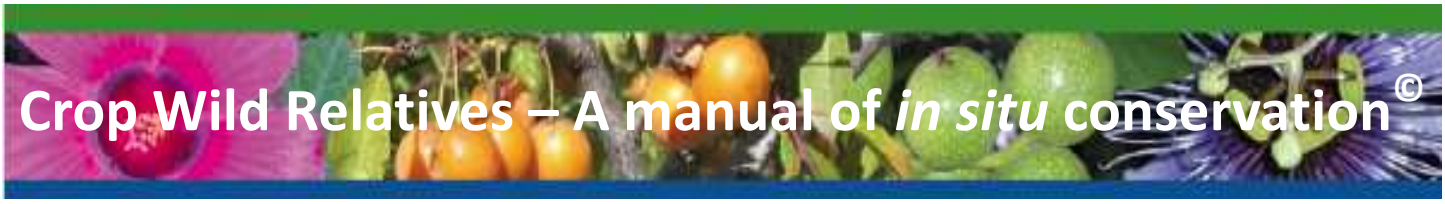

Adapting to global change

THE MESSAGE

Until recently, the conservation of biodiversity has been undertaken based on the assumption that we live in a dynamic but slowly changing world. This must be reconsidered in light of the rapid rate of change to which our planet is being subjected. These changes are collectively referred to as **global change.**

This module focuses on the overarching issues of global change likely to affect the survival of many CWR.

CLIMATE CHANGE AND PROTECTED AREAS

The projected impacts of climate change on protected areas in many parts of the world will force us to rethink their role in biodiversity conservation. **A fixed system of protected areas cannot effectively respond to global change and considerable rethinking in the design of such areas is necessary.** Climate change will also force protected area manages to reassess management objectives, paying attention to the maintenance of ecosystem health and the conservation needs of target species. They will need to be prepared for more frequent and sometimes intensive management interventions[1].

A strategy to mitigate risks associated with climate change should include[2]:

- Improved linkages between protected areas
- Improved protected area management
- Improved protected area design
- Improved management of surrounding matrix
- Improved connectivity to allow species to migrate in the face of climate change.

1 - Hagerman, S.M. and Chan, Kai M.A. (2009) 'Climate change and biodiversity conservation: Impacts, adaptation strategies and future research directions', F1000 Biology Reports 1:16, DOI 10.3410/B1-16.

2 - Ervin, J., Mulongoy, K. J., Lawrence, K., Game, E., Sheppard, D., Bridgewater, P., Bennett, G., Gidda, S.B. and Bos, P. (2010) Making Protected Areas Relevant: A guide to integrating protected areas into widerlandscapes, seascapes and sectoral plans and strategies, CBD Technical Series No. 44, Convention on Biological Diversity, Montreal, Canada.

CLIMATE CHANGE AND BIODIVERSITY CONSERVATION

Current and predicted patterns of climate change are a major cause of concern. However, evidence as the extent to which climate change will impact the environment is still uncertain. While trends revealed by the use of general circulation models (GCMs) are apparent, they are accurate only to a resolution of one to three degrees in latitude and longitude, and details are far from clear at the regional and local scale. The uncertainties make planning adaptation or mitigation strategies difficult.

There is already good evidence of recent phenological change – time of bud burst, flowering, fruiting – attributable to climate change[3]. If such trends continue or increase, the impacts on biodiversity will be significant. Changes in both temperature and precipitation regimes over the coming decades are likely to affect many biological processes, including the distribution of species.

3 - Cleland, E.E., Chuine, I., Menzel, A., Mooney, H.A. and Schwartz, M.D. (2007) 'Shifting plant phenology in response to global change', *Trends in Ecology and Evolution,* vol 22, pp 357–365.

The main components of global change

Population change

- Human population movement/migrations
- Demographic growth
- Changes in population pattern

Changes in land use and disturbance regimes

- Deforestation
- Degradation, simplification or loss of habitats
- Loss of biodiversity

Climate change

Defined by the Intergovernmental Panel on Climate Change (IPPC)

- Temperature change
- Atmospheric change (greenhouse gases)

Other climate-related factors

- Distribution of Nitrogen deposition
- Global dust deposition (including brown dust and yellow dust)
- Ocean acidification
- Air pollution in mega-cities.

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INDIGENOUS PEOPLES AND CLIMATE CHANGE

Indigenous peoples relying on traditional agriculture will be amongst the most severely affected by climate change. Sobrevila[4] notes that indigenous peoples have played a key role in climate change mitigation and adaptation. The territories of indigenous groups have been better conserved than the adjacent lands (i.e., Brazil, Colombia, Nicaragua, etc.).

A climate change agenda fully involving indigenous peoples has many more benefits than if only government and/or the private sector are involved. Indigenous peoples are a source of knowledge to the many solutions needed to avoid or reduce those effects.

4 - Sobrevila, C. (2008) *The Role of Indigenous Peoples in Biodiversity Conservation*: *the natural but often forgotten partners,* The World Bank, Washington D.C.

In response to climate change, plants have three possibilities: *adapt*, *migrate* or *become extinct*.

The likely responses of species to climate change

A great deal of effort has gone into developing tools that will help us predict the impacts of climate change on the future distribution of plants.

Among the questions we need to answer are[5]:

- Which species will be able to track their climate envelopes as they move?
- Which will not be able to migrate and why?
- What will the physical (climate-soil) conditions in these new climate envelopes be?
- What are sources of potential immigrants (both native and non-native)?
- What will the biotic diversity be like?
- Will the novel (emerging) assemblages be able to provide similar values of ecosystem services (including pollinators) as those that they replace?

5 - Heywood, V.H. (2009) 'Botanic gardens and genetic conservation', Sibbaldia guest essay, *Sibbaldia.* The Journal of Botanic Garden Horticulture, no 7, pp 5–17.

Bioclimatic modelling

The tool most frequently used to predict the impacts of climate change is **bioclimatic modelling**. Bioclimatic models combine computer-based models of the current climate with information on the current distribution of species to establish a bioclimatic (also known as edaphic, fundamental, environmental or Grinellian) niche model. This model of optimal environmental parameters is then fitted to a range of future climate scenarios to establish likely shifts in environmental optima for species.

One of the few studies so far published focusing on the impact of climate change on CWR (Jarvis et al. 2008) used current and projected future climate data for ~2055, and a bioclimatic model to predict the impact of climate change on the wild relatives of peanut (*Arachis*), potato (*Solanum*) and cowpea (*Vigna*). They considered three migrational scenarios for modelling the range shifts (unlimited, limited and no migration) and found that climate change strongly affected all taxa, with an estimated 16-22% of these species predicted to go extinct and most species losing over 50% of their range size.

Non-modelling approaches

Other approaches beyond bioclimatic modelling can be used to assess species' vulnerability on the basis of their biological and ecological characteristics and other factors that determine their sensitivity, adaptive capacity and exposure to climate change[6].

6 - Gran Canaria Group (2006) *The Gran Canaria Declaration II on Climate Change and Plant Conservation,* Cabildo de Gran Canaria, Jardín Botánico "Viera yClavijo" and Botanic Gardens Conservation International (BGCI).


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GLOBAL CHANGE, AGRICULTURE AND FOOD

Substantial improvements are needed in current crops to achieve higher yields and sustainable farming; the genetic diversity of CWR is key improved breeding programmes. As the *World Development Report 2010: Development and Climate Change* [8] notes, 'the weedy and wild relatives of today's crops retain higher genetic diversity and may be a useful base for enhancing crops' plasticity, and their adaptability to changing conditions—some weeds, for example, thrive in conditions of higher CO_2 and warmer temperature'.

8 - WDR (2010) Chapter 3 Managing Land and Water to Feed Nine Billion People and Protect Natural Systems

REDD - Reducing Emissions from Deforestation and Forest Degradation

Given that forest clearing and degradation is responsible for about 17% of global greenhouse emissions, according to estimates by the IPCC, efforts to reduce such emissions are essential.

The United Nations Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries (UN-REDD) is a mechanism that creates incentives for developing forested countries to protect and better manage their forest resources[9].

9 - Katerere, Y. (2010) 'A climate change solution?' *World Finance,* May - Jun 2010, pp 104–106.

GLOBAL CHANGE AND FOREST GENETIC RESOURCES

The effects of climate change on forestry species and their CWR are likely to be significant. These effects will include rising temperatures, changes in precipitation patterns, extreme weather events, prolonged droughts leading to more frequent incidence of forest fires and changes in the physiology and reproductive success of tree species [10].

10 - Rimbawanto, A. (2010) *Climate Change and the Potential Risk to Forest Genetic Resources*, Centre for Forest Biotechnology and Tree Improvement (CFBTI). http://www.apafri.org/FGR09%20CD%20final/Presentation%20Pdf/03_Anto%20Rimbawanto.pdf, accessed 3 April 2010.

Identifying taxa vulnerable to climate change[7]

Main criteria:

- Taxa with **nowhere to go**, such as mountain tops, low-lying islands or high latitudes.
- Plants with **restricted ranges** such as rare and endemic species.
- Taxa with **poor dispersal capacity** and/or **long generation times**.
- Species susceptible to **extreme conditions** such as flood or drought.
- Plants with **extreme habitat/niche specialization**.
- Taxa with **co-evolved or synchronous relationships with other species**.
- Species with **inflexible physiological responses** to climate variables.
- **Keystone taxa** important in primary production or ecosystem processes and function.
- Taxa with **direct value for humans** or with potential for future use.

7 - Gran Canaria Group (2006) *The Gran Canaria Declaration II on Climate Change and Plant Conservation,* Cabildo de Gran Canaria, Jardín Botánico "Viera yClavijo" and Botanic Gardens Conservation International (BGCI).

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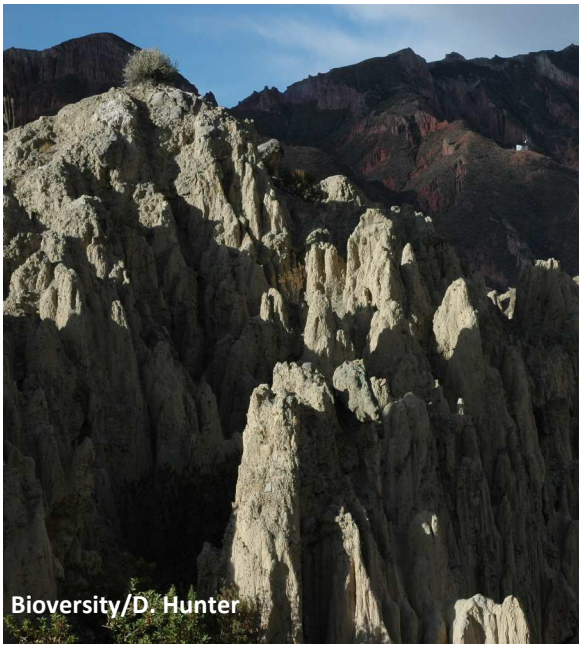
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Strategic responses and new conservation strategies

New approaches may need to be considered to conserve biodiversity in the face of climate change. One such approach is **human-aided translocation of species,** a controversial idea proposed for situations where the rate of change, existence of barriers or lack of continuous suitable habitat is considered likely to prevent natural migration. Also known as **assisted migration**[11] or **assisted colonization**[12], it is a complex and potentially costly venture and needs to be subject to careful cost-benefit analysis and perhaps used only in exceptional circumstances.

11 - McLachlan, J.S., Hellmann J.J., Schwartz M.W. (2007) 'A framework for debate of assisted migration in an era of climate change', *Conservation Biology,* vol 21, 297–302.

12 - Hunter, M.L. (2007) 'Climate change and moving species: furthering the debate on assisted colonization', *Conservation Biology,* vol 21, pp 1356–1358.
(Hunter uses the term *assisted colonization* in contrast to *assisted migration* 'because many animal ecologists reserve the word *migration* for the seasonal, round-trip movements of animals […] and because the real goal of translocation goes beyond assisting dispersal to assuring successful colonization, a step that will often require extended husbandry'.)

Other components of global change

Population change refers to changes in the pattern of distribution of human populations and to demographic growth. Urbanization levels are rising: in 2000, approximately 40% of people living less developed countries were in urban areas; this is anticipated to rise to 54% by 2025. Further, t e number of people migrating due to changes in climate is expected to increase by 200 million by the middle of this century. The effects on biodiversity could be serious as people move into territories which cannot support them without large scale disruption.

Changes in land use and disturbance regimes have increased in line with human demographic growth, as a result of industrialization, agricultural intensification, abandonment of traditional agricultural practices, population movements and other factors. If land use practices change the frequency, size, and intensity of natural disturbances, such as floods, fires and droughts then ecosystem functioning will be affected a different community composition may develop.

Tourism

Tourism is another form of population migration. It is estimated that carbon dioxide emissions from the tourism sector account for 4-6 % of total emissions. Changing climate patterns might alter major tourism flows, leaving coastal and mountain-based destinations in least developed countries and small island developing states vulnerable to direct and indirect impacts of climate change[13].

13 - UNWTO (2008) *Climate Change and Tourism – Responding to Global Challenge,* UN World Tourism Organization and the United Nations Environment Programme, Madrid.

FURTHER INFORMATION

'**Draft findings of the Ad Hoc Technical Expert Group on Biodiversity and Climate Change**', CBD/AHTEG (2009) Convention on Biological Diversity (CBD)
http://www.cbd.int/doc/meetings/cc/ahteg-bdcc-01/other/ahteg-bdcc-01-findings-en.pdf

Strategies for Managing the Effects of Climate Change on Wildlife and Ecosystems, Heinz Center (2008) The H. John Heinz III Centre for Science, Economics and the Environment, Washington D.C.
http://www.heinzctr.org/publications/PDF/Strategies_for_managing_effects_of_climate_change_on_wildlife_Nov_4_2008.pdf