Sustainability in action: mangroves as eco-engineers

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The term sustainability appears in almost every article, paper or political statement one sights these days. Wisely, the President of Engineering New Zealand, Dr Tim Fisher, highlights a vision for New Zealand based on 'resilient, sustainable economies and communities' (EG, September, 2022). For over 30 years the New Zealand Coastal Society has brought much needed focus to the huge and diverse shoreline of Aotearoa. Ecologists and engineers, especially, hold the key that can continue to translate this vision and focus into pragmatic reality; for what is needed most of all today are ways to measure sustainability and case studies of sustainability in action.

In this article we look at a novel yet interesting and hugely practical case study of how the foresight, wisdom, and imagination of a civil engineer ensured the sustained use of mangroves to protect human-made stop banks beside the Piako and Waihou Rivers of the Hauraki Plains. These twin rivers once brought estuarine and marine waters to what were flood plains of this region of Waikato. Without mangroves on the seaward and estuarine sides of the stop banks, coastal erosion was and is an ever-present challenge. Mangroves function as bio-engineers that sustain and maintain the stop banks. The stop banks function to protect the valuable dairy farms of the productive Hauraki Plains from tidal invasion. Figures 1, 2 and 3 illustrate these mangrove eco-engineers in action. A long history of optimistic pioneering in measures to drain the once semi-stagnant waters of this region of New Zealand was described years ago by Gillespie (1948).

More recently, a plant pathogen that was associated with mangrove dieback was found in the mangrove forest ecosystem near Pipiroa, beside the Piako River (Maxwell, 1968; Maxwell, 1971). This microbe is closely related to the causal organism of kauri dieback, as they both belong to the genus *Phytophthora*, a plant destroyer of global significance (Newhook, 1959; Newhook and Podger,1972; Beever 2010; and Hood, 2021). The discovery of this pathogen in mangroves was unwanted bad news to what was the Hauraki Catchment Board (HCB) back in the 1960s and 1970s, which had responsibilities in preventing tidal invasion of the Plains (see the dedication at the end of this article).

Very recently, these mangroves of the Thames Estuary and the twin rivers of the Hauraki Plains, the Waihou and Piako, were the focus of a public debate on mangroves. A parliamentary sub-committee was set up to investigate the issue. The main finding was that most citizens did appreciate the values of mangroves in terms of biodiversity, fisheries protection and stop bank protection, despite some minority counter viewpoints (Maxwell, 2018).

Climate change can be expressed in many ways. One frequently used line on climate change is that of sea-level rise. In the context of our Hauraki Plains case study, this aspect shot into stunning focus when tidal invasion of coastal land hit the news back in January 2018 (*Waikato Times*, January 24, 2018). Coastal roads along the western side of the Coromandel Peninsula and farmland near Miranda on the eastern side of the Firth of Thames experienced a tidal invasion event. This was a costly event and the evidence of salt water shock on pasture was visible, especially where mangrove stands were meagre. Tidal invasion events have been recorded before in the history of the Hauraki Plains. Reports of a shark stranded in a cow

Figure 1: Human (for scale) on the stopbank points towards the seaward mangrove belt; vehicle is adjacent to low lying farmlands of the Hauraki Plains. The Piako River flows just seaward of the mangrove belt (Photo: Gordon S Maxwell).

Figure 2: Stopbank protected by mangrove forest beside the Piako River on the Hauraki Plains, Waikato region, February 7 2023 (Photo: Gordon S Maxwell).

shed near the stop banks of the Piako a kilometre from Pipiroa exist (Maxwell, 1971). Mangroves feature in Māori culture and are valued. Indeed, the Māori name for the New Zealand mangrove is *Manawa*, which heralds an ecosystem respect system in which *Manawa* means heart. *Manawa* is like the mother of the harbour for fisheries (Kennedy, 2018).

Today, some 64,000 ha of valuable farmland worth NZ$34,265 per ha exists on the Hauraki Plains. In modern math terms the value can be expressed as 2.216946 e 9 in $. Expressed in English rather than obscure maths, this equates to some 2.2 billion dollars worth of property: a colossal figure. The mangrove belts on the estuarine and seaward side of the stop banks which decorate the Plains, are providing an ecologically based service which is of massive economic importance. This importance of mangroves can be measured in many ways, of which fisheries (Paphavasit et al, 2009) and stop bank protection are perhaps the two top examples. In the southern islands of Japan's Okinawa archipelago, shelter from cyclones (typhoons) is another (Maxwell, 2006).

The case study described above provides a much-needed example of how we can put a dollar value on what some books and scientific papers describe as 'the goods and services' of ecological and biological resources. For far too long we have just made comments and claims relating to the value of natural resources. Figures are rare or absent. The UK Sustainability Development Strategy of March 2005 highlighted the idea that we must respect natural resources to allow ecosystems to provide the life and economic support systems to do their job; in short people and their economies must have a strategy of 'living on earth's income rather than eroding its capital'.

As shown by Maxwell and Fung (2015) sustainability can be applied even in ultra-urban environments like most of high-rise Hong Kong. Here in one of the world's top financial hubs, climate change and sustainability has penetrated corporate business plans and statements. The concept has relevance and power. In an earlier edition of *Hong Kong Engineer* (once known as *Asia Engineer*) Irene Or advocated that we avoid allowing the word sustainability to be some sort of panacea without real meaning (Or, 2000).

What better way to inject real meaning into the twin terms of sustainability and sustainable development than quantifying

Figure 3: Waihou River edge, Firth of Thames in skyline, mangrove belt, stopbank and dairy cattle on farmland protected by the stopbank/mangrove system (Photo: Gordon S Maxwell).

their value. Our case study of the immense value of mangrove trees and shrubs to the farmlands and coastal settlements of the Hauraki and Coromandel regions does this. And does so in dollars. Engineers and those who are attracted to those professional orientations that see the values of our remarkable New Zealand coastline such as coastal geomorphologists, mangrove ecologists and foresters and conservationists are the sort of people that can help sustain our coastal environment for all in Aotearoa.

The adaptations inherent within Manawa, our New Zealand mangrove, *Avicennia marina*, offer a natural system to sustain a process of adaptation in the face of sea-level rise. This was the very theme highlighted by Lucy Brake in the NZCS Special Publication 5, *Coastal Adaptation*, of November 2022[1].

Dedication

This article is dedicated to the memory of former Chief Engineer of the Hauraki Catchment and Regional Water Boards, RW Harris, DSC, BE who with wisdom and foresight created a Hauraki Catchment Board Scholarship to support the MSc (Hons) research needed to save the mangroves and stop their mortality in the environs of Marshalls Flood Gate, near Pipiroa beside the Piako River (see Maxwell, 1971). These Boards were absorbed into the Waikato Regional Council. The value of mangroves as eco-engineers remains.

(1) *Coastal Adaptation: Adapting to coastal change and hazard risk in Aotearoa New Zealand*, available on the NZCS website www.coastalsociety.org.nz

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