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# Using remote sensing and traditional ecological knowledge (TEK) to understand mangrove change on the Maroochy River, Queensland, Australia

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ABSTRACT

Mangrove forests support a variety of ecosystem functions and services imperative for ecosystem health. Despite the importance of mangroves, however, mangrove forests worldwide are under threat from human development and climate change. To date, most research on mangrove change in Australia has drawn on approximately 40 years of remotely sensed imagery, a fraction of the time period required to assess spatial change. To improve our understanding of mangrove change, data were collected using historic and current remotely sensed satellite imagery and participatory mapping with Kabi Kabi Traditional Owners to assess mangrove change on the Maroochy River, Queensland, Australia. The results indicate that mangrove extent in the lower Maroochy River has changed significantly since European colonisation in the mid to late 1800s, and declined in recent decades by approximately 30%, a rate similar to global estimates of mangrove loss. Past drivers of change included land clearing for cattle grazing and sugar cane production, and present drivers include agricultural activities, population growth, rapid urbanisation and discharge of pollutants and sewage. These changes have consequences for coastal protection, water purification, biodiversity and cultural services. This research demonstrates how using traditional ecological knowledge (TEK) and remote sensing for understanding ecosystem change, particularly where scientific data are limited, can increase the time period during which change is assessed and enhance the detail and scope of the assessment.

## 1. Introduction

Mangroves grow exclusively within the intertidal zone of tropical and sub-tropical coastal regions, while saltmarsh ecosystems typically occupy the upper tidal zone but below the highest astronomical tidemark (Aslan, Rahman, Warren, & Robeson, 2016). These transitional ecotones are uniquely placed where ocean, land and fresh water converge, and perform a number of ecological functions that are vital to the health of near-shore marine environments and surrounding terrestrial systems (Kathiresan & Bingham, 2001). Research on mangroves in the Caribbean Sea (Sedberry & Carter, 1993), Indian Ocean (Pinto & Punchihewa, 1996) and Coral Sea (Morton, 1990) show that ecological functions are highly productive within large mangrove forests (Nagelkerken et al., 2000). The benefits provided by mangroves, however, stretch far beyond ecological boundaries. The estimated financial capital provided by these ecosystems approximates to US$1.6 billion (1997-dollar value) globally each year in ecosystems services (ES), which benefit many coastal communities (Aburto-Oropeza et al., 2008; Costanza et al., 1997). The Millennium Ecosystem Assessment (2005) categorised ES into four key factors: supporting, provisioning, regulating and cultural services. These services include water purification, nutrient cycling, carbon sequestration, biological control, food production, pollution control, shoreline defence, and sense of place and spirituality (Kathiresan & Bingham, 2001; Zedler & Kercher, 2005).

Mangrove and saltmarsh ecotones are sensitive to the onset of both natural and anthropogenic drivers of change (Lovelock et al., 2015). For example, human population growth and changes in desired spatial occupancy has seen more than 50% of the global population relocate to coastal areas prompting rapid development in these regions (Marine, 2006). Consequently, large expanses of coastal ecosystems including wetlands, mangroves and saltmarsh have been removed, reclaimed or heavily degraded, reducing water quality, habitat availability and vital ES (Polidoro et al., 2010). Conditions that are considered to have the greatest impact globally on mangroves include, sea-level rise (SLR), extreme high-water events, storms, and changes in precipitation, temperature and ocean circulation patterns (Gilman, Ellison, Duke, & Field,

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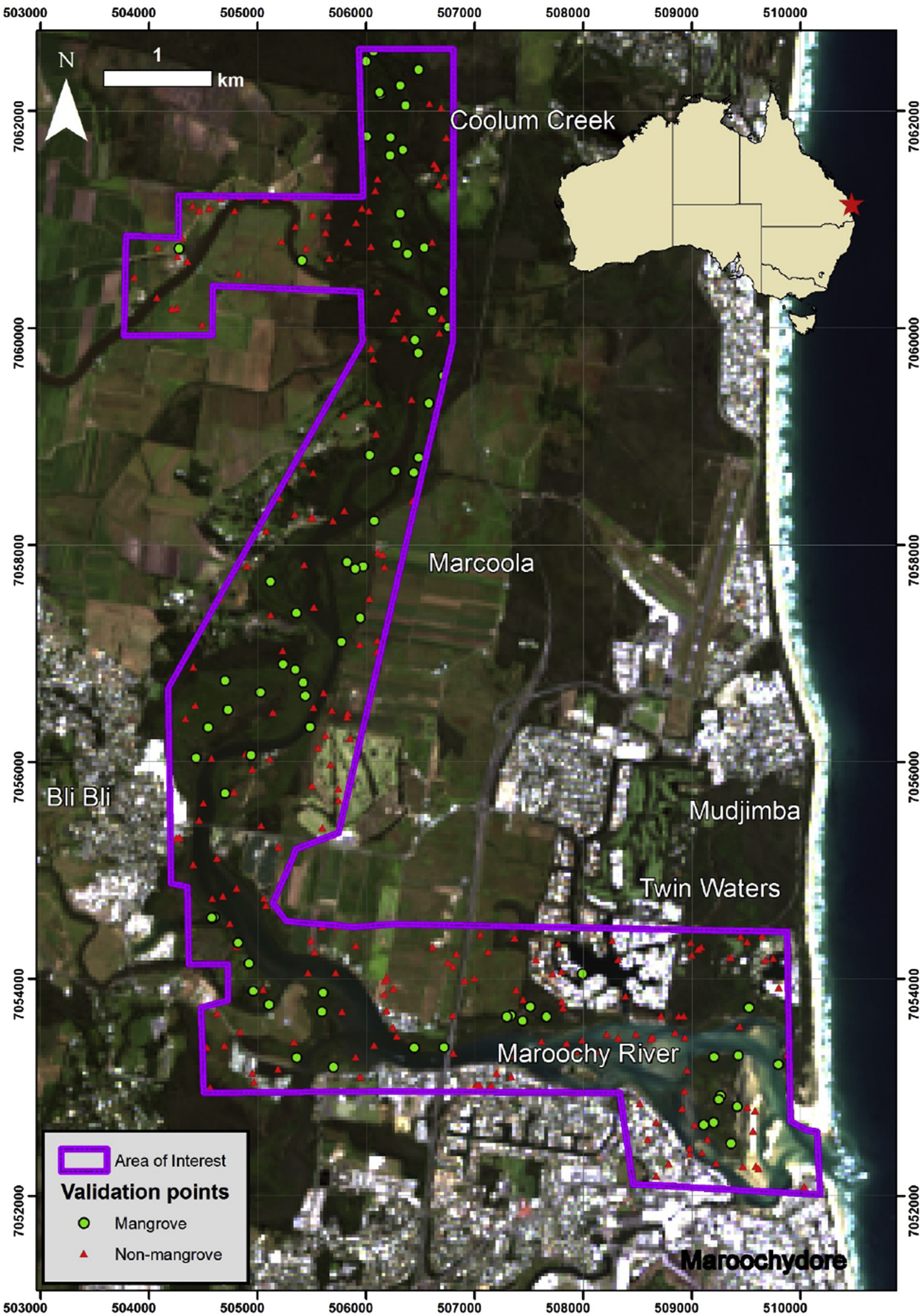


**Fig. 1.** Location map of the Maroochy River showing the study area defined with Kabi Kabi Traditional Owners (purple polygon) and 500 random sample points used for the calibration and validation of classified images. Source Map: ArcGIS 2016. (GDA94/MGA zone 56 coordinate system). (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

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