Potential impacts of climate change on the Wet Tropics of Queensland World Heritage Area

Background

This report was prepared on behalf of the Scientific Advisory Committee (SAC) as an action arising from the Conservation Sector Liaison Group (CSLG) report at the Board's August meeting. It was agreed that the SAC be asked to provide the Board with information relating to potential impacts of climate change, and specifically the principal impacts on the WTWHA.

Introduction

SAC recognises climate change as one of the major threats to biodiversity at both the species and ecosystem levels in the WHA. Climate change will lead to severe adverse impacts on habitats and wildlife as well as on ecosystems and the goods and services they provide society. In general, all native species will be more vulnerable, even those able to tolerate climatic changes *per se*, as they will have to deal with a variety of new competitors, predators, diseases and introduced species for which they have no natural defence. Existing ecosystems are predicted to undergo major changes: some may entirely disappear; some totally new or novel ecosystems may appear, while others will experience dramatic changes in species composition and geographic extent.

Climate change today differs from past climatic variability in two important ways that have serious implications on the region's biodiversity. First, the rate of temperature change is considered by scientists to be unprecedented in the past 10,000 years [1] and second, many of the region's ecosystems are already stressed by other human impacts such as land clearing, fragmentation and introduced pests. SAC stresses that good pro-active conservation and land management practices today are the most cost-effective and practical way of dealing with future variations and changes in climate at the regional scale.

Climate change projections for the Wet Tropics WHA

Predicting the magnitude, rate and spatial pattern of climate change is very complex and scenarios for areas as small as the Wet Tropics WHA contain a high degree of inherent uncertainty, nevertheless the most recent models predict:

- Increases in maximum temperatures from the current average maximum temperature of 28.9 ºC of between 0.3 ºC to 5.2 ºC for the period 2030 to 2070 [2].

- Increased frequency of extreme temperature periods (classified as days above 35 ºC) from the current annual average of three days to up to 41 days by 2070 [2].

- Changes in rainfall of -5% to +15% for December to February, and -15% to +5% for March to November by 2030 [3]. This would suggest overall drier conditions for the region.

- A rise in the altitude of the cloud-base above summit and mountainous areas. This rise is predicted to retard the "cloud stripping" ability of north Queensland's highland tropical forests, which derive up to 30% of their total annual precipitation from intercepting the cloud layer [4], thus reducing the input of water with serious impacts on hydrology, ecosystem processes and biodiversity [5].

- Increased frequency and severity of extreme weather conditions such as heat waves, cyclones, floods, droughts and destructive storms [6, 7, 8, 9].

- Increased frequency of El Niño events causing lower rainfall and longer dry seasons [6, 11].

- A rise in sea levels of up to about 90 cm by 2100 [6].

- Increased intensity of oceanic storm surges resulting from a combination of rising sea level and more severe cyclones [12].

Ecological and biological implications of projected climate change

- Both latitudinal and altitudinal shifts in species ranges [13, 14].

- Changes in abundance and local extinctions [15] (refer to predicted direct effects below).

- Changes in the length of plant growing seasons.

- Earlier flowering, emergence of insects and egg laying in birds [16, 17].

- Increased CO_2 levels will reduce the nutritional value and increase the toughness of most foliage. This could have significant detrimental effects on folivore abundance (endemic ringtail possums and many insects for example) [18].

- Predicted changes in geographic distribution will 'push' species off nutrient-rich, basaltic soils and onto increasingly poorer granitic soils at higher elevations. Research has shown that forests on these poorer soils support lower population densities of arboreal folivores [18].

- Raised cloud bases will affect species requiring high and consistent moisture levels [1] (directly affecting microhylid frogs, litter skinks, soil invertebrate faunas, and soil microbes).

- Longer dry seasons will probably affect the timing and sequencing of flowering, fruiting and leaf flush of plants. Changes to these processes will cause many flow on effects throughout food webs.

- Ecosystem disturbance and increased vulnerability to invasion by feral animals, weeds and pathogens [19, 20].

- Changes in fire regimes [20, 11]. Fire controls much of the boundary between rainforest and sclerophyll forests [21]. During the El Niño event of 2002/2003 fires encroached on Wet Tropics World Heritage rainforest types. El Niño increases and associated drought is likely to increase the frequency and severity of unusual fire years and may lead to large changes in the distribution of rainforest and sclerophyll communities.

Predicted direct effects of warming on higher altitude habitats

Many Wet Tropics endemic species live only in the cooler high altitude parts of the region [22]. **Figure 1** models how climate change may affect the spatial extent and pattern of habitats where average temperatures of less than 22ºC occur. This is approximately the temperature threshold for most arboreal folivores in the World Heritage Area [23].

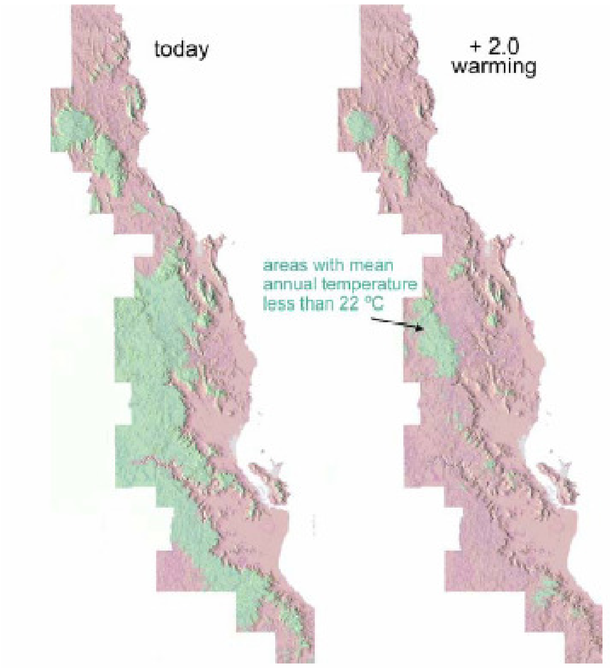

Figure 1. Areas in the Wet Tropics with mean annual temperatures less than 22 °C (green) in today's climate (left) and after 2°C warming [23].

A reduction of almost 50% of highland rainforest habitat environments is predicted when temperature is increased by 1 ºC and rainfall is reduced by 10% (**Figure 2**). The degree of fragmentation is also greatly increased.

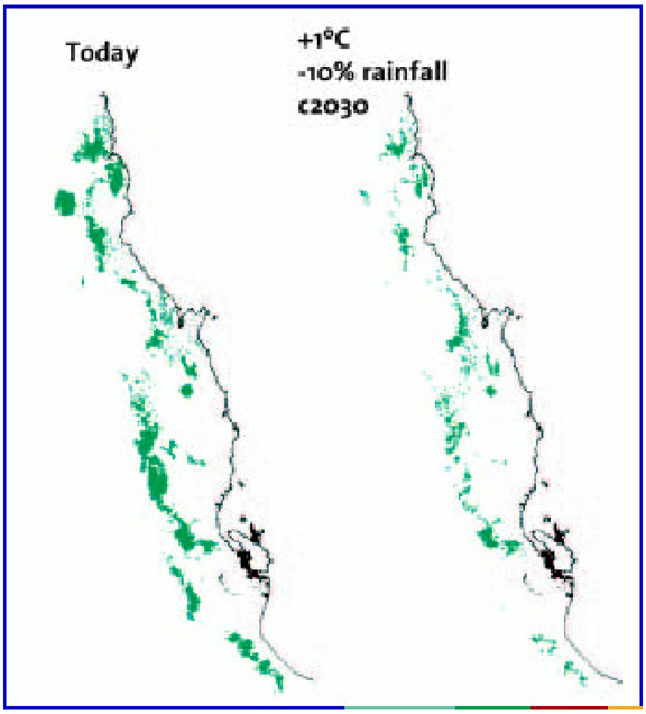

Figure 2: The distribution (green) of upland and highland rainforest types in 2003 climate (left) and their potential distribution after warming and a decrease in rainfall (right) [23].

Predicted direct effects of warming on higher altitude vertebrate fauna

Models by researchers from James Cook University, CSIRO and the Rainforest CRC suggest that global warming will have severe effects on many Wet Tropics endemic vertebrate species. An increase in regional average temperature of 1ºC is shown to produce a decrease of 60% in the distribution of endemic vertebrate species [14]. A midrange prediction, such as the 3.5 ºC figure put forward by the Intergovernmental Panel on Climate Change is shown to further reduce the distribution of endemic vertebrates to approximately 5% of their current range. Projected warming of this magnitude also simulated a loss of approximately 65% of endemic vertebrates currently in the region. This would imply a strong likelihood of approximately 50 species becoming extinct in the Wet Tropics WHA with only a moderate prediction of climate change. Most upland species will disappear under the worst-case scenarios with temperature increases of 5^{o}C or more [14].

Predicted effects could conceivably be greater if climate variables other than temperature were considered. Increased CO_2 concentrations may reduce the nutritional value and increase the lignin component of foliage. This could have significant detrimental effects on folivore abundance. In addition, changes in geographic distribution may push species off nutrient-rich basaltic soils and on to increasingly poorer granitic soils at higher elevations. Forests on these poorer soils generally support lower population densities of arboreal folivores.

Table 1 lists those Wet Tropics endemic vertebrate species predicted to lose greater than 50% of their current area of core environment with only a 1^{o}C increase in temperature. **Figure 3** illustrates the sequential decline in distribution of species richness of Wet Tropics endemic terrestrial vertebrates as the climate gets progressively warmer.

Table 1. List of Wet Tropics endemic vertebrate fauna predicted to be most vulnerable to climate change [14].

Frogs	
Thornton Peak nursery-frog	*Cophixalus* sp. Thornton Peak
Magnificent broodfrog	*Pseudophryne covacevichae*
Pipping nursery-frog	*Cophixalus hosmeri*
Northern barred frog	*Mixophyes* sp. Nov.
Tangerine nursery-frog	*Cophixalus neglectus*
Bloomfield nursery-frog	*Cophixalus exiguus*
Mountain top nursery-frog	*Cophixalus rheophilus*
Northern tinkerfrog	*Taudactylus rheophilus*
Mammals	
Atherton antechinus	*Antechinus godmani*
Mahogany glider	*Petaurus gracilis*
Daintree River ringtail possum	*Pseudochirulus cinereus*
Lemuroid ringtail possum	*Hemibelideus lemuroids*
Herbert River ringtail possum	*Pseudochirulus herbertensis*
Spotted-tail quoll	*Dasyurus maculatus*
Birds	
Golden bowerbird	*Prionodura newtoniana*
Atherton scrubwren	*Sericornis keri*
Mountain thornbill	*Acanthiza katherina*
Skinks	
Thornton Peak skink	*Calyptotis thorntonensis*
Bartle Frere skink	*Techmarscincus jigurru*
Czechura's litter skink	*Saproscincus czechurai*
skink (no common name)	*Saproscincus lewisi*
skink (no common name)	*Lampropholis robertsi*
skink (no common name)	*Eulamprus frerei*
skink (no common name)	*Glaphyromorphus mjobergi*

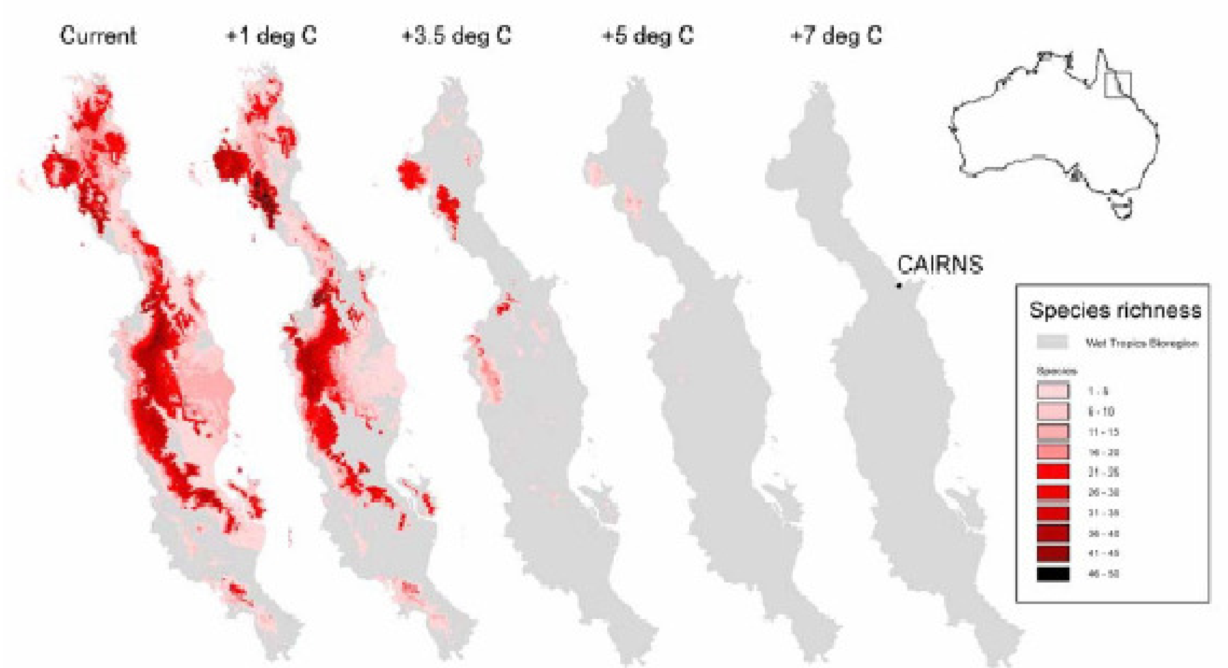

Figure 3. Indicates the decline in distribution of species richness of regionally endemic terrestrial vertebrates with increasing temperature [14].

Risk assessment & preparedness

The development of appropriate adaptation responses to climate change in the Wet Tropics WHA requires a clearer understanding of the primary and secondary impacts of climate change including:

- what species, ecological communities or broad habitat types might be most at risk
- where the threats might be greatest
- the long-term effects of these threats
- how climate change might interact with other threats such as clearing, fragmentation, fire, weeds and feral animals
- how climate change might interact with the broad range of urbanisation impacts and how these can be considered in regional development planning
- whether or where some areas may provide continued habitat or new areas of habitat in the future (ie. climate change 'refugia').

In a report by the Rainforest CRC [1] the following set of actions was identified:

- An assessment of the effectiveness of the current protected areas estate and its likely response to climate change should be undertaken. This should be followed by a strategic land acquisition program to increase the comprehensiveness and resilience of the estate to the impacts of climate change.
- There should be increased emphasis on off-reserve conservation to improve connectivity of reserves, allow movement of species and communities across the landscape in response to altered climates, and maximise the resilience of the whole landscape to altered climates.
- The biodiversity values of regrowth vegetation should be recognised. The protection of regrowth vegetation should be considered in areas that are important for maintenance of connectivity of natural vegetation in the landscape, in the light of planning for climate change.

- Decisions on land, water and biodiversity allocation and use should become more precautionary. Consideration of climate change should be incorporated in all levels of community-based natural resource management and environmental planning.
- Recovery planning for endangered species should include consideration of the effects of predicted climate change. In particular, the relative importance and likely effectiveness of both *in situ* and *ex situ* approaches need to be considered. The establishment of a DNA/germ plasm/seed bank is recommended for the 'most-at-risk' species.
- There should be a review of the distribution and impacts of weeds, feral animals and diseases/pathogens in the light of climate change predictions.
- Fire management strategies and plans should be revised to take account of the predicted future changes to climate and biodiversity.
- A Climate Change Commission managed by an independent group of commissioners with expertise in greenhouse science and policy, sustainability, resource and biodiversity management, resource economics, and public administration should be established to oversee and facilitate the changes required to minimise the effects of climate change on biodiversity in Queensland.
- Government investment in subsidies should be reviewed to identify any that exacerbate the impact of climate change. Reduction or removal of subsidies identified in this way could be considered to generate funds to pay for the measures outlined in this report.
- Water management should be revised in the light of predicted increases in variability and decreases in total river flow, to ensure that environmental flows are maintained in waterways and wetlands.
- A public education campaign to inform and educate the public about the nature and consequences of climate change on biodiversity and effects on landscape function and ecosystem services is essential.
- A strategic on-ground biodiversity monitoring system should be established to assess the progress of impacts of climate change across the landscape as well as responses to management interventions.
- It is crucial that management of the impacts of climate change on biodiversity be informed by an on-going, comprehensive and strategically prioritised program of research.

The key problems/obstacles impeding implementation of proposed actions relate principally to gaps in our knowledge. Many of the gaps represent significant barriers to the development of appropriate adaptation measures in the Wet Tropics region, and limit the objective comparison of the costs and benefits of unmitigated climate change with the costs and benefits of planned adaptation.

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