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Submission from the Antarctic Climate and Ecosystems Cooperative Research Centre to the House of Representatives Standing Committee on Climate Change, Environment and the Arts inquiry into Australia's biodiversity in a changing climate

Well-constructed climate projections using global climate models and plausible greenhouse gas emission scenarios are useful tools in assessing the potential impacts of climate change on a global scale. To obtain salient climate projections at the regional scale, these global climate model outputs need to be 'downscaled' using state-of-the-art modelling techniques.

The *Climate Futures for Tasmania* Project undertaken by the Antarctic Climate and Ecosystems Cooperative Research Centre produced a unique set of downscaled climate projections at relevant scales across the whole of Tasmania. These projections were then analysed to provide information relevant to all sectors of the Tasmanian economy[i].

The principles and methods used in the *Climate Futures for Tasmania* project are now being applied to questions of biodiversity in Tasmania, and will also be applied in another case study region of the Australian Alps (see details below). The methods are applicable to the whole of Australia, and would produce valuable information to better understand the potential impacts of climate change on Australia's biodiversity.

All of the *Climate Futures for Tasmania* reports are available at:

http://www.acecrc.org.au/Research/Climate%20Futures

Climate projections for Tasmania

The results of the *Climate Futures for Tasmania* project most relevant to Tasmania's biodiversity are summarised below here.

General Climate Impacts[ii]

- Tasmanian temperatures have risen since the 1950's, but at a slower rate than mainland Australia (0.10 ^{0}C per decade since mid 20th Century, compared to 0.16 ^{0}C per decade for mainland Australia).
- Tasmanian rainfall has declined since the 1970's (similar to southern mainland Australia), especially in autumn.

- Average temperature is projected to rise over this century by about 2.9 ^{0}C under a reasonably high greenhouse gas emissions scenario (we are currently following a high emissions pathway). This is less than the 3.4 ^{0}C projection of global warming and much less than some other places in Australia and the world. Under a lower emissions scenario, average temperature is projected to rise by about 1.6 ^{0}C over the century.
- While state-wide average rainfall is projected to remain roughly the same, there are projected to be changes in the spatial distribution and seasonal cycle of rainfall across Tasmania. The projections indicate

    - a general increase in rainfall over the state in the winter, except for the Central Plateau.
    - a large increase in rainfall in summer in the east of the state (up to 20% under the high emissions scenario) brought on mainly by an increase in episodic heavier rainfall events,
    - a large decrease in rainfall in the west (up to 18% under the high emissions scenario), the region of the South West Tasmania World Heritage Area.

One of the consequences of these changes, along with changes to wind speed and humidity, is a change in wildfire risks. For example, the drier conditions in summer could lead to increased wildfire risks in the west, Central Plateau and highlands of Tasmania. Another ongoing project of the ACE CRC is the analysis of changes to fire risk with climate change in Tasmania (see below). Wildfire in combination with other changes (such as a general drying pattern in the central plateau) will have important implications for some plant and animal species.

Impacts on natural systems[iii]

While much of the biophysical analyses done in the *Climate Futures for Tasmania* project concentrated on the agricultural sector, these principles and results are applicable to understanding potential impacts of climate change on biodiversity. For example:

- The incidence of frost is projected to reduce by around 50% by the end of the century under a high greenhouse gas emission scenario.
- An increase in temperature, changes to rainfall patterns, loss of frost and cold days, increases in the number of hot and warm days, as well as other effects such as plant 'fertilisation' from increased CO_2 concentrations will affect the distribution, abundance and growth rates of plant and animal species across the state.
- Changes to agricultural growing conditions, and the relative advantage of Tasmanian industries compared to other areas, will

directly affect land-use pressure and the motivation for intensive practices such as irrigation. This will have obvious flow-on effects for biodiversity management.

- The *Climate Futures for Tasmania* Project demonstrated that by the end of the century parts of the north and east of Tasmania are projected to be suitable for persistent populations of Queensland fruit fly under a high emissions scenario. The biosecurity implications of climate change are not only relevant to agriculture but to biodiversity generally.

Catchment level analyses[iv]

The *Climate Futures for Tasmania* project produced sophisticated hydrological projections for Tasmania to the end of the century for 78 river catchments and 1900 sub-catchments (about 70% of the state).

- Changes to runoff with vary between regions. The highlands are likely to see significantly less average runoff (up to 30%), while average runoff is projected to increase in the east.
- Seasonal runoff is projected to change markedly, with increased runoff in winter in the west and lower runoff in summer.
- Just as important as average runoff is the incidence of high and low runoff and river flows. There is projected to be an increase in high events in some regions, as well as a decrease in runoff and river flows for much of the low summer events in the west (due to the decreased rainfall mentioned above).

Changes to the hydrology of catchments will have impacts on aquatic organisms and on habitats reliant on, or affected by flooding.

Extreme events[v]

Along with the general changes in temperature and rainfall, the *Climate Futures for Tasmania* project made projections for changes in the frequency and intensity of extreme events.

- There is projected to be a decrease in cold days, cold nights and frosts, together with an increase in summer days, hot days and extreme daily maximum temperatures. Some areas are projected to experience regular 'tropical nights' (minimum temperatures above 20 ^{0}C) under a high emissions scenario.

- There is projected to be an increase in warm days and warm spells (consecutive warm days) particularly in the central north and midlands, the Derwent Valley and the west coast.
- Climate warming is projected to generally lead to an increase in heavy rainfalls interspersed by longer dry periods. This includes an increase in rainfall intensity, heavy one-day rainfall totals and the rain brought by extreme rainfall events, as well as an increase in the number of consecutive dry days.
- Extreme tide and sea level events are also projected to increase with, for example, historical 1-in-100 year events likely to occur at twice the rate by 2030[vi].

Changes in extremes of temperature and rainfall will have direct effects on the distribution and abundance of species, and also through secondary effects. For example, increases in dry spells have implications for wildfire and habitat management. Increased flooding due to extreme rainfall events will have impacts on aquatic organisms and on habitats reliant on, or affected by flooding.

Increases in extreme sea level events tide, through increasing mean sea levels as well as changes to storm surges combined with high will impact coastal and estuarine habitats, especially those with easily erodible shorelines.

Ongoing work

The ACE CRC is currently participating in the *Landscapes and Policy* research hub funded through the National Environmental Research Program (NERP). This is a nation-wide research collaboration looking specifically at questions of biodiversity and management, including climate change as a core consideration. The general goal of the hub is to develop tools, techniques and policy pathways to integrate biodiversity into regional planning.

The ACE CRC is providing high-quality regional climate projections for the case study regions of Tasmania and the Australian Alps in close collaboration with the research hub's projects on bioregional analysis, wildlife futures, freshwater futures, vegetation and fire , social and institutional futures and economic futures:

http://www.environment.gov.au/biodiversity/science/nerp/hubs.html

The ACE CRC is also conducting a research program titled *Impact of climate change on bushfires and severe storms in Tasmania* funded through the National Disaster Resilience Program (NDRP). This project uses the climate projections made for Tasmania to examine questions in four main areas: bushfire weather and ignitions, bushfire fuels, severe storms and public policy implications. The work ties in with a network of bushfires researchers in Tasmania and around Australia, and will inform questions of biodiversity both directly and through the Landscapes and Policy hub.

In summary, well conducted climate modelling experiments, undertaken at appropriate scales, can provide vital information about potential environmental change, and in turn, provide the basis for assessing impacts of climate change on biodiversity. These kinds of climate modelling projections have been carried out on a limited scale in Australia – the *Climate Futures for Tasmania* project being the most comprehensive yet undertaken. These methodologies are applicable to all of Australia.

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[i] The published *Climate Futures for Tasmania* Reports are:

Technical Reports

Climate Futures for Tasmania: water and catchments technical report
Bennett, J.C., Ling, F.L.N., Graham, B., Grose, M.R., Corney, S.P., White, C.J., Holz, G.K., Post, D.A., Gaynor, S.M. and Bindoff, N.L. (2010). Climate Futures for Tasmania: water and catchments technical report. Hobart, Tasmania, Antarctic Climate and Ecosystems Cooperative Research Centre: 1-90.

Climate Futures for Tasmania: climate modelling technical report
Corney, S., Katzfey, J., McGregor, J., Grose, M., Bennett, J., White, C., Holz, G., Gaynor, S. and Bindoff, N. (2010). Climate Futures for Tasmania: climate modelling technical report. Hobart, Tasmania, Antarctic Climate and Ecosystems Cooperative Research Centre: 1-82.

Climate Futures for Tasmania: general climate impacts technical report
Grose, M., Barnes-Keoghan, I., Corney, S., White, C., Holz, G., Bennett, J., Gaynor, S. and Bindoff, N. (2010). Climate Futures for Tasmania: general climate impacts technical report. Hobart, Tasmania, Antarctic Climate and Ecosystems Cooperative Research Centre: 1-68.

Climate Futures for Tasmania: impacts on agriculture technical report
Holz, G., Grose, M., Bennett, J., Corney, S., White, C., Phelan, D., Potter, K., Kriticos, D., Rawnsley, R., Parsons, D., Lisson, S., Gaynor, S. and Bindoff, N. (2010). Climate Futures for Tasmania: impacts on agriculture technical report. Hobart, Tasmania, Antarctic Climate and Ecosystems Cooperative Research Centre: 1-86.

Climate Futures for Tasmania: extreme events technical report
White, C., Grose, M., Corney, S., Bennett, J., Holz, G., Sanabria, L., McInnes, K., Cechet, R., Gaynor, S. and Bindoff, N. (2010). Climate Futures for Tasmania: extreme events technical report. Hobart, Tasmania, Antarctic Climate and Ecosystems Cooperative Research Centre: 1-84.

Summaries

ACE CRC (2010). Climate Futures for Tasmania: water and catchments: the summary. Hobart, Tasmania, Antarctic Climate and Ecosystems Cooperative Research Centre.
ACE CRC (2010). Climate Futures for Tasmania: climate modelling: the summary. Hobart, Tasmania, Antarctic Climate and Ecosystems Cooperative Research Centre.
ACE CRC (2010). Climate Futures for Tasmania: general climate impacts: the summary. Hobart, Tasmania, Antarctic Climate and Ecosystems Cooperative Research Centre.
ACE CRC (2010). Climate Futures for Tasmania: impacts on agriculture: the summary. Hobart, Tasmania, Antarctic Climate and Ecosystems Cooperative Research Centre.
ACE CRC (2010). Climate Futures for Tasmania: extreme events: the summary. Hobart, Tasmania, Antarctic Climate and Ecosystems Cooperative Research Centre.

[ii] Grose, M., Barnes-Keoghan, I., Corney, S., White, C., Holz, G., Bennett, J., Gaynor, S. and Bindoff, N. (2010). Climate Futures for Tasmania: general climate impacts technical report. Hobart, Tasmania, Antarctic Climate and Ecosystems Cooperative Research Centre: 1-68.

[iii] Holz, G., Grose, M., Bennett, J., Corney, S., White, C., Phelan, D., Potter, K., Kriticos, D., Rawnsley, R., Parsons, D., Lisson, S., Gaynor, S. and Bindoff, N. (2010). Climate Futures

for Tasmania: impacts on agriculture technical report. Hobart, Tasmania, Antarctic Climate and Ecosystems Cooperative Research Centre: 1-86.

[iv] Bennett, J.C., Ling, F.L.N., Graham, B., Grose, M.R., Corney, S.P., White, C.J., Holz, G.K., Post, D.A., Gaynor, S.M. and Bindoff, N.L. (2010). Climate Futures for Tasmania: water and catchments technical report. Hobart, Tasmania, Antarctic Climate and Ecosystems Cooperative Research Centre: 1-90.

[v] White, C., Grose, M., Corney, S., Bennett, J., Holz, G., Sanabria, L., McInnes, K., Cechet, R., Gaynor, S. and Bindoff, N. (2010). Climate Futures for Tasmania: extreme events technical report. Hobart, Tasmania, Antarctic Climate and Ecosystems Cooperative Research Centre: 1-84.

[vi] ACE CRC (2010). Climate Futures for Tasmania: extreme events: the summary. Hobart, Tasmania, Antarctic Climate and Ecosystems Cooperative Research Centre, p17.