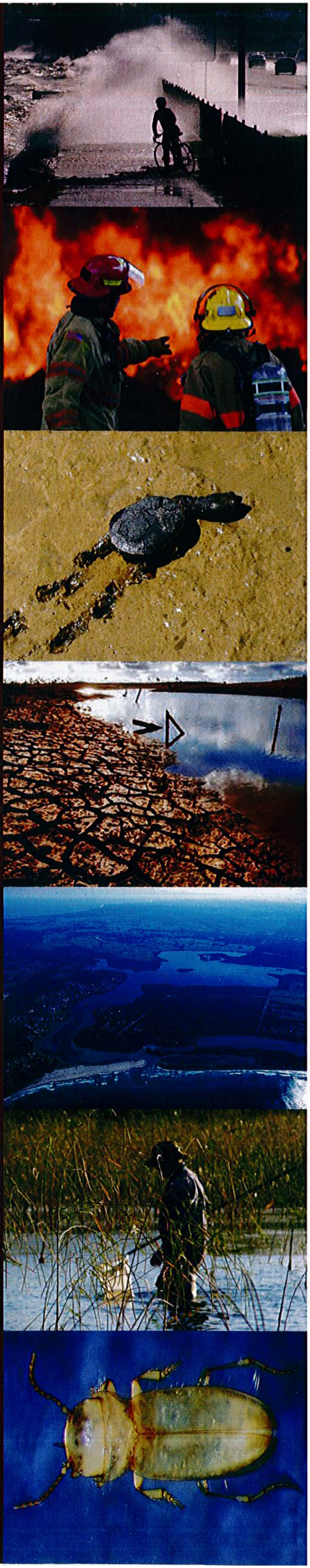

GOVERNMENT OF WESTERN AUSTRALIA

Department of **Water**

Department of **Environment and Conservation**

NCCARF
National Climate Change Adaptation Research Facility
Adaptation Research Network
WATER RESOURCES AND FRESHWATER BIODIVERSITY

Murdoch UNIVERSITY

Climate Change and Western Australian Wetlands and Waterways

Current knowledge and future directions

Symposium July 6th 2010
Perth, WA

Program and Abstracts

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This project has received funding from:

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Organising Committee

Frances D'Souza
(Department of Water)

Jane Chambers
(WA Node, Water Resources and Freshwater Biodiversity, National Climate Change Adaptation Research Facility/ Murdoch University)

Michael Coote and Romeny Lynch
(Department of Environment and Conservation)

We calculated the carbon footprint to offset emissions for this event. We are donating to Carbon Neutral (www.carbonneutral.com.au) to plant native trees to offset the emissions.

Program – Morning session

Time	Topic	Presenters
8.30-8.45	Guests arrive and beverages	
8.45-8.50	Welcome	Facilitator – Lucy Sands (Blue Sands Environmental)
8.55-9.00	Opening	Anne Mathews (Office of Climate Change)
9:00-9:15	Setting the scene	Jane Chambers (Murdoch University) Frances D'Souza (DoW) Michael Coote (DEC)
9:15-9:55	Climate projections for Western Australia and their implications for water-dependent ecosystems	Don McFarlane (CSIRO)
9:55-10:15	Changes in surface and groundwater in Western Australia	Mark Pearcey (DoW)
10:15-10:30	Discussion	Facilitator – Lucy Sands
10:30-10:45	Morning Tea	
10:45-11:50	**RIVERS SESSION**	
	Rivers in southwestern Australia: impacts of climate change and restoration priorities	Peter M. Davies (UWA)
	Unique inland fishes of south-western Australia: how may climate change exacerbate current impacts?	Stephen Beatty (Murdoch University)
	Aquatic ecosystems in tropical WA.	Michael Douglas (Charles Darwin University)
11:50-12:30	**ESTUARIES SESSION**	
	Estuaries in a drying climate – Western Australia.	Malcolm Robb (DoW)
	Western Australian estuaries and coastal wetlands.	Matthew Eliot (UWA)
12:30-1:00	Discussion	Facilitator – Lucy Sands

Program – Afternoon session

Time	Topic	Presenters
1:00-1:45	Lunch	
1:45-2:45	**WETLANDS SESSION**	
	WA's diverse wetland plant communities and climate change	Bronwen Keighery (OEPA) & Greg Keighery (DEC)
	Wetlands, aquatic invertebrates and climate change.	Jenny Davis (Monash University)
	Climate change, wetland ecology and waterbirds in Western Australia	Stuart Halse (Bennelongia Pty Ltd)
2:45-3:25	**GROUND WATER DEPENDENT ECOSYSTEMS SESSION**	
	Impacts of climate change on subterranean wetlands in Western Australia	Stefan Eberhard (Subterranean Ecology Pty Ltd)
	Groundwater dependent wetland ecosystem response to hydrological change: Examples of climate change impacts on the Swan Coastal Plain.	Ray Froend (ECU)
3:15-3:45	Discussion	Facilitator – Lucy Sands
3:45-4:00	Afternoon Tea	
4:00-4:20	**POLICY SESSION**	
	Challenges for managing water in the face of climate change	Frances D'Souza (DoW) & Lisa Mazzella (DoW)
	Climate change - can policy adapt?	Michael Coote (DEC)
4:20-5:00	Overall Discussion	Facilitator – Lucy Sands
5:00	Close	

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Climate change is already modifying our wetlands and waterways. It is therefore imperative that we understand the impacts on these inland aquatic systems now, in order to manage and conserve them for the future.

Objectives of the Symposium

The presentations by invited speakers at this Symposium will outline current knowledge on the effects of climate change on aquatic systems across WA, including systems in remote areas of the state, such as the Pilbara, Goldfields and Kimberley.

This information and the knowledge of one hundred invited delegates, will be canvassed during panel discussions in order to:

- determine the state of our understanding of how climate change affects inland aquatic ecosystems in Western Australia and what research and management is in place to address this;
- clarify that all of the most important impacts to wetlands, groundwater dependent ecosystems, waterways and estuaries have been considered;
- highlight any gaps in knowledge, policies and management; and
- develop adaptation strategies.

The symposium seeks to identify the most important impacts, knowledge gaps and strategies, with a view to developing collaborative research projects and identifying key management interventions and policy changes or initiatives which address the impact of climate change.

Capturing your thoughts

It is our intention to compile the state of our knowledge on climate change in aquatic ecosystems and the way forward for adaptation research, management programs and policy. Your expertise is vital to this project and we would like to optimise your opportunity to contribute.

You will find with your abstract booklet a pad of sticky notes. Please use these throughout the day to capture any thoughts you might have while listening to the speakers. For each topic, any thought under the categories listed below would be most welcome. We ask you to put them up on the appropriately labelled poster boards around the room during tea breaks or lunch. There is an 'other' category, in case what you have to tell us doesn't fit neatly into the headings below.

At the end of the day, these notes will be collected and the information collated for use in the report that summarizes this symposium and future deliberations as to our way forward. Please ensure you write your name on each sticky note so we know who to contact should we require clarification or further information.

Categories:

- Rivers
- Estuaries
- Wetlands
- Groundwater Dependent Ecosystems
- Other

Please consider:

Climate Change Variable or Stressor,
Ecosystem component or process affected,
Impact or issue
Relevant region of WA
Consequences for the ecosystem
Adaptation Research (Current or Required),
Knowledge Gaps,
Policy and management practices,
Barriers.

Type of information wanted:

Your Name then:
Publications we should know about and where to find them if grey literature
Relevant policies and management practices
Current or planned research or activities
Anything we haven't considered
Contact person or source

What is NCCARF?

In 2008 the Australian government established the National Climate Change Adaptation Research facility (NCCARF) to lead the Australian research community in a national interdisciplinary effort to generate the information needed by decision makers in government and in vulnerable sectors and communities to manage the risks associated with climate change impacts.

NCCARF is based at Griffith University Gold Coast campus and has nine partners: The Queensland Government, Griffith University, James Cook University, Macquarie University, Murdoch University, The university of Newcastle, Queensland University of technology, University of Southern Queensland and University of the Sunshine Coast.

NCCARF's priority activities are:

- To provide national scientific leadership for adaptation research including the development of National Climate Change Adaptation Research Plans.
- To coordinate researchers and funders to implement the National Climate Change Adaptation Research Plans using resources available world-wide.
- To coordinate the Australian research community, particularly through the Adaptation Research Networks.
- To undertake synthesis and integrative research to address national priorities and synthesise existing and emerging national and international research on climate change impacts and adaptation.
- To communicate research findings and facilitate the adoption of adaptation knowledge.

Setting the scene.

Jane Chambers[1], Mike Coote[2], Frances D'Souza[3]

[1]WA Node, Water Resources and Freshwater Biodiversity, National Climate Change Adaptation Research Facility/Murdoch University; [2]Department of Environment and Conservation; [3]Department of Water

ABSTRACT

A starting point for this symposium is to note the key messages of the Millenium Ecosystem Assessment (*Wetlands and Water Synthesis Report*) that due to human impact the degradation and loss of wetlands is more rapid than other ecosystem, that global climate change is likely to exacerbate the loss and degradation of many wetland systems, and that this will lead to a reduction in the services provided by inland aquatic ecosystems, including their capacity to mitigate climate change impacts (eg flooding, reservoirs, carbon sinks, drought refuge). This symposium is about adaptation not mitigation but clearly a primary message is that to protect wetland and waterways we need to reduce the underlying cause of climate change at local, regional and global scales.

The purpose of this symposium is to enable adaptation strategies to manage climate change in our inland waters to the best possible outcome. This requires a coordinated approach involving all stakeholders, adapting policies and management based on sound science. The first step is to collate what is known about climate change spatially across our state; then relate how this will impact the ecological processes in different aquatic ecosystems (wetlands, rivers, estuaries and groundwater dependent ecosystems). From this compilation we can identify knowledge gaps that will enable us to prioritise research goals and also allow us to address current policies and management interventions to ensure their efficacy in a changing climate. The success of this enterprise will depend on encompassing all involved organisations and individuals to both contribute to our state of knowledge and then act upon the information relevant to their vocation.

Climate projections for Western Australia and their implications for water-dependent ecosystems.

Don McFarlane

Water for a Healthy Country Flagship, CSIRO, Floreat, WA

ABSTRACT

Temperatures throughout Australia have risen by about 0.9oC since the 1950s in line with trends elsewhere in the world. By 2030, temperatures are projected to be about 1°C higher compared with a 1980 to 1999 baseline.

South-west Western Australia experienced a climate shift in the mid 1970s and modelling indicates that about half of this can be attributed to enhanced greenhouse gas accumulations in the atmosphere. Almost all global climate models used by the Intergovernmental Panel on Climate Change's Fourth Assessment project a further 7% reduction in rainfall by 2030 for the region. This consistency is unparalleled in Australia and possibly the world.

Streamflow into Perth dams has already reduced by about 55% since 1975 in the south-west and is projected to decrease by a further 25% and by up to 42% under a dry extreme climate. The greatest impacts have been recorded, and are projected to be, for low frequency events such that floodplains are not inundated as frequently as they used to be. Periods of no streamflow will increase in some regions by between 2 and 3 months. There are indications that groundwater levels in a number of south-west forested catchments have fallen which has changed runoff mechanisms such that streamflows are now lower for the same rainfall.

In the past three decades, groundwater levels in the Perth Basin have declined where the recharge areas are covered by perennial vegetation. By contrast, areas that are used for dryland agriculture have reported rises in levels and these may continue at lower rates under a future hotter and drier climate. Therefore it is only in areas where wetland values have been affected by nearby clearing that levels are likely to remain stable or high in the future.

The situation for northern Australia is less clear. While temperatures are also projected to increase in the Kimberley, rainfall may remain at similar levels in future with the possibility of higher intensity, though the consequence for cyclones is still uncertain.

The Pilbara, Canning Basin and West Kimberley have recorded significantly elevated rainfalls in recent decades and this increase may be influenced by raised levels of aerosols resulting from particulate pollution over South-east and East Asia.

Relatively small changes in climate variables can result in amplified responses in hydrology. A rough rule-of-thumb for south-west WA is that a one per cent reduction in rainfall results in a three per cent reduction in streamflow. There are likely to be

cumulative impacts over long periods of below average rainfalls so such a relationship may not be constant. Groundwater levels are buffered against falls when the watertable is close to the surface (i.e. where groundwater dependent ecosystems are common) because reduced rainfall can be offset by corresponding reductions in drainage and evapotranspiration. Once levels fall below 5 to 6 metres this buffering effect is lost and levels may respond more directly to reductions in rainfall.

Recharge to groundwaters is also not always intuitive. As was modelled in northern Australia, a decreased in rainfall may generate increased recharge, despite decreased streamflow, if the intensity and sequencing regime changes.

Sea levels measured at Fremantle have increased by about 15cm since 1900 and an increase in storm surge activity has been observed since 1990. Globally sea levels are projected to rise by 18 to 59 cm by 2100 with the possibility of an additional 10 to 20 cm due to icesheet melting.

An increase in fire weather risk is likely in south-east Australia. While such a risk may exist elsewhere, it has not yet been examined. Reduced rainfall can result in lower fuel loads so the relationship with fire risk is complicated. Wetlands however are more prone to burning if water levels fall.

Changes in surface and groundwater in Western Australia.

Mark Pearcey

Surface Water Assessment, Water Resource Management

Department of Water

ABSTRACT

In many parts of Western Australia major shifts in climate have been observed over the last 20-30 years. In particular the south west of Western Australia has observed changes to annual rainfall volumes, the seasonality of rainfall and in peak rainfall events. However, there has also been an observed upwards trend in summer rainfall in the Kimberley and Pilbara regions over the last 40 years.

The winter rainfall decrease has caused a marked reduction of in streamflows in the south west. The most dramatic of observed reductions have been in water supply catchments for Perth, where inflows have reduced by nearly 50% since the 1970s and 80s.

With the exception of the Kimberley and possibly the East Pilbara, current climate change projections for Western Australia point to widespread reductions in available surface water and shallow groundwater. The relative scale and risk vary significantly across the State.

In the south-west of WA studies to date have shown rainfall scenarios of annual rainfall decreases of around 12-14% by mid-century. Catchment models have shown that these annual rainfall reductions are predicted to result in 30 to 44% reductions in annual streamflow. The impact of climate change on shallow groundwater resources, although it can take time to become apparent, may be as significant as the impacts on surface water resources.

Rivers in southwestern Australia: impacts of climate change and restoration priorities.

Peter M. Davies

Centre of Excellence in Natural Resource Management, The University of Western Australia, Albany,WA

ABSTRACT

Southwestern Australia was one of the first regions globally to experience significance climate change with a reduction in streamflow and an associated increase in temperature. In this region, a 20% reduction in rainfall has resulted in almost a 40% change in streamflow. Seasonal changes to this streamflow may impact on reproductive triggers for native fish migration and the predicted reduction in winter flows will minimise the flushing of pools which are important fish habitat. Drying will increase fragmentation of aquatic communities and more extreme events may expose fauna to conditions not historically experienced. However, changes to freshwater ecosystems due to increased temperature are often neglected and may substantially impact on aquatic fauna. The current and predicted water temperatures in southwestern Australia often exceed the thermal tolerances of aquatic fauna, particularly in more cleared catchments. Gondwanic fauna, characteristic of southwestern Australia, are typically cold stenotherms and therefore intolerant of elevated temperatures. River restoration activities in this region therefore need to focus on producing a suitable biophysical envelope within species' thermal tolerances. Riparian replanting can reduce water temperature and mapping at a catchment scale is a useful tool to spatially prioritise restoration activities.

Unique inland fishes of south-western Australia: how may climate change exacerbate current impacts?

Stephen Beatty

Freshwater Fish Group and Fish Health Unit, Centre for Fish and Fisheries Research, Murdoch University

ABSTRACT

The freshwater fishes of Western Australia have high levels of regional endemism and can be grouped into specific Drainage Divisions: the Kimberley, Pilbara, and Southwest Coast. The fishes of south-western Australia are depauperate yet represent the highest rate of endemism (80%) of any Australian Drainage Division. These fishes have been severely impacted by habitat alterations and introduced species that have resulted in considerable range reductions and localised population declines. In particular, secondary salinisation has caused major inland range reductions of freshwater obligate fishes and facilitated a concomitant colonisation by native estuarine or salt-tolerant feral species. Endemic freshwater species are now mostly found in the forested reaches of major rivers, small fresh tributaries, and lentic and lotic groundwater maintained habitats. We predict that forecasted climate change, particularly reductions in annual rainfall in the extreme south-west corner of W.A., will exacerbate many of the current impacts on these fauna. For example, rainfall reductions may reduce the availability or suitability of remnant fresh refuge habitats (both surface and groundwater) and also may lead to more favourable conditions for colonisation of introduced species. The presentation details the current impacts on these unique fauna in south-western Australia, identifies high-priority conservation habitats, discusses some of the key risks that climate change poses and also the gaps in current knowledge that need filling to enable more precise quantification of future impacts.

Aquatic ecosystems in tropical WA.

Michael Douglas

Tropical Rivers and Coastal Knowledge (TraCK), School for Environmental Research

Charles Darwin University, Darwin, NT

ABSTRACT

The wetlands and waterways of the north-west are some of the most valuable in the tropics. They are recognised for their high biodiversity and conservation values, they are a focus for tourism and they contain an abundance of bush tucker. But these habitats are also likely to be among the most vulnerable to the adverse effects of climate change. A number of studies have considered the potential impacts of climate change in northern Australia, including the freshwater habitats. There is general agreement that climate change will likely result in a rise in sea level, higher average temperatures, more frequent hot spells and more intense tropical cyclones and other events such as fires. There is also evidence that tropical fauna is more susceptible to the impact of elevated temperatures than temperate counterparts. In this presentation I will draw on the very limited evidence, consider the likely effects of climate change on aquatic ecosystems, highlight key knowledge gaps and make recommendations for management/adaptation responses.

Estuaries in a drying climate – Western Australia.

Malcolm Robb

Water Science, Water Resource Management, Department of Water

ABSTRACT

The climate in South West of WA is drying resulting in reduced winter flows to estuaries and more erratic rainfall delivery in summer with occasional flood events sufficient to open bar closed estuaries. Detailed observations of a number of estuaries over the last five years provide insight into the estuarine response to an increasingly unpredictable climate. Erratic rainfall delivery over time and across catchments results in less flow which results in lower nutrient load delivery. For bar open estuaries such as the Swan and the Hardy Inlet however the delivered nutrient and sediment loads are deposited in the upper portions rather than being flushed to sea. In combination with increased saltwedge penetration the upper portions of estuaries are becoming more productive and more prone to stratification, deoxygenation and fish kills. Shifts in phytoplankton populations may result with a potential for more harmful or nuisance species. In bar closed estuaries such as Wilson Inlet where the reduced winter flows do not break the bar a rethink of bar opening decision making may be required.

Western Australian estuaries and coastal wetlands.

Matt Eliot

School of Environmental Systems Engineering,

University of Western Australia, Nedlands, WA

ABSTRACT

Estuaries and coastal wetlands occupy a special niche in coastal geomorphology. They experience various combinations of marine and terrestrial forcing, and are often dynamic as the relative strength of these forcings vary. Estuaries are typically responsive to sea level, with moderate changes in sea level capable of developing relatively large differences in estuarine extent.

Whilst every coastal water body is demonstrably unique, classifications schemes have been developed to group estuaries according to similarities of geological origin, physical structure and dynamics. The anticipated response to climate change is a function of the dynamics, and hence classification schemes may provide guidance for the general patterns of change. Across Western Australia, all estuary classification schemes have a strong geographic pattern, following spatial trends in rainfall, synoptic drivers, tides, wave climate, geology, soil type and vegetation.

The structural effects of sea level rise are strongly influenced by the relative availability and mobility of sediments to the geomorphic units defining the waterbody. For low mobility systems, say barrier lagoons, wetland flats are expected to "drown" under accelerated sea level rise, whilst the barriers may become more susceptible to overwash and collapse. For moderate mobility systems, such as those with larger basins, wind-driven waves may transfer sediment from sub-tidal flats towards the banks, partly offsetting the inundation. On high mobility systems, such as tidal deltas, those with a distribution network may be capable of rising with sea level; if they fail to keep pace, they tend to form a coastal ridge and swamp.

Climate changes are expected to cause movements of the salt-fresh water interface in both estuarine and groundwater systems, with corresponding changes to zonation, generally towards increasingly marine conditions. Ecological consequences of these changes are strongly influenced by species resilience. Within areas of high resilience, species abundance is likely to change; for areas of low resilience, more complete ecological disruption may occur. This change may be exacerbated or reduced by corresponding physical changes, such as tidal creek extension or contraction.

WA's diverse wetland plant communities and climate change.

Bronwen Keighery[1] and Greg Keighery[2]

[1]Office of the Environmental Protection Authority;

[2] Department of Environment and Conservation

ABSTRACT

Naturally vegetated wetlands can be defined and categorised on the type, frequency and cover of wetland plants. However, there are few comprehensive listings of plant species that regularly occur in wetland habitats. Comprehensive point (quadrat) based studies of plant communities are available for the Swan Coastal Plain, Wheatbelt and Pilbara. These lists have been used to determine common or obligate wetland plants. Included in these lists are widespread species of upland plants that contain un-recognised wetland forms. These taxa together with a series of recognized restricted, often endemic taxa, contribute to the diverse nature of our wetland plant communities.

With climate change/drought many of these plants persist and indicate past wetland habitats, but will eventually disappear if dry conditions persist. However if wetter conditions return beyond the life cycle of these plants, the re-established wetland will support a very different set of plants. This change in plant communities will be further disrupted as a set of plants rely on flood events for dispersal and the extent of natural area fragmentation will disrupt distribution. Finally yet to be formally recognized plants and restricted known taxa may well become extinct in this process.

Wetlands, aquatic invertebrates and climate change.

Jenny Davis

Australian Centre for Biodiversity, School of Biological Sciences,

Monash University, Clayton, Victoria.

ABSTRACT

Wetlands in south Western Australia are particularly vulnerable to the predicted climate change scenario of a warming and drying climate. Little thermal buffering is present in large, shallow, open wetlands where water temperatures closely track air temperatures. Extended dry phases result in increasing terrestrialisation, and, ultimately, the complete loss, of small and large shallow seasonal systems. However, the Australian continent's long history of climatic variability has resulted in a suite of 'boom and bust' strategies conferring considerable resilience to wetland biota. The results of long term monitoring of selected Jandakot wetlands indicates that the richness and composition of the aquatic invertebrate fauna tracks rainfall. Although simpler, less diverse communities were recorded in drier years, richer and more diverse assemblies returned under wetter conditions. This fauna appears to be resilient with respect to current climatic and hydrological variability. However, other aspects of wetland condition, including the presence of invasive weeds during extended dry phases, and lack of a suitable duration of water on the wetlands for waterbird breeding, are causes for concern.

Climate change, wetland ecology and waterbirds in Western Australia.

Stuart Halse

Bennelongia Pty Ltd

ABSTRACT

Western Australia can probably be divided broadly into three areas in terms of how climate change will affect wetlands. There is likely to be little change in the extreme south-west of the State, where geological records show wetland conditions have been stable over the past 10,000 years. Elsewhere in the south-west, considerable change in wetlands is likely as a result of reduced rainfall, perhaps with more summer storms. Wetlands in the Wheatbelt will be under particular pressure with the twin stressors of climate change and salinisation. Wetlands in the northern and more inland parts of the State are likely to flood more frequently and probably to greater depth as a result of more monsoonal rainfall.

As a result of these changes, the proportion of the State's waterbirds using northern wetlands will increase and the Swan Coastal Plain will probably become less important as a summer drought refuge, as well as a breeding area. Some species of waterbird (and also insect) characteristic of the north are likely to extend their ranges southwards with increased summer rain. The waterbird species most likely to be adversely affected by climate change are southern specialists such as Chestnut Teal and, perhaps, Hooded Plover.

Impacts of climate change on subterranean wetlands in Western Australia.

Stefan Eberhard

Subterranean Ecology Pty Ltd

ABSTRACT

West Australian groundwater supports diverse faunas (stygofauna) that include many obligate groundwater-dependent species (stygobites), often belonging to relictual lineages, and which are typically short range endemics. These characteristics make stygofauna vulnerable to habitat changes, particularly reduced water quantity, which is a key stressor linked with climate change.

In southwest Western Australia, a drying climate trend experienced over the past three decades has contributed to declining groundwater levels in the limestone caves at Yanchep and the Leeuwin-Naturaliste region. Groundwater pools and streams in these caves are habitat for assemblages of stygofauna associated with tree roots which grow in the cave pools and streams. Because of the declining water levels, these Aquatic Root Mat Communities were listed as Threatened Ecological Communities (TECs) (status Endangered) under the Federal Environmental Protection and Biodiversity Conservation Act.

A PhD study of the Leeuwin-Naturaliste caves and dependent stygofauna communities characterised their ecological relationships with hydrology, vegetation, rainfall, climate and other potential threatening processes. Radiometric dating and stratigraphic levelling of sediments were used to reconstruct a history of groundwater changes in Jewel Cave spanning the Early Pleistocene to Present. During a period in the Late Pleistocene (35,000 to 15,000 BP) the groundwater regime was influenced by a series of extreme flooding events associated with intense storms and fire. The lowest palaeo groundwater levels were recorded near the end of the Pleistocene (ca. 12,000 BP), followed by generally elevated levels through the Holocene.

Molecular genetic DNA evidence from two species of crustaceans endemic to Jewel Cave suggests that the stygofauna survived in situ, the extreme flood events and low groundwater levels experienced in the Late Pleistocene. In the last five years however, groundwater in Jewel Cave has declined below the lowest recorded Pleistocene limit, and all known occurrences of its root mat stygofauna community have disappeared, including locally endemic species such as *Areacandona admiratio*.

Recovery Plans prepared for the Leeuwin-Naturaliste and Yanchep TECs have met with limited success, and almost all known occurrences have disappeared in the last few years. Faced with a continued drying climate trend in southwest Western Australia, the future outlook for survival of these and other unrecognized subterranean TECs is less than optimistic.

Recently the Augusta-Margaret River Tourism Association (AMRTA) has instigated measures to control and manage the groundwater decline in Lake Cave, by harvesting rainfall to supplement groundwater recharge and sustain the cave lake, which is a major ecotourism drawcard. In tandem with this, a major study funded by an NRM grant, is underway to understand the hydrology and stygofauna in Lake Cave, with the ultimate goal of developing management strategies for coping with climate change.

At a strategic level, a major knowledge gap for stygofauna in Western Australia primarily relates to their taxonomy and distribution patterns, especially in southwest Western Australia. The impact of a drying climate in this region is compounded by increasing extractive demands on groundwater resources associated with urbanisation in the Perth Basin. The coastal limestone aquifers, which occupy a narrow linear band and provide the most prospective habitat for stygofauna, are also most impacted by urban developments, reduced water quality and contamination, and potentially saltwater intrusion caused by pumping or sea level rise. A second major knowledge gap concerns the resilience and ability of stygofauna to withstand and recover from these threatening processes, especially groundwater decline. A third major challenge relates to management policy and responses as described herein.

Groundwater dependent wetland ecosystem response to hydrological change: examples of climate change impacts on the Swan Coastal Plain.

Ray Froend

Centre of Excellence in Ecohydrology and Centre for Ecosystem Management,

Edith Cowan University.

ABSTRACT

Groundwater dependent wetland ecosystems on the Swan Coastal Plain have undergone a phase of accelerated change in recent years. Reduced rainfall as a consequence of climate change has contributed to the alteration of wetland ecological character. For example, each wetland plant species is adapted to a specific hydroecological habitat, i.e. range in water level and inundation duration, and therefore plant distribution and vigour will ultimately be affected by hydrological changes. Shifts in species distribution, community composition and structure are generally the result of progressive changes in wetland water levels and can be useful indicators of change in wetland function and ecosystem services. Long term monitoring and analysis of wetland ecosystem response on the Swan Coastal Plain has facilitated the identification of temporal and spatial changes in the distribution, composition and structure of fringing vegetation relative to altered water regimes. This information is of particular value in identifying the boundaries of 'acceptable' change in wetland hydrology as defined by the hydroecological distribution of indicator plant species. Species with relatively narrow hydrological distributions indicative of wetter conditions are less likely to persist in scenarios with progressive drying, whereas those species with broader ecohydrological distributions are typically more persistent and likely to constitute resilient wetland vegetation. This presentation will discuss the nature of the change observed in groundwater dependent wetland ecosystems and the opportunities for future research.

Challenges for managing water in the face of climate change

Frances D'Souza and Lisa Mazzella

Waterways Section, Water Resource Management, Department of Water

ABSTRACT

Many of the current policies to protect surface water and groundwater dependent ecosystems need to adapt to climate change. These include policies that protect waterway health by determining the amount of water that can be abstracted, plan land use and activities in and around waterways, protect water quality and maintain the natural hydrology.

Abstraction limits are managed through allocation plans which are either already in place or soon to be completed for high demand surface and groundwater areas in the state. One parameter considered in determining allocation limits is the sustainable yield for these systems. For surface water systems, this includes ensuring environmental flows are minimally impacted by water extraction and are based on low flow years instead of averages. By using this approach, yields (hence security of water for users) can be maintained in a drying climate. For groundwater systems, sustainable yields are based upon maintaining minimum summer groundwater levels that still support groundwater dependent ecosystems (including vegetation, wetlands and river base flows). This is quite challenging in a drying climate and considerable investigation is being done to guide management approaches.

Protecting and managing the health of waterways and their estuaries and floodplains is partly achieved though controlling activities within designated foreshore areas. These protect aquatic habitat and water quality, reduce erosion and sedimentation and provide public amenity. Determining foreshore areas include consideration of the extend of fringing and upland native vegetation, hydrology, soil type, erosion, geology, topography, habitat, land use and social values, many of which are changing due to climate-induced stressors.

The risk of impacts from flooding to infrastructure and human health is managed using planning and development controls (i.e. using floodplain maps, including designating floodway areas and recommended minimum habitable floor levels). These are relatively flexible to potential changes under a changing climate. Further studies on how the magnitude of major floods will respond in a changing climate will assist with future management.

The designation of public drinking water source areas offer protection of water quality in surface water reservoirs and aquifers. Projected climate changes will potentially impact directly on catchment hydrology, thermal structure of the reservoir and the physical, biological, chemical and ecological processes occurring within the reservoir. Depending on the frequency and magnitude of impacts, water quality may be effected.

In the Wheatbelt, a significant issue is the enhanced recharge of groundwater systems, triggered in past decades by land clearing processes. As groundwater systems continue to recharge, the water mobilises salts which are then expressed as stream and surface salinity.

There is some suggestion that changing climatic trends, that is a general reduction in annual rainfall, in the Wheatbelt/South West is leading to a reduction in groundwater recharge and thus a reduction in salinity could be expected. This is not a clear trend and not a long term observation. Many catchments are not yet at a point where increased groundwater recharge is balanced by groundwater discharge (hydrological equilibrium). Current modeling suggests may slow but not offset the additional recharge still occurring in many inland catchments. A series of Wheatbelt catchment-scale drainage and water management plans are being developed. They will inform decision making on water related issues within Wheatbelt waterways and catchments, including helping to identify the potential implications of climate trends for salinity in specific catchments and assisting stakeholders on ways to manage these trends.

Investigations into the impacts and risks associated with climate change and vegetation management on the surface water catchments of the south west Western Australia are being conducted. It has been noted that some groundwater levels have been lowering in this region to the point that they have been seasonally disconnected from surface water systems. The result has been seasonal cessation of flow in waterways that had been historically perennial. The consequence of this is that critical habitats can be lost to unique communities of plant and animal life that have no time to adapt to the change and are not mobile enough to migrate. There is also a loss of water volume in supply reservoirs. It is considered likely that there are a number of other interactions and impacts that have not yet been clearly identified. The Department of Water has been working with stakeholders and research bodies to investigate the risks and likely impacts of climate change on these habitats.

Incorporating water sensitive urban design features in developed catchments will assist in managing hydrological changes expected under a changing climate. This has benefits in terms of water quality, aquatic ecosystems and also provides potential stormwater reuse through recharging of local aquifers. By retaining water on-site or within catchments, direct pollutant transport to receiving water bodies such as waterways and estuaries will be reduced. The increased retention time of water in wetlands and other vegetated water bodies could also improve water quality. Managed recharge of stormwater may also provide an additional water source for local wetlands and waterways where reduced rainfall have resulted in lower groundwater levels.

Resilience to the changing climate is being built through better integration of land and water planning and adapting relevant policies to consider climate change. The key is putting good planning in place, considering science and long term trends and managing water resources carefully through the transition.

Climate change - can policy adapt?

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ABSTRACT

Current wetland conservation policy is challenged to adapt to the present and growing threat from climate change. Adaptation requires knowledge of climate change impacts, the imminence and scale of impacts and the risks associated with impacts.

The two accepted pathways of adaptation to climate change are building resilience in the total collection of natural resources and managing risk to minimize impacts. Knowledge of these pathways must inform policy which itself can feedback to redirect climate change research and priorities for building resilience and managing the risks. We have knowledge at broad scales of what are the impacts from climate change and these will all lead to risks to water resource supply and biodiversity integrity and the institutions that manage them. The Wetlands Conservation Policy for Western Australia is a key policy that supports environmental impact assessment that together with national policy of the Commonwealth and the current plethora of programs for management of natural resources, may be able to direct and assist in adapting to early impacts of climate change. The success of adapting these policies to mitigating climate change impacts will invariably depend on political will, senior agency executive support and informed public lobbying.

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