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The Koonamore Project: 100 years of research in a short-term rangeland ecology study

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Abstract

The Koonamore project is based at the Osborn Vegetation Reserve, located in arid lands of South Australia, 350 km NNE from Adelaide. The site was established in a badly degraded corner of a paddock that was fenced off to exclude stock and rabbit grazing in 1925. A series of permanent plots and photopoints have been established at the site and resurveyed regularly.

The data collected (which is available for research on request) include location and sizes of trees and long-lived shrubs in several permanent plots, and sequences of photographs for over 40 permanent photopoints.

The accumulated information provides important insights on the changes that occur in rangelands when stock and feral grazers are excluded. It also informs us on the dynamic associated to weather fluctuations and trends of climate change.

To our knowledge this is the longest running ecological study of rangelands in Australia and one of the oldest in the world. However, as the data shows, this period encompasses just a few generations of several species (e.g. *Maireana sedifolia*, *Sena artemisifolia*) and even less than one generation for some of them (e.g. *Acacia aneura*, *Myoporum platycarpum*). Given the long life span of key species in the system, and the long term nature of climatic variation, we argue that a century is a relatively short term, and that the project warrants to be continued for at least another 100 years.

Introduction

The Koonamore Project was started in 1925 with the aim of obtaining information about the recovery of rangelands in extremely degraded conditions, when stock grazing was removed. This objective was framed within Clement's recently formalised ideas about ecological succession. The project was started by Professor T.G.B Osborn by fencing off a 4 km^2 of a heavily degraded paddock in Koonamore station (between 30º07'S, 139º20′E, in the centre of the Koonamore Station) (Figure 1). This area is now the TGB Osborn/ Koonamore Vegetation Reserve (KVR). Several permanent plots and photopoints continue to be monitored (albeit with some temporal gaps) to this day, which make this project (to our knowledge the oldest Long Term Ecological study in Australia, and one of the oldest in the world.

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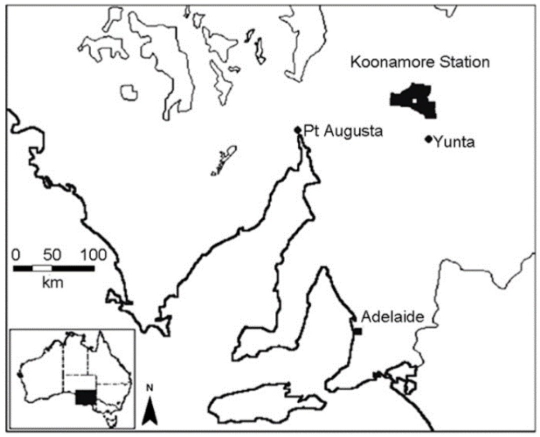

Figure 1: location of the T.G.B Osborn Vegetation Reserve, where the Koonamore Project is based.

The System

The whole area can be described as an open woodland with chenopod understorey, comprising a combination of low sand dunes alternating with sand plains and harder loam soils with travertine limestone at various depths on the intervening flats (Osborn, 1925). The annual rainfall, averages 200 mm, but shows substantial variability (between 50 and 850 mm during the period of the project). Vegetation is predominantly low open-woodland, with an sparse tree storey dominated by *Acacia aneura*, *Myoporum platycarpum* and *Alectryon oleifolius*. The tall shrub stratum include *Eremophila* spp., and *Senna artemisioides* (various subspecies). The low shrub stratum is dominated by *Atriplex vesicaria*, *Maireana sedifolia*, and *Maireana pyramidata*. Other shorter-lived chenopod shrubs grasses and ephemeral vegetation make up the lower stratum.

Central to the Koonamore Project are permanent plots where individuals of long lived plant species are mapped (x & y coordinates recorded) and, since the 1970's, dimensions of the canopy (diameters in N-S and W-E directions, and height) recorded. The main quadrat are four 100 m x 100 m areas representing the main types of vegetation (as understood when the site was established). (For more details see Sinclair and Facelli 2019). The data collected is in the public domain (currently through AEKOS (http://www.aekos.org.au/), and we are in the process of enhancing accessibility and ease of use. The data is particularly valuable since not only covers the recovery of the rangelands after de-stoking, but also the response of the system to variability in climate as the data covers several El Niño and La Niña events. It also includes several decades of important changes in climate driven by human activities.

Discussion and Conclusions

Previous recent publications (Sinclair 2005, Sinclair and Facelli 2019) report changes in population sizes, organization of the community (Lawley et al. 2013), persistence of dead logs and their effects in the creation of microsites (Bowman et al. 2014), and models of growth for the most abundant tree (*Myoporum platicarpum*) (Boland and Sinclair 2014). These publications, in our opinion, only cover a small fraction of the possible areas of research that could be explored using the massive data set accumulated. Here we present some of the areas of possible research we consider worth pursuing.

The data should allow studies of the life span of several species. The presence of species with highly contrasting life history strategies is well documented. The KVR data provide opportunities to assess several aspects of their demography. For example: is there a demonstrable trade off between life span and how often conditions conducive to recruitment occur? Because several species in permanent quadrats are mapped from establishment to death, the data base provides excellent opportunities for such studies. Equally, the role of density dependence in establishment and recruitment (a contentious issue in arid lands) can be effectively addressed with the data available. The site also provides unique opportunities to explore population genetics. The recording of date of establishment together with genetic information that can be obtained with molecular techniques could shine a light on genetic dynamics of plant populations recovering after undergoing a strong reduction in the number of individuals

The second important point we want to make is questioning whether, having reached the 100 years mark, is it worth continuing the project. It could be argued that data covering 100 years should contain ample information on the dynamics of these rangelands. Two issues are relevant. Firstly, we need to consider whether (still thinking within the Clementsian conceptual framework}, successional changes have reached a stable state. An inspection of the age population structure of some of the key species suggests that this is not the case. Indeed, populations of species such as *Myoporum platicarpum* and *Acacia aneura*) show sparse numbers of old individuals and relatively large numbers of juveniles, with no individuals in intermediate age classes. This suggest that these key populations have not reached a stable state. Further, as these species are likely to act as ecological engineers, it can be expected that as young individual mature, changes in soil and microhabitat will trigger further changes in ecosystem dynamics and in other populations. Secondly, to the successional consideration it must be added the influence of climate change. Indeed, this project has run during critical times for the climate of the planet. During the period global temperatures have risen by almost 2ºC. These changes, along with associated changes in rainfall patterns, have occurred as the vegetation and the ecosystem underwent recovery from extreme degradation. Compounding this, is the possibility of time lags in responses. Time lags are pervasive in ecological systems, and may be particularly important in rangelands, They may include responses of various species to changes in the soil, either produced by organisms, or by geological processes leading to soil formation. Microbial changes in the soil are also candidates to produce time lags. As soil changes through biotic and abiotic processes, soil microorganisms respond at different rates, which in turn through can lead to further vegetation changes.

These considerations highlight that various processes can occur in short periods of time, while others can take much longer times. Even when considering population dynamics only, species with relatively short life spans may complete several generations in a couple of decades, while species with long life spans may have not completed a single generation turnover in the 100 years of the project. Indeed, *Atriplex vesicaria*, with a life span of ca. 30 years may have have some 3 or four population turnovers. On the other hand species like *A. aneura* or *M. platycarpum*, with life spans of 150-250 years have not completed a single generation turn over. Thus, while for short lived species this project can be considered a long term study, for the later mentioned species this 100 year is a short term study documenting mortality of old individuals present at the site when the reserve was established, and establishment and recruitment of new individuals in episodic events, providing a simple snapshot of how the populations change. A corollary of this is that defining long term ecological studies require explicit identification of the variables of interest, and the identification of relevant time scales. Potentially, sampling intervals could also be defined in the same study at various intervals for the different variables.

Thus, in view of the importance of long lived trees in modulating the function of ecological systems, the required long time for changes to eventuate in rangelands, and the urgent need for better understanding of the effects of climate changes, we conclude that the Koonamore Project should be continued for at least another 100 years. Achieve this will not be easy, as several issues difficult the continuity of LTERs, Under most granting programs obtaining funds for this type of project is not feasible, so alternative sources of

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funding must be achieved (through establishment of specific funds to support the project via fund raising bequests, etc.). Secondly, the leading of such project do not always get the recognition they deserve, both at the institutional and global academic level. Finally, it is often difficult to ensure continuity requires academic succession planning. Given the importance of this type of studies there should be enough incentive to overcome these obstacles.

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