CLIMATE CHANGE IN AUSTRALIA

IMPACTS & ADAPTATION INFORMATION FOR AUSTRALIA'S NRM REGIONS

CLIMATE CHANGE ISSUES AND IMPACTS IN THE WET TROPICS NRM CLUSTER REGION



Left: Mackay Harbour. Photo: Reef Catchments NRM; Centre: Green turtle (*Chelonia mydas*) on Great Barrier Reef. Photo: Matt Curnock; Right: White lemuroid possum (*Hemibelideus lemuroides*). Photo: Mike Trenerry.

Key messages extracted from the Synthesis of Climate Change Issues and Impacts in the Wet Tropics NRM Cluster region

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INTRODUCTION

This "Key messages" document accompanies the Hilbert *et al.* (2014) report *Synthesis of climate change issues and impacts in the Wet Tropics Cluster NRM region* (hereafter 'Science Synthesis report'). The Science Synthesis report was drafted in response to specific information needs articulated by the Regional Natural Resource Management (NRM) groups in the Wet Tropics Cluster region[1]. The Science synthesis report is framed by the topics and issues defined by the NRM groups, reflecting their planning processes and priorities as well as the characteristics of their regional communities. The report is based on the synthesis of current knowledge and expert opinion relevant to the topics and issues identified by NRM groups. This document presents the Topics and Key messages extracted from each chapter of the Science Synthesis report.


Left: Tropical Acacia Seed Collection. Photo: J.Morse; Right: Tropical vegetation in coastal rainforest near Townsville, far northern Queensland. Photo: John Coppi.

1 The Wet Tropics Cluster region includes the Torres Strait, Cape York Peninsula, Wet Tropics and Mackay-Whitsunday NRM regions; refer Hilbert *et al*. 2014 for detail.

CLIMATE CHANGE PROJECTIONS FOR THE WET TROPICS CLUSTER

Terra satellite image of tropical cyclone Ingrid in the Coral Sea. Photo: NASA.

Air and sea surface temperatures and heat waves

1. Average air temperatures are projected to increase in the future.
2. More hot days and fewer cold days will occur in the future.
3. Average sea surface temperatures are projected to increase throughout the year.

Changes in annual and seasonal rainfall

4. Projections of annual rainfall do not show a consistent tendency towards an increase or decrease; however, there is a large spread in model simulations with a tendency towards a decrease.
5. Wet season rainfall does not show a consistent tendency towards an increase or decrease; however, there is a large spread in model simulations.
6. Dry season rainfall, particularly during the monsoon retreat season (autumn), is more likely to decrease; however, there is a large spread in model simulations.
7. It is expected that the high natural rainfall variability will continue in future and may mask any trend in average rainfall for some decades to come, particularly in the wet season.

Extreme weather events

8. Extreme rainfall intensity will increase in the future.
9. The intensity of tropical cyclones is likely to increase in the future, while overall cyclone frequency may decrease.

Changes in sea level

10. Sea levels should continue to rise and may vary at the sub-regional level.
11. Frequency and height of storm surges are expected to increase.

Other aspects of climate

12. Solar radiation is expected to decrease in winter (dry season) and spring (wet season build up), and increase in autumn (monsoon retreat season) under the highest representative concentration pathways (RCP) emission scenario; however, there is a large spread of model simulations.
13. Small decreases in relative humidity are favoured over increases during summer and autumn periods, with little change in winter and increases more likely in spring, especially under the highest RCP scenario.
14. Evapotranspiration is projected to increase in all seasons.
15. Wind speeds are expected to increase across eastern Australia.
16. Acidification of the oceans adjacent to the cluster region is projected to increase in line with changes in atmospheric CO_2.
17. Fire weather conditions are expected to worsen.

Damaged cassowary habitat in Far North Queensland caused by Cyclone Larry. Photo: CSIRO Sustainable Ecosystems.

POTENTIAL CHANGES IN BIODIVERSITY

Darwin stringybark (*Eucalyptus tetradonta*) Forest. Photo: Alex Thomas.

Vegetation communities and ecosystems

1. Novel environments will occur that are outside the range now existing in the region and this may lead to new vegetation structures and communities.
2. Longer dry seasons and higher temperatures could cause a general opening up of vegetation.
3. Fire regimes will probably change, impacting vegetation in complex ways.

Freshwater and tidal wetlands

4. Freshwater wetlands will decrease in extent and become more isolated.
5. The expected outcome of rising temperatures will be the expansion of mangrove species into higher latitudes.
6. The expected outcome of rising sea levels will be mangrove dieback at lower intertidal elevations, with expansion of mangrove assemblage zones into higher elevations and upstream in estuaries.
7. The expected outcome of increasing rainfall will be greater biodiversity, biomass and abundance of mangrove plants in tidal wetland estuaries upstream and across the tidal profile. The expected outcome with decreasing rainfall will be reduced biodiversity, biomass and abundance of mangrove plants in tidal wetland estuaries upstream and across the tidal profile.
8. More severe storms and storm surges will result in significant losses in biodiversity, biomass and abundance of mangroves, with the real prospect of ecosystem collapse and loss of ecosystem functionality.
9. Increasing ocean acidity will impact key mangrove–fauna relationships.
10. Increases in sea level, temperature, heavy rainfall events and the intensity of tropical storms will have mostly negative impacts on seagrass meadows.

Fringing reefs

11. Increased intensity of extreme events associated with climate change, such as increasing mean temperatures, frequencies of heat periods, ocean acidification, intensifying storms and rainfall variability, will decrease coral cover.
12. Increased rainfall variability associated with global warming is likely to affect runoff and pollutant transport into the Great Barrier Reef lagoon.

Abundance and distribution of key species

13. Climate change is likely to impact on ecosystem processes such as dispersal, pollination and migration.
14. Climate change will lead to shifts to the locations of suitable climate space for many species.
15. Endemic species are likely to have higher vulnerability to climate change due to high habitat specificity.
16. Species vulnerability to climate change is likely to be determined by their ability to disperse to new areas of suitable climate.

Aerial view of the reef. Photo: Reef Catchments NRM.

Cassowaries

17. Climate change will reduce the distribution and size of cassowary populations due to reduction in the extent and quality of their habitat.
18. Higher temperatures will reduce the capacity of cassowaries to utilise open vegetation types.
19. Cassowary populations will be reduced by the impact of more frequent extreme events on the quality and extent of their habitat.
20. Invasive plants have the potential to reduce quality of cassowary habitat and cassowary population sizes.

Cassowary (*Casuarius casuarius*), Mission Beach, Queensland. Photo: John Manger.

Freshwater biodiversity

21. Climate change poses a high risk to the freshwater biodiversity of Cape York and the Wet Tropics Bioregion.
22. Freshwater species with poor dispersal capacity and high specificity for habitat requirements are likely to have higher vulnerability to climate change.

Marine turtles and dugongs

23. Projected increases in sand temperature are likely to influence the reproductive output of marine turtles.
24. Sea level rise may impact marine turtle nesting grounds.
25. Extreme weather events can impact dugongs.
26. Warmer ocean temperature may expand the distribution of dugongs southward.

Invasive species

27. The suitable climatic space for most invasive species will shift towards the south and contract towards the east coast. However, the Wet Tropics cluster region will remain suitable for most tropical invasive plant species.
28. Cape York will have an increased biosecurity risk from countries to the north.
29. Climate change will create new opportunities for invasive species to recruit, spread and increase in abundance.
30. Increases in growth and recruitment of invasive weeds are likely to follow severe cyclones.
31. Dispersal opportunities for invasive species are likely to increase due to extreme rainfall events.
32. The degradation of coastal habitats by invasive species is likely to increase the impact of extreme events on human communities and infrastructure.
33. Spread of high biomass invasive grasses may transform savanna ecosystems into ones dominated by exotic grass.
34. Seasonally inundated waterholes in the dry tropics are likely to be increasingly impacted by invasive animals.

Infectious diseases

35. The abundance and diversity of mosquitoes will increase at higher elevations and latitudes, and during winter periods, increasing both the range and timing of disease risk.

Infection pathways

36. The spatial and temporal concentration of hosts, vectors and victims will be influenced by changes in water availability and distribution. When water is scarce disease risk will increase around water points where pigs, mosquitoes, other wildlife and people may concentrate.
37. Disease risk may increase with changing lifestyles and home design associated with changing climate. Open tropical homes with integrated gardens may increase human exposure to biting insects, increasing disease risk.

i. Hendra

38. Disease risk from Hendra virus is unlikely to change in response to climate change–driven changes in vegetation distribution.

ii. Dengue

39. Increased temperatures and longer dry seasons may reduce Hendra spillover risk.
40. Extreme rainfall events and higher temperatures will increase mosquito populations and accelerate population dynamics, increasing the risk of dengue outbreaks.

iii. Japanese encephalitis

41. Climate change may move dengue to higher elevations and southern latitudes.
42. Wild pigs may become hosts to Japanese encephalitis (JE), which was recorded in Torres Strait but is not known to occur in the Australian mainland at present.

Biodiversity and disease

43. Climate change–driven changes in community structure may influence disease prevalence in wildlife and disease risk for humans.

THE IMPACTS OF CLIMATE CHANGE ON KEY REGIONAL ECOSYSTEM SERVICES

Flood water runoff from a canefield in the Herbert River catchment, northern Queensland. Photo: CSIRO.

Applying an ecosystem services framework relevant for regional NRMs

1. Since the Millennium Ecosystem Assessment framework was developed, there have been various modified versions as well as some new ecosystem services frameworks developed.
2. An ecosystem services framework for NRMs (based on established science) is required to describe the linkages between ecosystems, ecosystem functions, ecosystem services and the community's wellbeing (such as the SEQ Catchments ES framework).

Adding value to regional NRM ecosystem services

3. Ecosystems contribute to the wellbeing of people in a multitude of ways. Most of these 'contributions' are not captured in the marketplace and are thus unpriced. But absence of price does not mean absence of value.
4. There are many different economic valuation techniques that seek to highlight the importance of those non-priced values – often by attaching a 'price' to nature.
5. These techniques are exceedingly complex and not well-understood by non-economists. One size does not fit all. So extreme care must be taken when using and interpreting results from those studies.

Impacts of climate change on ecosystem services

6. Climate change is projected to have a significant adverse impact on Australia's agricultural products and exports.
7. Adopting a diversified approach will enable farmers to farm longer and more sustainably in an environment of greater uncertainty, in the face of climate change.
8. Classifying ES according to their spatial characteristics might assist NRM regions' assessments and planning at the appropriate scale.
9. Future food, fodder and fibre production and ecosystem services will be under additional risk and uncertainty from climate change.
10. Increased attacks of pests and diseases related to changes in the abundance and distribution of insects, many of which are vectors for disease.
11. Increased exposure of soils leads to further soil degradation and erosion that reduces water infiltration and soil moisture content.
12. Climate change will drastically impact the critical habitat provision for biodiversity.
13. Economic significance of the emerging carbon economy, if all the potential opportunities are realised, could also generate environmental livelihood benefits.
14. Ecosystem degradation threatens water availability, quality and regulation.
15. There is a need to address the underestimation of ecosystem services in farmlands.
16. Establishing mechanisms such as Payments for Ecosystem Services (PES) can support the transition to more sustainable farming systems.
17. Growing human pressures, including climate change, are having profound and diverse consequences for coastal/marine ecosystems and ES.

Impacts of climate change to coasts and communities

18. Recognition of the carbon sequestration value of vegetated coastal ecosystems provides a strong argument for their protection and restoration.
19. Seagrass ecosystems have been recognised as a significant carbon stock.
20. Communities will need to have strategies in place for extreme events.

THE IMPACTS OF CLIMATE CHANGE ON INFRASTRUCTURE

Residents of Saibai Island on a community seawall, Torres Strait. Photo: Torres Strait Regional Authority.

Sea level rise

1. The most immediate threats are to islands.
2. There will be more frequent and extensive inundation of existing and planned infrastructure in coastal areas.
3. There will be saltwater contamination of water supply for domestic, agricultural and industrial uses in coastal areas.
4. Inundation by seawater will likely lead to more rapid deterioration of coastal infrastructure.
5. Sea level rise may raise water tables and lead to increased freshwater flooding of coastal infrastructure.
6. Sea level rise will lead to increased coastal erosion.

Mackay Harbour. Photo: Reef Catchments NRM.

More extreme weather events

7. Infrastructure will be damaged more often by increases in the magnitude, extent and duration of river and flash flooding, landslips, erosion and transport of sediment and debris.

Increased number of 'hottest' days and heat waves

8. There will be increased interruption to industry operations, especially power transmission.

More intense tropical cyclones

9. There will be increased damage to and destruction of infrastructure from strong winds, storm surges and heavy rainfall associated with more intense tropical cyclones.

Changes in rainfall patterns

10. There will be more uncertainty around water availability.

Changed fire regimes

11. More intense and frequent bush fires will damage and destroy infrastructure, including in areas not currently subject to bushfire threat.

Population shifts in response to climate change

12. Higher temperatures, sea level rise and more intense extreme events will substantially reduce liveability, particularly in low-lying islands and coastal locations, in remote regions and parts of Cape York.

View over beach, Port Douglas, Queensland. Photo: Fiona Henderson.

POTENTIAL IMPACTS OF CLIMATE CHANGE ON INDUSTRIES

Ross River Marina, fishing boat harbour. Townsville, Queensland. Photo: Willem van Aken.

Vulnerability of dominant industry sectors in NRM cluster

1. The private sector in this region is heavily dependent upon just a small handful of industries (agriculture, fishing, mining, tourism, and to a lesser extent, forestry) for income, employment and livelihoods.
2. These industries are reliant upon the natural environment, and thus are vulnerable to the potential impacts of climate change.
3. This is particularly so in remote areas; the regional centres have generally more diversified economies and may be in a somewhat less vulnerable position (except from damage to built infrastructures through extreme weather events or sea level rise).
4. Possible increases in geopolitical instability mean that export-oriented businesses (agriculture, mining and tourism) are likely to see greater fluctuations in revenue streams, irrespective of local climate impacts.
5. To the extent that climate change causes more extreme weather events, it will contribute to variability in business profitability across time and across space. Some businesses will see increases in costs and marked reductions in production (for example, from asset damage); others may see higher prices and/or more demand for their services (e.g. road repair, health professionals).

Tourism

6. Extreme events, particularly those that damage important areas of the Great Barrier Reef or rainforest, may generate severe and long-lasting reductions in visitation.
7. The media's portrayal of extreme weather events will negatively influence visitor perceptions and may exacerbate the negative economic consequences on the tourism industry.
8. Gradual changes to the natural environment may not have discernible impacts on visitation, but tour operator costs may increase if they need to travel further to find undamaged sites.
9. There is likely to be change in seasonal visitation patterns with more tourists in the dry season (winter) and fewer in summer when there is higher rainfall and temperatures, and an increased risk of extreme weather events.
10. Perceptions (real or imagined) of increased human health risks from climate-related diseases such as dengue, malaria or heat stress could affect visitation.

Grazing

11. Most graziers can expect to have to deal with new (and possibly more) pests, weeds and diseases.
12. Higher temperatures, more CO_2 and less rainfall mean that pastures may grow more quickly, but they could be less nutritious.
13. Climate change may increase the frequency and intensity of extreme fire days, but this will not necessarily translate into higher fire risk – that will also be influenced by rainfall and ground cover.
14. Higher temperatures, higher evaporation rates and reduced rainfall (if it occurs) will reduce surface water.
15. Droughts adversely affect pasture growth and availability, raising costs and reducing margins in the short term.
16. More frequent and more severe droughts will exacerbate existing problems and contribute to land degradation, lowering productivity in the long term.

Cattle in pasture near Tully, Queensland. Photo: Willem van Aken.

17. Associated losses of land cover will make the land more susceptible to erosion, impacting downstream users and ecosystems.
18. The cost of fuel and insurance is likely to increase and the future of government assistance to cope with exceptional circumstances is uncertain.

Cropping, horticulture and forestry

19. The cropping, horticultural and forestry industries are particularly vulnerable to extreme events.
20. The combined effect of increased temperatures, higher evaporation rates, possibly lower rainfall and higher concentrations of CO_2 on crop productivity is uncertain.
21. Rising sea levels may impact underground water resources in low-lying areas.

Fishing

22. Higher sea temperatures and ocean acidification may affect the biological process of fish reproduction, growth and behaviour.
23. Extreme weather events may damage important coastal ecosystems that support fisheries.
24. Sea level rise will fundamentally alter coastlines, as the inter-tidal zone moves inland. If mangroves, salt marshes and seagrass beds are unable to colonise these new areas, the impacts on fisheries could be substantial and permanent.

Pivot irrigator over sugarcane in the Pioneer Valley. Photo: Reef Catchments NRM

Mining

25. Loss of seagrass habitats could also further endanger dugong and sea turtle, key species in the non-commercial but culturally crucial traditional fisheries.
26. The mining industry is most vulnerable to extreme events (particularly cyclones and flooding), but generally copes well with such disasters.
27. The industry provides a potentially valuable resource to help others in recovery efforts.

Emerging opportunities: Payments from carbon abatement projects

28. The science, economics and policy of the carbon price are changing rapidly.
29. Current arrangements in Australia are highly dependent on government policy.
30. Abatement opportunities exist through vegetation management.
31. Land prices, lost opportunity cost, establishment cost and discount rate hamper profitability.
32. Threats to carbon sequestration in the area include disturbances from fires, cyclones, wild pigs or termites.
33. Abatement opportunities exist in reducing emissions from savanna burning.
34. The main method is shifting of burning from the late dry season (approximately October–November) towards the early dry season (March–April).
35. One savanna burning project has been established so far in the cluster region.
36. Abatement opportunities exist through reduction of methane emissions from livestock.
37. Methods include change in diet for domestic animals and humane management of feral animals.
38. Abatement opportunities also exist through landfill waste management and diversion of some materials from landfills.
39. Composting waste, such as technology implemented by the Cairns Advanced Resource Recovery Technology Facilities project, also reduces emissions.
40. Future opportunities may exist through improved fertiliser management for industries such as sugar; however, likely economic return from such methods is estimated to be low.

SOCIAL IMPACTS IN THE PRIMARY INDUSTRIES OF THE WET TROPICS CLUSTER

Farmers in the Burdekin, Queensland. Photos: Nadine Marshall.

Psychological impacts

1. Psychological impacts are likely to be severe, especially when producers can no longer remain viable within their industry.

Health risks

2. Future physical health risks to people living in the wet tropic clusters may include those associated with heat exhaustion and dehydration during heatwaves; and there may be increased cases of some vector-borne diseases.

Family impacts

3. Family impacts are likely to be associated with climate changes that decrease the viability of the land, making primary production a less enticing venture for younger family members and women.

Unemployment

4. Unemployment and employment transience within rural sectors may result from climate changes that threaten the viability of primary industries and producers.

Rural communities

5. Persistence of rural communities despite limited viability.

Shifts in enterprise type

6. A tendency towards larger, corporate-style production enterprises rather than lifestyle-based enterprises, affecting the cultural basis of rural regions.
7. Economic impacts are likely to be severe but could bring opportunities.

Recovery from extreme events

8. Impacts of floods, extensive bushfires, droughts and cyclones are experienced by primary producers for months or even years after the events.

Going fishing! Holidaymakers launching boats from Mission Beach, near Dunk Island. Queensland. Photo: Willem van Aken.

INDIGENOUS PEOPLES: CLIMATE CHANGE IMPACTS AND ISSUES

Lama Lama Ranger, Peter Liddy, burning country at the junction of the Annie and North Kennedy Rivers. Copyright: Cape York NRM and Lama Lama Rangers. Reproduced with permission from Peter Liddy and Lama Lama Traditional Owners.

Indigenous knowledge and climate change

1. Australian Indigenous peoples' culture, history and geography underpin simultaneous high resilience and high vulnerability to climate change impacts.
2. Supporting Indigenous peoples to document and share their Indigenous knowledge is a necessary first step to the bigger challenge of engaging with Indigenous processes of knowing about environmental change.
3. Indigenous-led innovations in multimedia platforms for environmental and cultural knowledge systems offer good prospects for documenting climate change impacts.
4. Indigenous peoples' management and observations of their environment accumulated over time can contribute to overall understanding of climate change.
5. Local environments have recently become less predictable and readable for some groups, impacting their livelihood.
6. Indigenous groups frame and perceive climate change based on their unique world view and socio-economic context while also engaging with western science and societies.

Indigenous communities and climate change

7. Liveability in Indigenous communities is likely to worsen. The existing poor state of infrastructure in Indigenous communities such as housing, water, energy, sewerage, and roads is likely to further deteriorate. Attracting educators, health workers and other skilled people to work in Indigenous communities is likely to become harder.
8. Indigenous health and wellbeing is likely to be adversely affected by climate change. Chronic health disabilities, including asthma, cardiovascular illness and infections, are likely to be exacerbated by climate conditions (particularly through heat stress); extended distributions and prevalence of several vector-, water-, food- and air-borne diseases; and by declining access to health services.
9. Indigenous engagement in natural resource management for climate adaptation, mitigation and other outcomes is likely to improve health and wellbeing.
10. Indigenous peoples in remote (and some regional) contexts face a double disadvantage burden of high prices and low incomes that is likely to be exacerbated as climate extremes pressure transport infrastructure, costs and availability of bush foods and resources.
11. Climate change intersects with and is likely to exacerbate significant social-economic-institutional barriers to sustainable development in remote/regional Indigenous economies.
12. Climate change potentially offers new economic opportunities for Indigenous communities, for example in energy production, carbon sequestration and GHG abatement, co-benefits and aquaculture.

Cultural practices and climate change

13. Indigenous peoples' cultural practices, including customary harvesting, rely on access to a range of resources that are likely to be impacted negatively by climate-induced changes, including cyclones, storm surge, sea level rise, changed water availability, changes to vegetation patterns and reduction in species availability.
14. Indigenous peoples' fire management practices are likely to be negatively impacted by climate change, for example through damage from frequent bush fires and phase shifts in vegetation patterns.
15. Indigenous peoples need to have access to land and sea country to maintain cultural practices and associated Indigenous knowledge, and have the opportunities to respond to climate variability and change.

ADAPTATION SCIENCE RELEVANT TO NATURAL RESOURCE MANAGEMENT PRACTICE

Participants in a participatory planning workshop run by Reef Catchments NRM in Mackay, Queensland. Photo: Matt Curnock.

Preparing for and adapting to change

1. While the future will always be uncertain, the need for adaptation from local to regional scales is vital.
2. Understanding the likely interactions between proposed adaptation options is critical to assess their strengths and weaknesses, prevent undesirable outcomes and to inform development of integrative policies.
3. Societies are increasingly vulnerable to the impacts of climate change, due to reasons other than climate change.
4. Effective adaptation to climate change requires sufficient adaptive capacity across scales.

Adaptation approaches

5. Adaptation approaches need cross-sectoral strategies that fit into a broader framework of regional sustainable development and address the entire cascade of climate change impacts to avoid unintended negative side effects.
6. Adaptation to climate change is highly context-specific as it depends on the specific environmental, social, economic, cultural and political conditions in the target region or sector.

Adaptation planning

7. Adaptation planning requires close collaboration of scientists, practitioners, managers, decision-makers, policy analysts and the people likely to experience climate change impacts.
8. Participatory scenario planning is a method and process allowing identification, deliberation and agreement on 'no regrets' or 'low regrets' strategies and programs.

Left: Saibai Island, Torres Strait. Photo: Torres Strait Regional Authority; Right: Flood water runoff from a canefield in the Herbert River catchment, northern Queensland. Photo: CSIRO Sustainable Ecosystems.

This Activity received funding from the Australian Government.

High tide inundation of graves on Saibai, Torres Strait. Photo: Torres Strait Regional Authority.

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