Climate Change is Threatening Mangroves

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Grey Mangrove (*Avicennia marina*) in Sydney Olympic Park and nearby areas in eastern Australia appears to have been struggling to cope with climate change, particularly from extreme temperature events. This claim is based on the results of a 10-year study on the phenology of the Grey Mangrove, which was prompted by some prior observations that these mangroves had been flowering heavily, but had not been fruiting as successfully as they had in previous years.

The majority of the Grey Mangrove forests on the estuarine flats in Sydney Olympic Park (Figure 1) have developed after infilling with dredged materials from large-scale land changes at Homebush Bay on the edge of Sydney. Grey Mangroves have since colonized the site and this forest is now nearly 80 years old. The estuary is about 14.0 km from Sydney Harbour, which is the mouth of the Parramatta River that debouches into the Tasman Sea. Over this time period the greater Homebush Bay area has experienced extensive colonization by Grey Mangrove primarily due to sedimentation from catchment disturbances during the early decades of European settlement in Australia. It also has a history of industrial pollution, much of which was remediated in preparation for the hosting of the 2000 Olympic Summer Games.

This onsite study on the phenology of Grey Mangrove flowering and fruiting patterns (Figures 2 and 3) was initiated in 2012 and has been ongoing. Mangrove flowering and fruiting success have been quantitatively monitored at monthly intervals during the flowering and fruiting seasons. Whilst each one of those years have recorded significantly extensive flowering, fruiting was negligible, or almost absent other than for one year (2014). Closer examination of the ambient temperature in the peak flowering period, when early buds of the seeds (propagules) should be formed, have revealed two opposite phenomena. One, that sudden drops in night-time temperature by 20°C or more have caused mass dieback of flowers and subsequent dropping of dead flowers. Two, unusually sharp rises in temperature and/or a persistent high band of night-time temperatures over a few consecutive days have also had the same outcome. These phenomena are known to the researchers as 'chilling' and 'cooking' effects, respectively.

FIGURE 2. Early flower buds of the Grey Mangrove on February 4, 2019. (Photo by S. Paul)

Occasional observations in nearby estuaries have shown mixed results. Mangrove forests further away from the influence of regular tidal flushing have shown similar impacts, but those nearer the mouth of the estuary were displaying normal or near-normal abundance of propagules.

Further efforts to identify the actual causes of this poorer abundance in the mangroves in Homebush Bay and similar sites have not been undertaken. Nevertheless, the initial study prompts many hypotheses, including those given below.

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1. Grey Mangrove stands that are further away from the mouth of the sea are susceptible to temperature shocks due to their relatively weaker vigor from hydrological variations and salinity gradients.
2. Grey Mangrove stands that are standing on historical or even more recently polluted sediments are weaker and less able to handle temperature shocks.
3. Although Grey Mangroves are highly adaptable to environmental cues, micro-level temperature variabilities beyond a yet unidentified range might still influence their health and wellness.
4. Grey Mangroves in marginal latitudes are hanging on by a fine thread and some localized forests in such latitudes are more susceptible to climate change impacts than others.
5. Elevated levels of atmospheric carbon dioxide may be further weakening the already weak mangroves and climate change impacts are manifested in more pronounced extent.
6. Rainfall events specific to the early fruit bud formation period may be critical to the pollination and development cycle.

It is recognized that other, as yet unidentified, factors may be behind the negligible fruiting. Other contributing factors, such as storm events, lightning from electrical storms, air pollution, and pest attack were not considered to have influenced the above results. Therefore, it is postulated that Grey Mangroves in Sydney Olympic Park are highly vulnerable to climate change impacts in the form of temperature shocks. It is also plausible that one or a combination of several of the above hypotheses are applicable in this case.

Further studies are required to examine these hypotheses and confirm the actual causative factor(s). Getting to the bottom of the cause is an important objective of existing, albeit low-keyed, efforts to better manage these mangroves and maintain the biodiversity values of this important part of the local environment in the vicinity of the grand city of Sydney, the host of the 2000 summer Olympic Games, and to support the social-ecological legacy of those games that resulted in the creation and restoration of the parklands and wetlands within the Sydney Olympic Park.

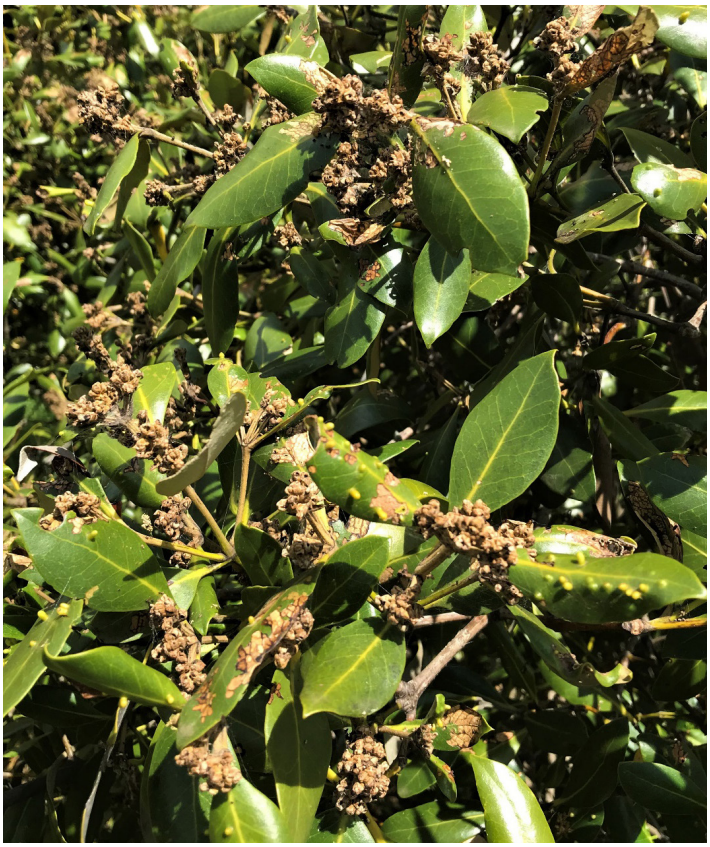

FIGURE 3. Flower dieback of the Grey Mangrove on February 26, 2019. (Photo by S. Paul)

Further information on the ecology and management of the Sydney Olympic Park wetlands, including the mangroves, is available in a "Workbook for Managing Urban Wetlands in Australia", edited by Dr. Swapan Paul, and accessible at https://www.sopa.nsw.gov.au/Resource-Centre/WET-eBook-Workbook-for-Managing-Urban-Wetlands-in-Australia. ■