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Indigenous Water Engineering and Aquaculture Systems in Australia: The Budj Bim Cultural Landscape and Baiame's Ngunnhu (the Brewarrina Aboriginal Fish Traps)

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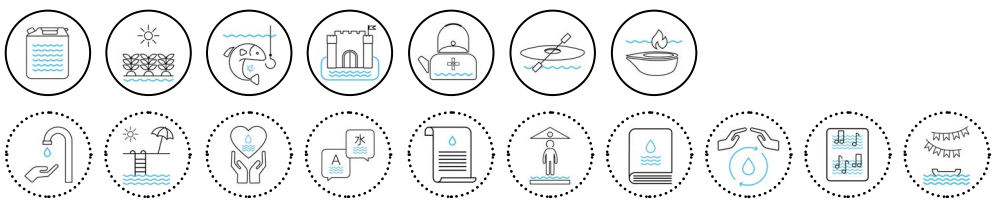
In Australia, First Peoples have practiced sustainable forms of water management for millennia. They have done so by respectfully caring for Country through their use of engineering and maintenance processes, including sophisticated fish and eel trapping structures and weir systems. Some of the largest continuing sites of water engineering and aquaculture in the world are still visible and used by local Aboriginal groups – the Budj Bim in Victoria and Baiame's Ngunnhu (Brewarrina Aboriginal fish traps) in New South Wales (NSW). Recent scholarship and successful heritage listings, including the World Heritage listing of the Budj Bim Cultural Landscape and work by and with traditional custodians in these river systems, are starting to bring into public discourse and knowledge these sophisticated and important places of global cultural significance. The principles used in the design of these systems, and the social and environmental contexts of their maintenance and convening power over millennia, are particularly important as we navigate new technologically mediated forms of water management today and into the future. These management challenges include communities in Australia and globally working on the importance of significant places, values, rights, justice and voice for Indigenous peoples in building sustainable futures, including through innovation and safe, sustainable and responsible cybernetic approaches to water governance and the SDGs.

Keywords: *First People, aquaculture, eel traps, fish traps, Free, Prior, and Informed Consent (FPIC)*

KEY THEMES



< Fig.1 Brewarrina Aboriginal fish traps – Baiame's Ngunnhu – 10 April 2024, view from outside the Brewarrina Aboriginal Cultural Centre on tour with Bradley Hardy (Source: Bradley Hardy, 2024).

Introduction

Fish-trapping systems are found all over Australia in both coastal and inland water systems (Martin et al. 2023). Traditional custodians of Country, whether of land, water, sea or sky have continuously kept knowledges and forms of governance of these structures alive through cultural practices, including the maintenance of songlines, ceremonies, oral histories and art (Neale and Kelly 2020). The ingenuity and sophistication of the fish-trapping and aquaculture practices of Aboriginal and Torres Strait Islander peoples have always been known by the communities managing and maintaining them; they have also been acknowledged by settler colonists in Australia (see examples in Pascoe 2014; Dargin 1976; Coutts et al. 1978). More recently, specific instances of these systems have been acknowledged as heritage places at the state, federal and international levels. In particular, the Budj Bim Cultural Landscape in South-Eastern Victoria is considered one of the oldest examples of an aquaculture complex in the world. It has been carbon dated to at least 6,600 years, constructed from basalt rocks from a volcanic lava flow, and managed by the Gunditjmara using a variety of practices and technologies, including adding woven traps to the rock structures (UNESCO 2019; Gunditjmara and Wettenhall 2022; Rose et al. 2016). The cultural landscape and effective management of water for the community, including food production, also includes clear evidence of rock-built living structures, supporting the relatively sedentary lifestyles of Aboriginal peoples in the area (Pascoe 2014; ADEE 2017). Another prominent example, Baiame's Ngunnhu at Brewarrina on the Barwon River in the Barka-Darling River basin system and on the edge of the Great Artesian Basin groundwater system in Northern NSW, is also millennia old. Baiame's Ngunnhu is central in the creation stories of Country and cultural practices and ceremonies of the many Aboriginal groups who have built, maintained and used the large system of rock weirs and fish traps, shaped itself like a large fishing net (DAWE 2005). The Ngunnhu is the "largest system of traditional fish traps recorded in Australia" (NSW Government 2022) and is believed to be over 40,000 years old which would make it one of the oldest surviving human-made structures in the world (Ngemba CWP 2019). It is known as one of the most important meeting places for Aboriginal people in South-East Australia. The Ngunnhu is particularly used during medium and low-flow periods in the river but has been engineered to withstand high flows. Repair and maintenance is possible in low-flow periods (Dargin 1978). Both examples of Indigenous engineering, culture and shaping Country for community are important in dispelling the myths of *terra nullius* and *aqua nullius* (Marshall 2017) perpetuated through the colonization of the Australian continent, particularly because they are both sites of important Indigenous resistance, knowledge, values and strength of community (Bell and Johnston 2008; Gunditjmara and Wettenhall 2022; Maclean et al. 2012).

Current Approaches to Preserving and Managing Water Heritage

Heritage preservation and management of fish and eel-trapping sites across Australia varies, with traditional custodians and land management corporations working with governments

1. As explained by AIATSIS (2022), "Country is the term often used by Aboriginal peoples to describe the lands, waterways and seas to which they are connected. The term contains complex ideas about law, place, custom, language, spiritual belief, cultural practice, material sustenance, family and identity."

^ Fig. 2 Water flows through the Brewarrina Aboriginal fish traps – Baiame's Ngunnhu – 10 April 2024, view from outside the Brewarrina Aboriginal Cultural Centre on tour with Bradley Hardy (Source: Bradley Hardy, 2024).

and other bodies to develop recognition and support of these sites. Each system and community's journey is different, with much work still ongoing.

Baiame's Ngunnhu was inscribed on the NSW State Heritage Register on 11 August 2000 (NSW Government 2022) and on the National Heritage List on 3 June 2005 (DCCEEW 2021a), with the Ngemba people as traditional custodians, and recognition of the shared importance, maintenance and cultural significance with many neighboring First Peoples. The importance of the site is highlighted in the Brewarrina Aboriginal Cultural Museum constructed in 1988, which now stands in the listed area following an extension in 2015. Significant efforts have been undertaken in engagement and truth-telling to the community through in-person tours and social media, including an active Facebook page, and the system is now highlighted in many education programs, including in cultural, engineering and cybernetics education, at all levels in Australia (e.g., Ruddell and Randell-Moon 2022; Butta 2021; Pascoe 2019). The Ngunnhu has been significantly impacted by colonization. For example, changes have been made to the system to allow paddle steamers

to navigate, and weirs have been constructed for irrigation, which has changed water regimes and blocked the passage of fish. Listings and management plans suggest that both the preservation of values and additional restoration are possible and a number of activities have been undertaken to support this, including some trap wall reconstruction and an engineered fish ladder (MacClean 2012; NSW Government 2022). The ability to restore water in the area (Jackson 2022) and to support traditional custodians in leading restoration efforts and governance will be key to success. Discussions are ongoing regarding the potential for World Heritage listing and an application is in development (Ngemba CWP 2019).

The Budj Bim Cultural Landscape is managed by traditional custodians through the Gunditj Mirring Traditional Owners Aboriginal Corporation and a range of other governance mechanisms (ADEE 2017). Budj Bim was inscribed on the National Heritage List on 20 July 2004, recognized as an Engineering Heritage National Landmark on 20 October 2011 (Peake 2011; Jordan 2011), and inscribed on the UNESCO World Heritage List on 6 July 2019 (DCCEEW 2021b). The Traditional Owners work under a participatory and collaborative framework with the Victorian Government and others, as outlined on the Budj Bim Cultural Landscape website, and have aligned their efforts with future management objectives as outlined in their Masterplan 2022–2030 (Arup 2022); these include the pursuit of economic opportunities through low impact tourism, site development, cultural preservation and ensuring community access. Budj Bim is regularly used in education in a range of domains, including as an applied case study in the University of Melbourne's Indigenous Engineering and Design course, where students learn and work with Traditional Owners on Country (Bowra 2020; Prpic and Bell 2022).

The significance of fish-trapping structures and technologies across Australia is also given a prominent place in the First Australians gallery in the National Museum of Australia in Canberra.

Current and Future Challenges to these Water Systems

As a Federal nation, throughout the continent there are jurisdictional differences and historical legacies of colonization that impact approaches to the custodianship of fish-trapping sites that are significant to Indigenous people. At both national and state levels, reforms related to water policy are underway to improve the management of land, water and extreme events. Increasing variability and shifts in climate due to global warming, along with high water demand and extractions throughout the river basin, are impacting flow regimes, ecological health and fish availability, and hence the ability of traditional custodians to care for the Country and these sacred sites. This is particularly the case in the Barwon and Barka-Darling Rivers, part of Australia's famous and over-allocated Murray-Darling River Basin, where Indigenous water injustice through a lack of allocations is particularly acute in relation to colonial-settler allocations (Hartwig et al. 2021). Reforms to support justice for Aboriginal and Torres Strait Islanders across Australia are also gaining significant attention following the Statement from the Heart signed in Uluru (PCoA 2018) and the 2023 Constitutional Referendum (not passed) on an Indigenous Voice to Parliament, although this is only one part of the proposed changes required for justice for First People, which include the need for Treaty, Truth and *Makaratta* (reparations and "walking with a limp") (Loughrey 2022; PCoA 2018; Linder and Hobbs 2023). In Victoria, state-level Aboriginal Water Initiatives and processes that recognize and pro-

^ Fig. 3 The Brewarrina Aboriginal Cultural Museum – 10 April 2024, on tour with Bradley Hardy (Source: Bradley Hardy, 2024).

mote Aboriginal-led management of water as part of Country have gained support through government action, collaborative partnerships, and efforts to raise public awareness. These initiatives are increasingly seen as a source of pride at both the state and national levels, providing momentum for further action following initial steps toward rectifying injustices. These include the foregrounding of Aboriginal engineering ingenuity through the Budj Bim Cultural Landscape with its World Heritage listing and strategic management plan, and the recognition of the Yarra River in Melbourne as a living entity with legal protections through the Yarra River Protection (Wilip-gin Birrarung murron) Act 2017 (Wardle 2021). Despite some small federal reforms to include greater provisions for Indigenous values and more Indigenous engagement in formal structures in the Murray-Darling River Basin and current discussions on reforms to enhance this component of the National Water Initiative, at the NSW state level, work toward Indigenous recognition, water rights and Aboriginal-led water governance initiatives have had a rockier history. Progress was made during the time of the NSW Government Aboriginal Water Initiative (Taylor et al. 2016), but since the initiative's discontinuation and due to larger political conflicts and media attention on issues such as massive fish kills and alleged

water theft (Jackson 2021), progress has been slower. Potential directions for future water reforms are in dispute; these include increasing investments in water infrastructure, including by installing new dams, higher weirs and irrigation technology upgrades, which local Barka-Darling Indigenous communities say will further impact their ability to care for Country, including the fish traps. Moving forward on core issues of Indigenous justice in NSW will likely provide traditional custodians of Country – including the Ngemba custodians of Baiame's Ngunnhu and neighboring First Peoples groups who share it as a significant cultural place – with a greater platform for gaining broad support for Ngunnhu futures in an uncertain and changing world. These futures will include whether greater legislative protections and/or international-level recognition is sought and how these might uphold Indigenous values and rights (Moggridge 2021; Moggridge and Thompson 2021; Hartwig et al. 2021, 2022; SoE 2021), offering cultural, economic, social and environmental benefits to Indigenous and other communities with whom the fish traps are shared.

Conclusion and Future Approaches

The millennia-old Indigenous aquaculture complexes around Australia, of which Budj Bim and Baiame's Ngunnhu are prominent examples, present a range of principles that can support more sensitive and sustainable ways of caring for Country, kinship networks and community globally. These are engineered systems that work carefully with flow, ecology, climate changes and culture to sustain communities and help them thrive. These examples of water engineering, aquaculture and cultural heritage also extend global knowledge about continuing cultural practices, heritage preservation and evolution into deep time in a way that is not so commonly recognized outside of Australia but is gaining traction (e.g., Iwabuchi 2022). More importantly, these systems are not just part of cultural heritage and the past but are intimately involved in current discussions and practices about building the future (Bell 2021a, b): they are enmeshed in the "everywhen," an Indigenous perspective on circular time (McGrath et al. 2023). These are sophisticated technological systems that show environmental and social sensitivity through their careful design and engineering. Continuous maintenance and renewal rely on complex governance processes focused on respect, meeting, sharing and ceremony. Working with Country – connecting to it, shaping practices and adapting with it rather than working against it to control "resources" that are seen as separate from place and community can be an inspiration when addressing many of today's challenges with technology, environment and society (Butta 2022). Indeed, Country-centered design is supporting the development of culturally appropriate technologies needed to underpin sustainability, including artificial intelligence (Abdilla et al. 2021). Such design is being included in education at all levels. The principles and inspiration from these examples and others across ancient living water systems can facilitate means of creating more effective Country-centered and "two-ways" governance systems, help to bridge knowledges in today's world and offer open space for listening to Indigenous leaders (Bawaka et al. 2015; Daniell and Daniell 2019; RiverOfLife et al. 2021). This is a holistic and cybernetic approach that has more universal application when linked to the implementation of the UN Declaration on the Rights of Indigenous Peoples (UN 2018) and the pursuit of the achievement of the SDGs in safe, responsible and sustainable ways (Daniell et al. 2022).

Policy Recommendations

- Any proposed international, national or local actions related to Baiame's Ngunnhu, Budj Bim and other Indigenous places of value should be led by traditional custodians and/or through free, prior and informed consent (FPIC) to develop proposals (UN General Assembly 2018). Appropriate processes for FPIC should benefit and not burden traditional custodians and be carried out in alignment with the UN Declaration on the Rights of Indigenous Peoples (UNDRIP).
- Translation of FPIC and UNDRIP principles to specific proposals may require significant professional and cultural support to ensure recognition and practice in accordance with the relevant First Peoples' cultural protocols, depending on who seeks to engage in the process.
- Investing in Indigenous leadership and high-quality FPIC processes can build sustainable support and justice for Indigenous peoples.

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