

National Climate Change Adaptation Framework

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THE FRAMEWORK FOR ADAPTATION

Australia's climate is changing. Some impacts are already observable and there is broad scientific consensus that further change will occur. Even if the world makes a significant reduction in greenhouse gas emissions, the lag in the climate system means that we are faced with decades of climate change due to the emissions already put into the atmosphere. Adaptation is therefore a necessary complement to measures to reduce greenhouse gas emissions.

Adaptation is the principal way to deal with the unavoidable impacts of climate change. It is a mechanism to manage risks, adjust economic activity to reduce vulnerability and to improve business certainty.

Australia is vulnerable to the impacts of climate change. Projected changes in rainfall and sea level rise and more extreme weather may also bring risks to the security of our water resources, agricultural systems and settlements, and to the health of our people; risks which could be severe in parts of Australia. The current drought and its associated impacts on water supply have already galvanized public opinion for building resilience to climate change. Temperature increases of 2-3°C could have irreversible effects on some natural ecosystems such as coral reefs, alpine areas and low-lying freshwater wetlands.

The Council of Australian Governments requested the development of a National Adaptation Framework in February 2006 as part of its *Plan of Collaborative Action on Climate Change*. This Framework outlines the future agenda of collaboration between governments to address key demands from business and the community for targeted information on climate change impacts, and to fill critical knowledge gaps which currently inhibit effective adaptation. A key focus of the Framework is to support decision-makers understand and incorporate climate change into policy and operational decisions at all scales and across all vulnerable sectors.

This Framework will guide action by jurisdictions over the next five to seven years to (summary of actions provided at Annex 1):

- support decision-makers with practical guides and tools to assist in managing climate change impacts;
- establish a new centre for climate change adaptation to provide decision-makers with robust and relevant information on climate change impacts, vulnerability and adaptation options;
- provide, for the first time, climate change projections and regional scenarios at scales relevant to decision-makers;
- generate the knowledge to understand and manage climate change risks to water resources, biodiversity, coasts, agriculture, fisheries, forestry, human health, tourism, settlements and infrastructure;
- work with stakeholders in key sectors to commence developing practical strategies to manage the risks of climate change impacts; and
- assess the implications of climate change and possible adaptations for important regions such as the Murray-Darling Basin, south-west Western Australia, the tropical north, and the drying regions of eastern Australia.

All governments recognise that adaptation is a long-term agenda and that it will take time to quantify risks of climate change impacts and to build capacity to minimise costs and to take advantage of any benefits.

Goal

The long term goal of this Framework is to position Australia to reduce the risks of climate change impacts and realise any opportunities.

In the medium term (5-7 years), targeted strategies in this Framework will build our capacity to deal with climate change impacts and reduce vulnerability in key sectors and regions.

Government leadership

Leadership by governments on adaptation is essential, particularly at this early stage in understanding and preparing for the impacts of climate change. National, state and territory and local government have differing and complementary roles in climate change adaptation which include:

- developing, implementing and reviewing policies and strategies, including regulation, standards and economic instruments. This includes integrating climate change considerations into existing policies and strategies;
- establishing and maintaining community and essential services to deal with the impacts of climate change, including emergency management and health services;
- building adaptive capacity, including providing tools and information, raising awareness of adaptation options, educating key professionals about adaptation and investing in climate change science as well as related social, ecological and economic studies; and
- managing risks from climate change to their own programmes, activities and assets, including natural ecosystems for which governments have management responsibility (eg crown land, state forest, national parks) and infrastructure (eg transport, electricity and water).

The Framework also recognises that risks should be managed by those best equipped to understand the context and likely consequences of action, and there is a clear need to build capacity at local and regional scales. There is an important role for business and the community in addressing climate change risks, and governments will pursue a partnership approach to adaptation to manage risks and identify any opportunities.

Implementation

Governance

Adaptation cuts across sectors and disciplines and there are significant benefits from national coordination and collaboration. The COAG Climate Change Group can provide high level strategic oversight on adaptation in Australia. Links and lines of responsibility with respect to Ministerial Councils will be confirmed through the development of an implementation plan.

Implementation planning

An implementation plan will be developed in 2007 in consultation with key stakeholders. The implementation plan will include details of partnerships, milestones and resources. It will also outline the roles and responsibilities of the different levels of government in advancing the actions. Monitoring and evaluation components will also be outlined, including arrangements for review and reporting.

The Framework builds on initial action by governments including the work of some Ministerial Councils in developing sectoral adaptation plans. In developing implementation approaches, governments will recognise the importance of equity and cost-effectiveness and pursue adaptation actions with multiple benefits. Implementation will be in accordance with jurisdictions' budgetary frameworks.

Review and reporting

Climate change science continues to build new knowledge about the potential effects of a changing climate system. Adaptation to climate change is a relatively new endeavour and it is expected that much will be learned through the early steps with the practical actions set out in this Framework. Regular monitoring and review of adaptation plans will be necessary as new and better information becomes available, and in light of experience.

Biennial reports on implementation will be produced and the Framework reviewed in year four.

STRATEGIES AND ACTIONS

This Framework has two priority areas for potential action:

1. *Building understanding and adaptive capacity*. This comprises significant new actions to identify and fill knowledge gaps to enable effective adaptation action at the national and regional levels, including:
 - the proposed ‘Australian centre for climate change adaptation’;
 - improved regional climate change information and tools for decision makers; and
 - integrated vulnerability assessments of climate change impacts.
2. *Reducing vulnerability in key sectors and regions*, in particular, water resources, biodiversity, coastal regions, agriculture, fisheries, forestry, health, tourism, and settlements. This will include:
 - addressing critical knowledge gaps, much of which would be coordinated through the ‘centre for adaptation’;
 - building sector relevant tools and information; and
 - developing and implementing climate change action plans for vulnerable sectors.

The potential actions in each priority area are national in focus, can be achieved or well advanced in five years, and provide a solid foundation for future adaptation actions.

1. *Building Understanding and Adaptive Capacity*

There are substantial gaps in our knowledge and we need to improve the synthesis and dissemination of information for decision-makers. Decision makers need improved information, guides and tools which are tailored to their field and scope of operation to enable effective adaptation.

Key components of adaptive capacity include the ability to generate, access and interpret information about climate change and its likely impacts; suitable methods for identifying and assessing potential adaptation strategies; appropriately skilled people; adequate financial and other resources; governance systems with sufficient flexibility and foresight to embrace adaptation planning; and willingness to adapt. Knowledge and methods will need to span a range of disciplines, including climate science, biophysical sciences, engineering, social sciences and economics, and planning. Inter-disciplinary studies will also be important.

1.1 *‘Australian centre for climate change adaptation’*

Sound advice for decision makers is essential for vulnerability assessment and adaptation planning. However, Australia’s current impact and adaptation research effort is ad hoc, fragmented and limited in scope. Establishing the new ‘Australian centre for climate change adaptation’ will provide governments, industry and the community with clear and reliable information to assess risks and develop adaptation strategies. The centre will have a strong focus on the needs of decision makers and will synthesise and communicate existing and emerging knowledge for adaptation. Its central role will be to strategically focus research efforts in areas of common benefit, link existing research organisations and coordinate multidisciplinary and cross sectoral investigations.

Its form will be uniquely Australian, reflecting the diverse and varied nature of expected climate change impacts in a country as big as Australia, and enabling a flexible approach that can quickly respond to changing needs of governments, industry and the community.

The centre would build on existing capabilities by bringing coherence to Australian adaptation research, focusing existing institutional capacity on agreed priorities, and providing a mechanism to foster new capacity where needed.

The centre would have a key role in filling the information and knowledge gaps, identified in this Framework. The centre would synthesise knowledge, coordinate and commission research activities, broker research partnerships and provide information for decision makers in a form relevant to their sectoral or regional needs.

Potential areas of action

- a) Establish a centre for climate change adaptation that has the following objectives:
 - delivering the information to support climate change adaptation decision-making at the national, regional and local levels through coordination, integration, synthesis and communication of research;
 - coordinating Australia's adaptation research resources to more effectively support climate change decision-making, including by brokering research partnerships and providing a vehicle to commission new research;
 - building the capacity of the Australian research community to generate information relevant to decision-makers;
 - establishing an interface between researchers and decision-makers; and
 - promoting coordinated programmes of work on impacts and adaptation across Australia, working in collaboration with stakeholders and other researchers in national, regional and sectoral contexts.

1.2 Regional climate change and vulnerability information

Australia's scientists have generated a base of information about how the climate is changing and the broad physical impacts these changes may have. However decision makers require improved information about the projections of climate change, particularly of extreme events, social and economic trends that affect climate change vulnerability, and the social and economic impacts of climate change.

Potential areas of action

A national programme to develop and widely communicate information for regional assessment of vulnerability and likely climate change impacts. This includes the following elements:

- a) Analysis of social and economic data and trends to assess how these factors are likely to influence vulnerability to climate change. Socio-economic scenarios will also be developed to provide decision makers with possible future situations to assist in assessing risk and developing adaptation strategies within appropriate planning timeframes;
- b) Research to identify social and economic costs of climate change including the cost of not taking adaptation action;
- c) Development of improved regional climate projections and extreme events projections; and
- d) Improvement of regional climate modelling and downscaling techniques.

1.3 Integrated regional vulnerability assessments

Major regions across Australia face considerable risks from climate change impacts, and in many cases these risks will span a range of sectors. Effective decision-making will need to be supported by integrated, multi-disciplinary assessments of vulnerability to climate change. For example,

understanding the implications of sea level rise for coastal planning will require insights from climate scientists, engineers, ecologists, economists and planners. Remote and Indigenous communities may have more limited capacity to adapt.

Potential areas of action

- a) Conduct integrated assessments of the impacts of climate change on priority vulnerable regions including the Murray-Darling Basin, south-west WA, the tropical north, select parts of Australia's coast and marine environment, remote regions, vulnerable Indigenous communities, the drying region of the eastern Australia and alpine regions.

1.4 Communication, information and tools

Decision-makers need accessible and robust information, tools and guides. It is necessary to make existing knowledge widely available and fill the gaps in decision-makers needs. Incorporating climate change into education and training programs is also important.

Understanding some potential climate change impacts, particularly on the coast, requires a national digital elevation model (DEM) – which does not currently exist. Such a DEM would also have important benefits for catchment managers and other natural resource managers. Considerable cost savings are likely to be achieved by taking a national approach.

Potential areas of action

- a) Develop and implement a comprehensive communications strategy to raise awareness of climate change impacts and the advantages of early attention to adaptation, including partnerships with key national professional and interest groups to develop best practice networks.
- b) Develop and promote tools for adaptation planning tailored to user's requirements. These would include:
 - Decision-support tools such as methods for assessing the costs and benefits of adaptation strategies, and guides for risk management;
 - methods for understanding social impacts;
 - a national 'one stop shop' website where decision-makers and their advisers can access information about climate projections, likely climate change impacts, tools, guides and approaches to adaptation planning.
- c) Integrate climate change into education and training for key professions, including engineering, architecture, planners, reserve managers and local government.
- d) Develop a national digital elevation model (DEM) for the whole of Australia, with vulnerable regions being mapped using very high resolution images. This would involve linked topographic and bathymetric information at a resolution relevant to decision-making.

1.5 International connections and partnerships

Australia has much to offer other countries and can learn from their experiences. Partnerships will be maintained and enhanced with other nations to share information and explore adaptation strategies of mutual benefit. Australia will continue to work with the United Nations Framework Convention on Climate Change in developing and implementing their five-year programme of work on impacts, vulnerability and adaptation. Adaptation is also an element of bilateral climate change partnerships with the United States, China, and New Zealand and of Australia's aid program in the Pacific.

The impacts of climate change on other countries in our region would have implications for Australia. It will be important to understand these implications and to continue working through our aid program in partnership with other countries, other donors, regional and international organisations to increase the capacity of the countries in our region to adapt to climate change.

Potential areas of action

- a) Further identify the implications for Australia of climate change impacts in other countries in our region.
- b) Identify opportunities to strengthen Australia's support for adaptation through regional and international organisations, including:
 - considering adaptation in future aid program strategy discussions, where appropriate; and
 - where included in aid program strategies, develop regional or bilateral overseas aid initiatives that focus on adaptation.

2. *Reducing Sectoral and Regional Vulnerability*

Most sectors of society and the economy are likely to be affected to some extent by the impacts of climate change. This Framework focuses on sectors and regions where:

- there is national significance for social, economic, biophysical or cultural outcomes;
- decisions to be made in the next few years could be affected in the longer term by climate change impacts; and
- actions have a high level of potential to capture the benefits from early adaptation planning.

There are many inter-relationships and connections within and between vulnerable sectors and regions. For example, impacts of climate change on water resources in the south and east of Australia will also affect environmental flows for biodiversity, irrigation for agriculture and water supply for settlements and industry.

Early adaptation will be influenced by the extent to which climate change factors are incorporated into sectoral and regional planning. It is recognised that there are cost efficiencies in taking a national approach to adaptation.

2.1 Water resources

Australia is the driest inhabited continent and rainfall and stream flow are highly variable. Climate change presents significant additional challenges for managers of water resources in Australia.

In a changing climate, droughts are expected to become more severe in the south and east of Australia. The potential for replenishment of groundwater is expected to continue to decline and water quality is also likely to be affected. Rainfall is likely to be concentrated more in extreme rainfall events affecting water availability (both surface and groundwater), water quality, the balance between environmental and consumptive demand and allocation, as well as the design and safety of dams.

Improved knowledge is needed to assist water managers to understand the wide range of impacts climate change will have on surface and groundwater resources and the demand for water.

Adaptation to changed water availability could require the sourcing of additional water supply and retrofitting water infrastructure, with the associated costs. It could also mean new ways of managing water.

The National Water Initiative (NWI) and other water management frameworks are central to dealing with reduced water availability due to climate change. Information on climate change will be essential for water managers.

Potential areas of action

- a) Research to address key knowledge gaps about climate and water resource, needed to implement the National Water Initiative and other water management initiatives. This will include research on:
 - high quality projections of climate variables relevant to supply and demand of water resources;
 - understanding of impacts of climate change on water resources and dependent ecosystems; and

- methods and approaches to integrating climate change related risks into water management.
- b) Work with the water industry to ensure that climate change impacts and risks are incorporated into water resource and infrastructure planning and management including:
- assessing the implications of changes in extreme rainfall events for water infrastructure;
 - updating estimates of probable maximum precipitation and rainfall extremes for use in products such as the Australian Rainfall and Runoff handbook to reflect likely climate change;
 - jurisdictions dam safety authorities to review major dam safety policies to accommodate the impacts of climate change.

2.2 Coastal regions

The coastal zone is vulnerable to sea level rise, increased sea surface temperature, increased storm intensity and frequency, ocean acidification and changes to rainfall, run-off, wave size and direction and ocean currents.

Much of Australia's population and infrastructure is in the coastal zone and continued migration to the coastal zone may increase vulnerability to climate change impacts. The combined influence of sea level rise, storm surge and storm events (including cyclones) may pose severe localised threats and result in damage from shoreline erosion, salt water inundation, flooding, and high velocity winds. Increasing sea surface temperatures can lead to the spread of marine pests, changes in fish stocks and bleaching of coral reefs.

The *Framework for a National Cooperative Approach to Integrated Coastal Zone Management* adopted by the Natural Resource Management Ministerial Council (NRMMC) has a strong focus on climate change. In particular it assigns priority for an integrated and coordinated national assessment of the vulnerability of Australia's coastal systems to climate change, involving all jurisdictions and major sectors. The absence of a national Digital Elevation Model (refer to action 1.4(d)) and nationally consistent mapping in the coastal zone has limited the analysis of coastal vulnerability to date.

Potential areas of action

- a) Building on the 'first pass' assessment of Australia's coastal vulnerability being conducted under the auspices of the NRMMC, undertake a national assessment of Australia's coastal vulnerability to provide information required by coastal managers and decision-makers at a range of spatial scales. This will include measures to:
 - develop and implement a national OzCoasts Portal – a one-stop-shop, web-based system of information, maps, tools and products related to the coast and climate change;
 - map national geomorphology and ecosystem information to the high resolution Digital Elevation Model for Australia (refer to action 1.4 d);
 - identify and address priority knowledge gaps required to progress the national coastal vulnerability assessment, eg. extreme events and coastal impacts; current and projected demographic change; and socio-economic analysis of impacts
 - develop and apply models for analysing coastal responses to changes in sea level, wave action, storm surge and near shore current activity and
 - assess the vulnerability of infrastructure, settlements, and environments of significance using biophysical and socio-economic scenarios and inundation modelling.
- b) Identify vulnerable coastal areas and apply appropriate planning policies, including ensuring the availability of land, where possible, for migration of coastal ecosystems.

2.3 Biodiversity

Many ecosystems are likely to be adversely affected by increasing temperatures, changes to rainfall patterns, the spread of pests and weeds, changed fire regimes and sea-level rise. Higher temperatures, possible changes in ocean currents, and potential changes in ocean chemistry are likely to affect marine ecosystems. Impacts on biodiversity will affect ecosystem services such as water filtration, soil quality and shelter.

Reducing other stresses on biodiversity, such as overuse and pollution, is likely to ameliorate species loss, system degradation and range contraction due to climate change. Healthy ecosystems are more resilient to climate change impacts and able to 'bounce back'. Some ecosystems are particularly vulnerable such as coral reef systems, coastal wetlands (including Kakadu) and saltmarshes, alpine areas, rainforests, fragmented terrestrial ecosystems and the kwongan heathlands of south-west Western Australia. Environmental flows of key riverine systems are also vulnerable, with increased competition for diminishing water resources.

Most of Australia's World Heritage properties are listed for their natural heritage values and are likely to be vulnerable to the impacts of climate change. However, there has been no systematic analysis of this vulnerability across the whole suite of properties.

Potential areas of action

- a) Review the National Biodiversity and Climate Change Action Plan 2004-2007, developed by the Natural Resource Management Ministerial Council, and outline strategic national directions and actions post 2007.
- b) Establish a national programme of research on the impacts of climate change on biodiversity and ecosystem processes. The research will address:
 - i) Terrestrial, aquatic and marine & estuarine ecosystems with a focus on:
 - > analysis of changing distribution and phenology;
 - > the interactions and combined impacts of climate change and other threatening processes;
 - > identification of critical thresholds for natural ecosystems and approaches to increasing their resilience to the impacts of climate change including connectivity; and
 - ii) The implications of climate change for existing strategies, such as the National Reserve System and planning for threatened and migratory species and ecological communities.
- c) Provide practical guidance on how to integrate existing and emerging knowledge about climate change into management of disturbance regimes (for example, fires, floods, invasive species) in areas managed for biodiversity conservation.
- d) Assess the vulnerability of Australia's World Heritage properties and Ramsar wetlands to the impacts of climate change. Regular reviews of management plans for each World Heritage property will explicitly consider vulnerability to climate change impacts and plans will include actions, where necessary, to reduce vulnerability or manage impacts.
- e) Finalise and implement key steps in the Climate Change Action Plan for the Great Barrier Reef.

2.4 Agriculture, fisheries and forestry

Industries dependent on natural resources are particularly vulnerable to climate change. Increasing temperature, changing precipitation patterns and water resources availability, increasing atmospheric levels of CO₂ and ocean acidification will impact on sustainability of agriculture, forestry and fisheries. The impacts will vary across regions and between the different industry sub-sectors.

Agriculture

Agriculture is highly dependent on climate, it is practiced on large areas of land, and it is the key industry of many regional economies. Seasonal weather variability in conjunction with climate change will have longer-term effects on agricultural production, agribusiness investments, and regional prosperity.

The costs of the impact of climate change on agriculture could be considerable, for example, should there be an increased frequency of severe drought. The cost of the 2002-03 drought to the Australian economy was around 1% of GDP and there were considerable social impact on regional communities. Adaptation can reduce these costs building on the experience of dealing with climate variability.

Effective adaptation actions would provide farmers with added resilience and coping ability in circumstances of a changed climate system. Information on how seasonality will alter due to climate change will also assist the agriculture industry to adapt.

Potential areas of action

- a) Implement the relevant components of the National Agriculture and Climate Change Action Plan, as released by the Natural Resource Management Ministerial Council in August 2006. In particular:
 - support research to improve understanding of the implications of climate change for agriculture at the national, sectoral and regional levels, including:
 - vulnerability assessments of regions and agricultural industries;
 - effects of climate change on seasonal variability and reliability, and on climate extremes (eg droughts, cyclones) affecting agricultural production; and
 - understanding barriers to adaptation and opportunities to adapt.
 - increase resilience of farming systems and regions to climate change, and help agribusinesses identify where changes may be needed to the longer-term investment strategies;
 - enhance current programmes and structures to incorporate climate change adaptation considerations into natural resource management, rural support and adjustment, research and development and plant and animal health, pest and weed policies and programmes, and environmental management systems
 - develop decision support tools, pilot adaptation options, inform and encourage adaptation, and engage industry in participatory research, communication and review.

Fisheries

Climate change is likely to affect Australian commercial and recreational fisheries through increasing ocean temperatures, changes to ocean currents, wind and nutrients, changed rainfall patterns and ocean acidification. There are specific and different threats to inland fisheries and aquaculture. Aquaculture is likely to be impacted by climate change through higher temperatures, water availability and coastal impacts.

Greater precision in assessing vulnerability of wild fish stocks to climate change is needed to ensure sustainability of commercial and recreational fisheries. Initial estimates show that the

prawn, western rock lobster, salmon and estuarine species could be particularly vulnerable. Climate change is expected to make interpretation and use of historical fisheries management data more difficult.

Potential areas of action

- b) Develop a Climate Change and Fisheries Action Plan, to be considered through the Natural Resource Management Ministerial Council and Primary Industries Ministerial Council, that includes:
 - identifying risks associated with climate change for the sustainable use of Australia's commercial and recreational fish stocks;
 - determining ways of distinguishing climate change impacts from the impacts of other environmental and management factors;
 - developing strategies in collaboration with industry and community stakeholders; and
 - assessing the impacts and risks of climate change on aquaculture.

- c) Support research, in association with industry and research providers, to address major knowledge gaps about the impact of climate change on wild catch fisheries and aquaculture. This may include analysis of the impact of changing sea temperatures, ocean acidification, currents and wind on the distribution and abundance of marine species; vulnerability and resilience of marine systems; ocean productivity; and social and economic systems using marine environments.

Forestry

Climate change could have significant impacts on Australia's forest industries, through slower growth due to reduced water availability, raised temperatures, increased bushfires and wind damage and greater pest and disease pressures and through growth fertilisation by higher atmospheric CO₂ levels. Frequent or extensive damage to production forests can significantly reduce the sustainable supply of timber to capital intensive processing industries with consequences that last for many years. Climate change may also impact on the species that can be grown productively in plantations in different regions influencing financial returns. Much forest land has multiple uses, and climate change may also impact on water yields and biodiversity and recreation values of forests.

Potential areas of action

- d) Develop a Climate Change and Forestry Action Plan under the Primary Industries Ministerial Council and Natural Resource Management Ministerial Council. This would include:
 - identifying key impacts, vulnerabilities and research priorities;
 - developing strategies in collaboration with industry; and
 - developing communication strategies.

- e) Support research to address major knowledge gaps about the impact of climate change on forestry and the vulnerability of forest systems. This may include assessing implications of climate change for native and plantation forests used for timber production; the capacity of forest systems to sequester carbon; the role and impacts of forests in natural resource management; and social and economic aspects of forests and forestry.

2.5 Human health

Risks to the health of Australians from climate change include increases in morbidity and mortality from thermal stress (especially heat-waves), floods, cyclones and bushfires, and increased transmission of vector-borne, food-borne and water-borne diseases. Changes to industry, land use and climate events such as drought can result in adverse mental health consequences within rural communities, along with a range of other health risks (e.g. from freshwater shortages, increased exposures to heat and dust, and changes in local food availability and affordability).

The World Health Organisation has indicated that changes in climatic conditions can have three kinds of health impacts: direct impacts (e.g. heat-waves), health consequences of changes to ecosystems and biological processes (e.g. mosquito-borne infections, agricultural food yields), and the many health consequences that occur when populations are disrupted or displaced.

Health impacts due to climate change will affect some regions, socioeconomic groups and demographic groups more than others. For example, older people are more susceptible to extremes of temperature. Many rural and remote communities have less capacity than larger settlements to deal with the health impacts of climate change. Any geographic extensions of mosquito-borne infections are likely to impinge more on northern than southern Australian populations.

Potential areas of action

- a) The Australian Health Ministers' Conference will develop and implement a National Action Plan on Climate Change and Health that includes:
 - research on climate change impacts on physical and mental health and identify key vulnerabilities;
 - identifying the capacity of the public health system and hospital system to plan for and respond to these vulnerabilities including links to emergency services and health disaster management policies; and
 - incorporating the potential for climate change impacts on health into community and public health education programs.
- b) Develop and implement heat wave warning and response systems.
- c) National Health and Medical Research Council to increase its focus on research on climate change and health.
- d) The Sport and Recreation Ministers' Council develop and implement an action plan to assess, and develop strategies to address, the impact of climate change on sporting and recreational activities.

2.6 Tourism

The impact of climate change on infrastructure and the natural environment has the potential to affect the tourism industry. In some cases this could result in social and economic impacts in regions with a high dependency on tourism as a source of income and employment. However, the impacts will depend on the relative attractiveness of different destinations and the potential for alternative attractions in the current tourism areas. As tourist attractions, areas such as the Great Barrier Reef, the Wet Tropics, alpine areas, and coastal regions are particularly vulnerable.

Potential areas of action

- a) The Tourism Ministers' Council develop an action plan in partnership with industry stakeholders which would include:
 - assessment of the impacts of climate change on tourism and tourism values (physical, social and economic) and on the relative impact of climate change on the different forms of tourism; and
 - developing adaptation strategies for nature based tourism including tourism based on the use of natural and cultural resources, specific tourism regions, and the industry more broadly.

2.7 Settlements, infrastructure and planning

The physical infrastructure and the social and economic fabric of settlements are likely to be affected by climate change, especially by changed frequency of intensity of extreme weather events.

Infrastructure such as buildings, roads, bridges, railways and ports are designed for a life of 20-50 years. Dams can be designed for a 100 year life. Planning decisions for development and the replacement or refurbishment of long-lived infrastructure, need to take account of the different climate in the future including higher temperatures and changes to precipitation, water tables and humidity.

Increasing urbanisation in coastal areas and urban expansion into regional areas are likely to increase the exposure of people and infrastructure to the impacts of climate change. People living in remote communities may be more vulnerable. The impacts will vary depending on the form of the settlement, geographic considerations and the nature of the local economy.

Adaptation measures include planning to reduce vulnerability and/or increase resilience, and using codes and standards that take account the impact of climate change on frequency and duration of rainfall, storm water capacity, changes in wind speed. The finance and insurance industries help manage society's risk from weather related damages.

Climate change impacts on settlements will depend upon a range of local factors, including the form of the settlement, the nature of the local economy, and geographic considerations such as elevation and proximity to the coast. Integrated assessment is an approach to understanding climate change impacts and adaptation options at the local scale.

However, decision makers need additional information about the vulnerability of major infrastructure, including energy systems, transport systems, communication networks and building stock, in order to develop adaptation strategies.

Potential areas of action

- a) Research to address key knowledge gaps about human settlements and climate change impacts, including information needed to effectively implement actions set out below in relation to planning, codes and standards and major infrastructure.
- b) All jurisdictions will evaluate and share relevant information about the extent to which planning and development systems promote decisions that increase resilience to the impacts of climate change and discourage decisions that increase vulnerability, and consider changes where appropriate. The Local Government and Planning Ministers' Council would coordinate a national report based on these assessments.

- c) Analysis and revision of planning systems including revision and development of codes, standards and guides to increase resilience to climate change including:
- the Australian Building Codes Board consider climate change as part of their periodic reviews;
 - reviewing standards used for building, plumbing and electrical standards and specification for the development and subdivision of land. This would include a particular focus on standards related to buildings and utilities and would be ongoing as better information becomes available;
 - review information used to determine vulnerability of settlements land to climate-related hazards (floods, bushfires, cyclones and coastal inundation) and develop new or revised risk management guidance to take into account any projected changes as a result of climate change. This review should take into account the contribution of 'urban forests' to modify the impact of climate change in the urban environment; and
 - revision of stormwater and sewerage guidelines.
- d) Identify and address the impact of climate change may have on major infrastructure including:
- identifying priority infrastructure assets that may be vulnerable to climate change and liaise with the owners on business continuity plans take this vulnerability into account; and
 - analyse the vulnerability of electricity, transport, communications, water infrastructure and other key infrastructure to climate change, and develop appropriate risk management strategies to reduce this vulnerability. For example, the review could consider road, rail, airports, ports and encompass existing transport infrastructure, planned transport infrastructure and transport infrastructure management and planning. A review of the electricity supply infrastructure could consider possible effects from projected increases in temperature and changes in rainfall patterns and the changes in energy demand due to climate change.
- e) Develop capacity and tools for the planning sectors including:
- work with the insurance and finance industries to share nationally consistent data on climate change risks and impacts, identify adaptation actions to reduce risk, and identify approaches that support the viability and robustness of the finance sector, society and business; and identify and fill gaps in the information needed to properly assess insurance risk; and
 - establish approaches to support local government in preparing for climate change impacts.

2.8 Natural disaster management

In 2003, COAG gave in-principle approval to recommendations of the report - *Natural Disasters in Australia: Reforming mitigation, relief and recovery*. Actions proposed in this Adaptation Framework complement the directions in this reform agenda.

Climate change is likely to increase the risk of natural disasters in a number of regions of Australia. Bushfire, floods and storms are a feature of Australia's variable climate. However, climate change is likely to increase the frequency and/or severity of extreme events.

The high concentration of people and infrastructure in urban areas, especially along the coast and coastal lowlands are likely to result in severe economic losses with changing exposure to extreme events. Remote settlements can be particularly vulnerable to natural disasters.

Natural disasters already cost the Australian community an average of over \$1 billion per year on average excluding death and injury costs. It is likely that climate change will increase the frequency or intensity of some climate-driven weather extremes. The 2002-03 fire season destroyed over 3 million hectares of native forest and agricultural land and 629 homes.

Climate change impacts need to be factored into natural disaster management risk reduction, emergency services planning, and recovery management, especially for areas more vulnerable to extreme events. Community awareness and developing a culture of preparedness in conjunction with emergency services will contribute to effective adaptation responses.

Potential areas of action

- a) Undertake research to improve knowledge on the nature and expected extent of changes to existing risk profiles as a result of climate change for key events such as bushfires, flooding, cyclones, storm surges, wind and hail damage.
- b) Incorporate climate change impacts into planning for natural disaster response management, in particular the risk and changing behaviour from bushfires, flooding, cyclones, storm surges, wind and extremes in temperature. This will include:
 - incorporating climate change issues in the review of the Natural Disaster Mitigation Programme and proposals submitted under the Programme; and
 - improving information for emergency services and communities to foster awareness of climate change and adaptation responses.

GLOSSARY

Adaptation – is a process by which strategies to moderate, cope with, and take advantage of the consequences of climatic events are enhanced, developed and implemented. This can include strategies to increase the resilience of systems, such as reducing pollution and pests for natural ecosystems.

Adaptive capacity – the ability of a system to adjust to climate change (including changes in variability and extremes) so as to moderate potential damages, to take advantage of opportunities, or to cope with the consequences.

Adaptation technology – utilising existing technology or developing new technologies is likely to be one component of strategies to adapt to climate change impacts. Adaptation technologies are likely to be sector specific. For example, there are a number of technologies for reducing water use that will be relevant to managing reduced stream flows expected in many parts of Australia.

Assessment

- **Impact assessment** – the practice of identifying and evaluating the detrimental and beneficial consequences of climate change on natural and human systems.
- **Integrated assessment** – a method of analysis that combines results and models from the physical, biological, economic, and social sciences, and the interactions between these components, in a consistent framework to evaluate the status and the consequences of climate change and the policy responses to it.

Bathymetry – The measurement of the depth of the ocean floor from the water surface - the oceanic equivalent of topography. Bathymetric maps illustrate the shape of the ocean floor.

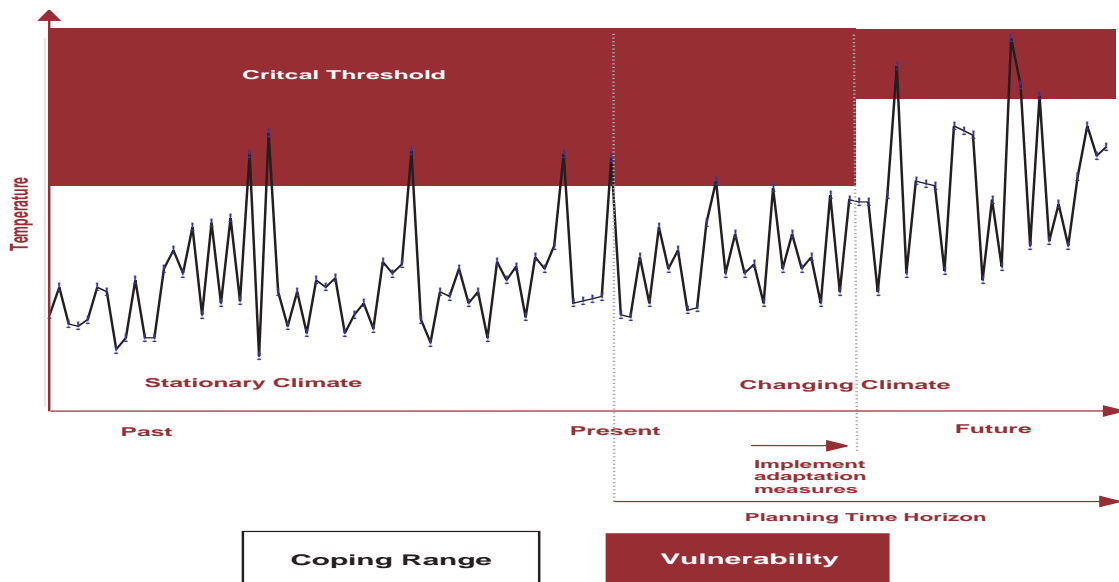
Climate prediction – or climate forecast is the result of an attempt to describe the actual weather in the future. Daily weather forecasts are predictions of what the weather is expected to be like in the near future. They are based on observations and weather models and are often expressed in probabilistic terms (eg 10% chance of rain).

Climate change projection – Projections are sets of future conditions, or consequences, based on explicit assumptions. Climate change projections estimate the response of the climate system to scenarios (see below) of greenhouse gases and aerosols, or radiative forcing scenarios, often based upon simulations by climate models. Projections are therefore subject to substantial uncertainty.

Climate change scenario – A climate scenario is a plausible and often simplified representation of the future climate. Scenarios are based on an internally consistent set of climatological relationships, which has been constructed for explicit use in investigating the potential consequences of anthropogenic climate change. The IPCC has developed emission scenarios which are based on assumptions including population change, socioeconomic development and technological change. These IPCC emission scenarios feed into the development of climate change projections.

Coping range – is the range of climate where the outcomes are beneficial or negative but tolerable; beyond the coping range, the damages or loss are no longer tolerable and a society (or system) is said to be vulnerable. See diagram below.

Critical threshold – the point at which an activity faces an unacceptable level of harm, such as a change from profit to loss on a farm due to decreased water availability, or coastal flooding exceeding present planning limits. It occurs when a threshold is reached at which ecological or socioeconomic change is damaging and requires a policy response. See diagram below.



Source: R Jones (CSIRO)

Downscaling – deriving finer regional or temporal detail of climate parameters from global and regional climate models. A variety of approaches are possible, some based on statistical methods and others on ‘nested’ climate models.

Impacts – are the detrimental and beneficial consequences of climate change on natural and human systems.

Resilience – the amount of change a system can undergo without changing state.

Risk management approach – the implementation of strategies to avoid unacceptable consequences.

Vulnerability – the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity.

NATIONAL ADAPTATION FRAMEWORK (SUMMARY OF POTENTIAL AREAS OF ACTION)

BUILDING ADAPTIVE CAPACITY

Potential Areas of Action	Timeframe
<p><u>1.1 Australian centre for climate change adaptation</u></p> <p>(a) Establish a centre with the following objectives:</p> <ul style="list-style-type: none"> ➤ delivering the information to support climate change decision-making at the national, regional and local levels through coordination, integration, synthesis and communication of research; ➤ coordinating Australia's research resources to more effectively support climate change decision-making including by brokering research partnerships and providing a vehicle to commission new research; ➤ building the capacity of the Australian research community to generate information relevant to decision-makers; ➤ establishing an interface between researchers and decision-makers; and ➤ promoting coordinated programmes of work on impacts and adaptation across Australia, working in partnerships with stakeholders and other researchers in national, regional and sectoral contexts. 	5-7 years +
<p><u>1.2 Regional climate change and vulnerability information</u></p> <p>(a) A national programme to develop and widely communicate information for regional impact assessments. This includes:</p> <ul style="list-style-type: none"> ➤ analysis of social and economic data and trends and development of socio-economic scenarios to assist in assessing risk and developing adaptation strategies; ➤ research to identify social and economic costs of climate change including the cost of taking no adaptation action; ➤ developing improved regional climate projections and extreme events projections; and ➤ developing improved regional climate modelling and downscaling techniques. 	5 years
<p><u>1.3 Integrated regional vulnerability assessments</u></p> <p>(a) Refine methods for and conduct integrated assessments of the impacts of climate change on priority vulnerable regions such as:</p> <ul style="list-style-type: none"> ➤ Murray Darling Basin ➤ south-west Western Australia ➤ the tropical north ➤ drying regions of eastern Australia ➤ highly vulnerable settlements including remote and Indigenous communities ➤ alpine regions 	5 years

Potential Areas of Action	Timeframe
<u>1.4 Communication, information and tools</u>	
(a) Develop and implement a communication strategy to raise awareness and develop best practice networks.	1 year with annual review
(b) Develop and promote tools for adaptation planning tailored to users requirements including: <ul style="list-style-type: none"> ➤ decision support tools such as methods for assessing costs and benefits of adaptation strategies and risk management guides and user manuals; ➤ methods for understanding social impacts; and ➤ a national 'one-stop-shop' website for information, tools, guides and adaptation planning approaches. 	5 years
(c) Integrate climate change into education and training for professional groups including engineers, architects, planners, reserve managers and local government.	5 years
(d) Develop a national digital elevation model (DEM) for the whole of Australia with linked topography and sea bathymetry.	5 years+
<u>1.5 International connections and partnerships</u>	
(a) Further identify the implications for Australia of climate change impacts in other countries in our region.	3 years
(b) Identify opportunities to strengthen Australia's support for adaptation through regional and international organisations.	3 years

REDUCING SECTORAL AND REGIONAL INSTABILITY

Potential Areas of Action	Timeframe
<u>2.1 Water resources</u>	
(a) Research to address key knowledge gaps about climate change and water resources, needed to implement the NWI and other water management initiatives. This would include research on: <ul style="list-style-type: none"> ➤ high quality projections of climate variables relevant to supply and demand of water resources; ➤ understanding of impacts of climate change on water resources and dependent ecosystems; and ➤ methods and approaches to integrating climate change related risks into water management. 	7 years
(b) Work with the water industry to ensure that climate change impacts and risks are incorporated into water resource and infrastructure planning and management including: <ul style="list-style-type: none"> ➤ assessing the implications of changes in extreme rainfall events for water infrastructure; ➤ reviewing and updating the estimates of Probable Maximum Precipitation and rainfall extremes; and ➤ reviewing major dam safety policies to accommodate the impacts of climate change. 	5 years

Potential Areas of Action	Timeframe
<p><u>2.2 Coastal regions</u></p> <p>(a) Undertake a comprehensive national assessment of Australia's coastal vulnerability building on the first pass assessment. This includes:</p> <ul style="list-style-type: none"> ➤ develop and implement a national web site for information, maps, tools and products; ➤ map geomorphology and coastal ecosystem information to the national digital elevation model (action 1.4d); ➤ identify and address knowledge gaps for coastal vulnerability including system thresholds, interaction between climate events, socio-economic impacts; ➤ develop and apply models of analysing regional vulnerability and responses to climate change; ➤ assess vulnerability for priority regions or systems. 	5 years
<p>(b) Identify vulnerable coastal areas and apply appropriate planning policies, including ensuring the availability of land for migration of coastal ecosystems.</p>	5 years
<p><u>2.3 Biodiversity</u></p>	
<p>(a) Review the National Biodiversity and Climate Change Action Plan 2004-2007</p>	2 years
<p>(b) Establish a national program to understand the impacts of climate change on biodiversity, synthesising existing knowledge and commissioning research on:</p> <p>i) Terrestrial, aquatic and marine & estuarine ecosystems with a focus on:</p> <ul style="list-style-type: none"> ➤ analysis of changing distribution and phenology; ➤ the interactions and combined impacts of climate change and other threatening processes; ➤ identification of critical thresholds for natural ecosystems and approaches to increasing their resilience to the impacts of climate change; and <p>ii) The implications of climate change for existing strategies, such as the National Reserve System and planning for threatened and migratory species and ecological communities.</p>	5 years
<p>(c) Provide practical guidance on how to integrate existing and emerging knowledge about climate change into management of disturbance regimes (fires, floods, invasive species, cyclone disturbance) in areas managed for biodiversity conservation.</p>	3-5 years
<p>(d) Assess the vulnerability of Australia's World Heritage and other properties of international significance to the impact of climate change.</p>	2 years
<p>(e) Finalise and implement key steps in the climate change action plan for Great Barrier Reef.</p>	5 years
<p><u>2.4 Agriculture, fisheries and forestry</u></p> <p>Agriculture</p> <p>(a) Implement the adaptation components of the National Agriculture and Climate Change Action Plan, as released by the Natural Resource Management Ministerial Council in August 2006. This includes:</p> <ul style="list-style-type: none"> ➤ support research to improve understanding of the implications of climate change for agriculture at the national, sectoral and regional 	5years+ NRMCC undertaking some initial priorities over 2 years

Potential Areas of Action	Timeframe
<p>levels;</p> <ul style="list-style-type: none"> ➤ increase resilience of farming systems and regions to climate change, and help agribusinesses identify where changes may be needed to the longer-term investment strategies; ➤ enhance current programmes and structures to incorporate climate change adaptation considerations into natural resource management, rural support and adjustment, research and development and plant and animal health, pest and weed policies and programmes, and environmental management systems ➤ develop decision support tools, pilot adaptation options, inform and encourage adaptation, and engage industry in participatory research, communication and review. 	
<p>Fisheries</p> <p>(a) Develop a Climate Change and Fisheries Action Plan, to be considered through the Natural Resource Management Ministerial Council and Primary Industries Ministerial Council.</p>	2 years
<p>(b) Address major knowledge gaps about the impact of climate change on wild catch fisheries and aquaculture. This may include analysis of the impact of changing sea temperatures, ocean acidification, currents and wind on:</p> <ul style="list-style-type: none"> ➤ distribution and abundance of marine species; ➤ vulnerability and resilience of marine systems; ➤ ocean productivity; and ➤ social and economic systems using marine environments. 	5 years
<p>Forestry</p> <p>(a) Develop a Climate Change and Forestry Action Plan under the Primary Industries Ministerial Council and Natural Resource Management Ministerial Council. This would include:</p> <ul style="list-style-type: none"> ➤ identifying information needs and research priorities; ➤ identifying key areas of impacts and vulnerability and potential adaptation options; ➤ integrating climate change considerations in forestry policy and programme development; and ➤ developing communication strategies. 	2 years
<p>(b) Address major knowledge gaps about the impact of climate change on forestry and the vulnerability of forest systems. This may include assessing implications of climate change for:</p> <ul style="list-style-type: none"> ➤ native and plantation forests used for timber production; ➤ the capacity of forest systems to sequester carbon; ➤ the role and impacts of forests in natural resource management; ➤ social and economic aspects of forests and forestry. 	5 years
<p><u>2.5 Human health</u></p> <p>(a) The Australian Health Ministers' Conference develop and implement a National Action Plan on Climate Change and Health that includes:</p> <ul style="list-style-type: none"> ➤ researching climate change impacts on physical and mental health and identify key vulnerabilities; ➤ identifying the capacity of the health system to plan for and respond to these vulnerabilities including links to emergency services and health 	3 years

Potential Areas of Action	Timeframe
<p>disaster management policies and other related social infrastructure; and</p> <ul style="list-style-type: none"> ➤ incorporating information on climate change impacts on health into community and public health education programs. 	
(b) Develop and implement heat wave warning and response systems	3 years
(c) National Health and Medical Research Council to increase its focus on research on climate change and health.	5 years +
(d) The Sport and Recreation Ministers' Council develop and implement an action plan to assess and develop strategies to address the impacts of climate change on sporting and recreational activities.	2 years
<p><u>2.6 Tourism</u></p> <p>(a) The Tourism Ministers' Council develop an action plan in partnership with industry stakeholders, assess the impacts of climate change on tourism and tourism values (physical, social and economic), including working with industry and community stakeholders to develop adaptation strategies.</p>	2 years
<p><u>2.7 Settlements, infrastructure and planning</u></p> <p>(a) Identify and address knowledge gaps including synthesis of existing information.</p>	5 years
(b) All jurisdictions evaluate and share information about the extent to which planning and development systems promote decisions that increase resilience to the impacts of climate change and discourage decisions that increase vulnerability, and consider changes where appropriate. The Local Government and Planning Ministers' Council would coordinate a national report based on these assessments.	2 years
(c) Analysis and revision of planning systems including revision and development of codes, standards and guides to increase resilience to climate change including: <ul style="list-style-type: none"> ➤ The Australian Building Codes Board consider climate change as part of the periodic reviews; ➤ reviewing standards including building, plumbing, electrical standards and specifications for development and subdivision of land; ➤ assessing vulnerability and revise guides for all hazards (floods, bushfires, cyclones and coastal inundation); ➤ revision of stormwater and sewage guidelines. 	on-going
(d) Identify and address the impact of climate change on major infrastructure including: <ul style="list-style-type: none"> ➤ identifying priority infrastructure assets; ➤ analyse the impact of climate change on electricity, transport, communications, water and other key infrastructure and develop adaptation strategies. 	5 years +
(e) Develop a partnership with the insurance and finance industries	5 years
(f) Establish a programme to support local government in adapting to climate change including a toolkit.	5 years

Potential Areas of Action	Timeframe
<p><u>2.8 Natural disaster management</u></p> <p>(a) Undertake research to improve knowledge on the nature and expected extent of changes to existing risk profiles as a result of climate change for key events such as bushfires, flooding, cyclones, storm surges, wind and hail damage.</p>	5 years
<p>(b) Incorporate climate change impacts into planning for natural disaster response management, in particular the risk and changing behaviour from bushfires, flooding, cyclones, storm surges, wind and extremes in temperature. This will include:</p> <ul style="list-style-type: none"> ➤ incorporating climate change issues in the review of the Natural Disaster Mitigation Programme and proposals submitted under the Programme. ➤ improving information for emergency services and communities to foster awareness of climate change and adaptation responses. 	3 years