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From climate projections to climate change services in Australia – retrospective and future directions

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Australia is the World's driest inhabited continent. It is highly exposed to the impacts of climate change: surrounded by sensitive marine ecosystems including the Great Barrier Reef, vulnerable to tropical cyclones and changing monsoonal patterns in the north, experiencing declining rainfall and runoff in the heavily populated southern and eastern parts of the country, and subject to increasingly severe bushfires. The ever-present flood, drought and bushfire cycles have historically motivated government investment in programs that aim to understand the nation's climate and its drivers, and to inform adaptation planning and disaster risk management.

Accordingly, the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and the Australian Bureau of Meteorology (BoM) have been at the forefront of understanding Australia's past and future climate for four decades.

The most recent national climate projections were published in 2015. These focussed on the needs of the natural resource management sector and represented a first step towards delivery of climate change services tailored to the sector's needs. Products included decision support tools and provision of training for capacity building. A key component of the research program was stakeholder engagement from inception. The resultant Climate Change in Australia website (www.climatechangeinaustralia.gov.au) and Help Desk represented the most ambitious steps to date towards a comprehensive Australian climate change service, and were a first attempt at user-driven information delivery.

Now five years on, users' needs have evolved substantially. Key drivers of this include: (1) the Paris Agreement (2015) to limit global temperature rise to below 2.0°C (ideally below 1.5°C) above pre-industrial levels, (2) implications of the Taskforce for Climate-related Financial Disclosures (TCFD, 2017), and (3) IPCC Special Reports. This has occurred on top of a trend towards increasingly sophisticated uses of climate projections datasets for decision-making. Existing products do not meet all user needs. There is a pronounced 'pull' from users of climate projections for sector-specific "decision-relevant" information for risk-management decisions. The cross-jurisdictional impacts of climate change have also resulted in a need for authoritative, standardized and quality-assured climate scenarios for the entire country, to facilitate whole of sector, cross-agency and multi-sector responses and adaptation. As Lourenco et al (2016) said, climate change services for Australia need to shift from "science-driven and user informed services to user-driven and science

informed services.”

There is increased emphasis on sector-specific tools that aim to provide decision-relevant information and underpinning datasets. An ongoing challenge is the need to enable the uptake of climate information in decision-making. This necessitates a skill uplift on the user side. To date, efforts have focused on the water, finance, energy, and indigenous land management sectors. Increasingly, the focus within Australia is on working together across jurisdictional boundaries to provide nationally consistent information; with enhanced transparency drawing upon climate science resources within universities and all levels of government. Strong partnerships with the private sector are also needed in order to deliver to burgeoning demand. Success will require genuine co-design, co-production and co-evaluation of sector-specific products with a suite of support services appropriate to the needs of diverse users.