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Adapting the botanical landscape of Melbourne Gardens (Royal Botanic Gardens Victoria) in response to climate change

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ABSTRACT

Botanic gardens around the world maintain collections of living plants for science, conservation, education, beauty and more. These collections change over time – in scope and content – but the predicted impacts of climate change will require a more strategic approach to the succession of plant species and their landscapes. Royal Botanic Gardens Victoria has recently published a 'Landscape Succession Strategy' for its Melbourne Gardens, a spectacular botanical landscape established in 1846. The strategy recognizes that with 1.6 million visitors each year, responsibility for a heritage-listed landscape and the need to care for a collection of 8500 plant species of conservation and scientific importance, planting and planning must take into account anticipated changes to rainfall and temperature. The trees we plant today must be suitable for the climate of the twenty-second century. Specifically, the Strategy sets out the steps needed over the next twenty years to transition the botanic garden to one resilient to the climate modelled for 2090. The document includes a range of practical measures and achievable (and at times somewhat aspirational) targets. Climate analogues will be used to identify places in Australia and elsewhere with conditions today similar to those predicted for Melbourne in 2090, to help select new species for the collection. Modelling of the natural and cultivated distribution of species will be used to help select suitable growth forms to replace existing species of high value or interest. Improved understanding of temperature gradients within the botanic garden, water holding capacity of soils and plant water use behaviour is already resulting in better targeted planting and irrigation. The goal is to retain a similar diversity of species but transition the collection so that by 2036 at least 75% of the species are suitable for the climate in 2090. Over the next few years we hope to provide 100% of irrigation water from sustainable water sources, and infrastructure will be improved to adapt to predicted higher temperatures and more climatic extremes. At all times there will be a strong focus on assisting the broader community in their response to climate change.

1. Introduction

Over coming decades, the southern Australian city of Melbourne is likely to experience more extreme hot days in summer, less rainfall overall and more 'tree-toppling' storms (Australian Bureau of Meteorology, 2016, Figs. 1 and 2). Based on annual average temperatures projected for 2090, currently temperate Melbourne is expected to be warmer than present-day Sydney (a subtropical city, 870 km to the north-east), and more like Algiers in northern Africa, central China or the inland Australian town of Dubbo (Figs. 3–6).

Melbourne Gardens, one of two botanic gardens managed by the Royal Botanic Gardens Victoria (the other is Cranbourne Gardens, including the award-winning Australian Garden), is universally recognised as one of the most beautiful and stunning botanical landscapes in the world. For 170 years it has been home to a diverse collection of plants from across the globe, some of them rare and threatened with extinction, others awe-inspiring for their size, beauty or botanical curiosity. As custodians of this living masterpiece, the Royal Botanic Gardens Victoria has to plan for more than the next few years. Our 'planning horizon' should be calibrated more towards the life of a tree – a century or two. On that scale, climate change looms large. In 2002, the Royal Botanic Gardens Victoria embarked on an ambitious project (Working Wetlands) to collect, treat and distribute storm water from within and around

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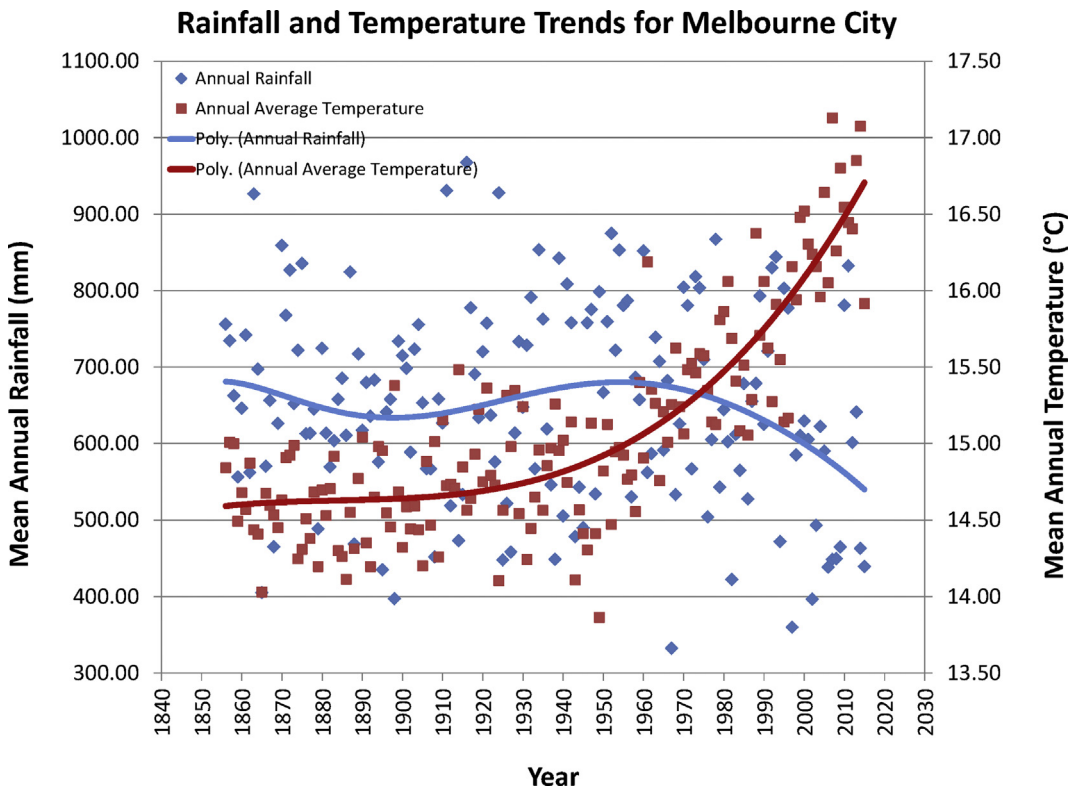

Fig. 1. Rainfall and temperature for the city of Melbourne 1855–2015. Data from Australian Bureau of Meteorology (2016).

Group	Parameter	Averaged	Now	+/-	2090
Temp.	Annual Mean (°C)	1986-2005	**15.9**	+3.1	**19**
	Mean Days >35 (°C)	1981-2010	**11**	+13	**24**
	Annual Mean Max.(°C)	1986-2005	**20.4**	+3.3	**23.7**
Rainfall	Annual Mean (mm)	1986-2005	**624**	-9%	**574**
	Winter Mean (mm)	1986-2005	**147**	-10%	**132**
	Spring Mean (mm)	1986-2005	**180**	-19%	**146**

Fig. 2. Current climate and that predicted for Melbourne in 2090. Data from Australian Bureau of Meteorology (2016) and Grose (2015).

the Melbourne Gardens. The combined infrastructure of a wetland filtration system, water treatment centre and complementary landscaping confirmed our reputation as world leaders in integrated water management. In 2016, we took the next step, adapting our living collections and landscape to the likely impacts of climate change.

2. Landscape Succession Strategy

2.1. Context and content

The *Landscape Succession Strategy* (Royal Botanic Gardens Victoria, 2016, Fig. 7) is a natural extension of the Working Wetlands project, guiding our transition to a botanic garden suited to the projected climate and environmental conditions of 2090 while retaining the Gardens' heritage character, landscape qualities and species diversity. Ambitious but achievable targets are set, including the kind of research and data needed to make evidence-based decisions. While no doubt you'll see more drought tolerant plants in Melbourne Gardens, it's not all about cacti and succulents. It's also about planting with new temperature regimes in view— 'heat tolerance' will need to become more part of the Australian plant selection vernacular! The Happy Tree (or Xi Shu; *Camptotheca acuminata*) beside the William Tell Rest House and the Rainbow Gum (*Eucalyptus deglupta*) at the end of Fern Gully are both water-loving trees doing very nicely beside our lakes. On the other hand, the Mexican Blue Palm (*Brahea armata*), prominent in the Guilfoyle's Volcano landscape, is a good example of an attractive and unusual plant we would recommend for drier situations. The Forest Elder (*Nuxia floribunda*) from Africa is expected to withstand the predicted higher temperatures but as a typical riparian species would likely require a situation with some available water. Each species is to be assessed on its merit, using the best available information on its climate preferences and tolerance,