, the GNPS has decided to focus on reducing other threats to Galápagos penguins, thus improving their overall resiliency. The GNPS has worked on eliminating introduced species that prey on penguin chicks (such as feral cats, rats and fire ants) and on building suitable nesting sites, which are considered to be a limiting factor for reproductive success.

Engaging surrounding stakeholders: Ichkeul National Park (Tunisia)

Ichkeul National Park (inscribed 1980) is located at the very north of Tunisia, in the midst of the country's prime agricultural lands. The wetland park is a major stopover point for hundreds of thousands of migrating birds, such as pochard and wigeon ducks, coots, graylag geese, storks and flamingoes, who come to feed and/or nest there. It is considered the last remaining lake in a chain that once extended across North Africa.

Water quantity and quality at Ichkeul is crucial to ensure a wetland ecosystem suitable for the migratory birds. The site lies at the bottom of a watershed and is separated from the sea via a small waterway leading to a salt lagoon. For this reason, the wetland's salinity is affected by the volume of water flowing into it. In the summer, salinity increases as water inflow decreases. In the winter, the reverse holds true – resulting in a delicate balance which provides suitable habitat quality for migratory birds. However, during prolonged

Ichkeul National Park (Tunisia). © UNESCO/Marc Patry

droughts, and as sea levels rise, more sea water invades the wetland, increasing salinity to the point of having a detrimental impact on habitat quality. Compounding the challenges faced by the management agency, upstream capture and diversion of freshwater is increasingly an issue. The water is used to meet the needs of Tunisia's capital city, Tunis.

In response to these challenges, the Government of Tunisia has, over several years, installed water-flow control structures at the outflow point of the wetland. The structures help to keep out excess salt water during droughts, while letting water out during particularly wet periods. Upstream, management agreements between various user groups have been developed, ensuring a minimum water flow to the park during critical times. Together, these measures have helped Ichkeul National Park to improve its resilience to drought and sea level rise.

Infrastructure works: Keoladeo National Park (India)

Keoladeo National Park is an artificial wetland complex, created in the 18th century when the local maharaja built a water retention wall at the confluence of the Gambhir and Banganga rivers – he wanted to attract more waterfowl to the area for hunting expeditions. This relatively tiny natural World Heritage site (2,873 ha, inscribed 1985) is now one of the major wintering areas for large numbers of aquatic birds from Afghanistan, Turkmenistan, China and Siberia. Some 364 species of bird, including the rare Siberian crane, have been recorded in the park. The park relies on floodwaters originating from monsoon rains to ensure a minimum level of wetland habitat.

Over the years, agricultural production has grown in the lands surrounding Keoladeo National Park, and competition from local farmers for fresh water supplies, particularly in dry years, has increased. In the early 2000s, successive years of poor monsoons and high demand from the agricultural sector led to Keoladeo National Park almost drying up and losing many of the features for which it was inscribed on the World Heritage List. This issue was raised by the World Heritage Committee, which requested that the Government of India take the necessary measures to reverse the situation.

The government embarked on an ambitious infrastructure programme that included an 18 km pipeline, local water retention and management infrastructure and a river diversion scheme.

Combined with an effort to identify and protect other smaller wetlands in the region, which serve as a buffer to Keoladeo, the threat from lack of water in the park has been much reduced – even in years of drought. As climate change is expected to lead to more frequent and more intense years of drought, Keoladeo National Park is now better prepared to deal with the expected climate change stresses in the years ahead.

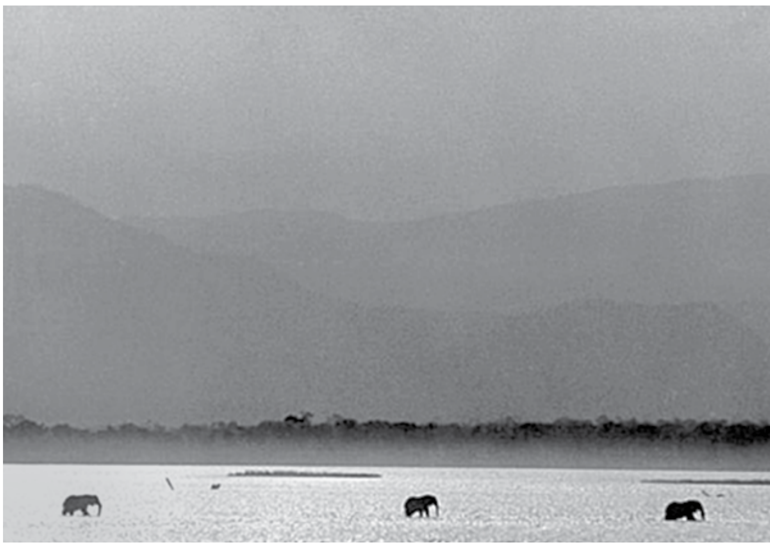
Building better buffer zones: Mana Pools National Park, Sapi and Chewore Safari Areas (Zimbabwe)

Mana Pools National Park, Sapi and Chewore Safari Areas are located in northern Zimbabwe, along the Zambezi River. Inscribed in 1984 for its diverse wildlife, the site is relatively well conserved and not particularly threatened by surrounding communities, although poaching in the past had led to the eradication of the black rhino, recognized as one of its constituent species at the time of inscription.

This site is surrounded by subsistence-level communities, who work the land and gather forest products to make their living. Conditions can be difficult, and food security

Water management infrastructure, Keoladeo National Park (India). © UNESCO / Marc Patry

Mana Pools National Park, Sapi and Chewore Safari Areas (Zimbabwe). © Nomination file



is poor, particularly during the dry season. These conditions compel people to search for alternatives for their livelihoods. These include activities that could eventually conflict with the objective of conserving the Outstanding Universal Value of the neighbouring World Heritage site. Poaching for bushmeat or for the trade in wildlife products, or wood cutting to make and sell charcoal, may become a growing concern if climate change leads to increasingly harsh conditions for local populations.

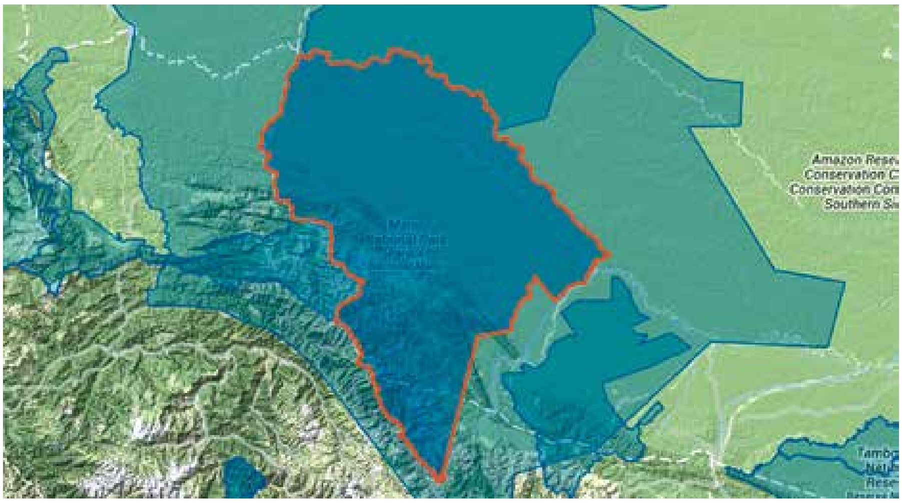
In this respect, a climate change mitigation project in the lands abutting the western boundary of this site may help to avoid a future scenario whereby local communities are compelled to turn to the World Heritage site for subsistence, thus undermining its Outstanding Universal Value. The *Kariba* REDD+ (United Nations Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries) project, certified under recognized international carbon verification standards, is selling carbon credits and funds are being applied to help communities improve agricultural practices, stabilize land use, and restore degraded forests. In so doing, the project will be improving the resilience of the World Heritage site, reducing the risk of incursions from surrounding communities in an age of climate change – when droughts are expected to be more common and severe. The project will also strengthen the connectivity of the site to the broader landscape, further supporting site resilience.

The intimate link between the World Heritage site and the project area was used to raise the interest of potential buyers of carbon credits on the voluntary market. There are more sellers of carbon credits than there are buyers. Under these circumstances, using the connection to nearby World Heritage sites, and demonstrating how a REDD+ project will support World Heritage site adaptation to climate change, may help to attract potential carbon credit buyers.

Designing for resilience: Area de Conservación Guanacaste (Costa Rica) and Manú National Park (Peru)

Perhaps the best approach to ensuring climate change adaptation is to create protected areas that, by their very design, offer greater resilience to any stresses. Some World Heritage sites enjoy a 'built-in' resilience thanks to their overall design from the outset. They are large, and cover wide climatic gradients, connecting lowlands to highlands, dry areas to wet areas. As temperature and moisture gradients shift over the years, the values of these sites should be better able to adapt to such shifts. One additional supporting strategy is having a site embedded into a larger protected landscape.

Guanacaste Conservation Area – providing linkages through altitudinal and moisture gradients (Costa Rica). © Area de Conservación de Guanacaste



The vast 1.7 million ha Manú National Park (Peru) is completely surrounded by other protected areas, further bolstering its resilience to climate change.
IUCN and UNEP-WCMC (2011), The World Database on Protected Areas (WDPA).Cambridge, UK: UNEP-WCMC. Available at: www.protectedplanet.net [Accessed 01/11/2011]

The Area de Conservación Guanacaste in Costa Rica (inscribed 1999, extension 2004) extends from sea level on the Pacific Ocean, over coastal hills and into interior valleys, before rising to the cool mountain tops inland at 1,500 m altitude.

In Peru, Manú National Park (1,716,295 ha, inscribed 1987 with a minor modification in 2004) is a vast stretch of land that encompasses Andean highlands at over 4,000 m, to the Amazon basin. Not only does its large size and altitudinal gradients give its resident species room to adapt to climate variations, it is also surrounded by other protected lands, further buttressing it against climate change risks.

Salonga National Park (Democratic Republic of the Congo).
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