Generalized additive modelling helps untangle East Australian coastal processes

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Abstract: The high level of investment in coastal infrastructure along the Gold Coast (Queensland) and Northern New South Wales makes this area possibly the most financially at risk region to the impacts of sediment supply, coastal erosion and sea-level rise in Australia. The area is dominated by southeast winds and waves forcing a net northerly littoral drift in the surf zone with sediment sourcing eroding beaches and sediment sinks blocking estuary mouths. During severe storms and strong East Australian Current eddy events, sediments can be transported further offshore and deposited on the inner shelf. Furthermore, uplift and upwelling could be an influencing factor for cross shelf transport but often appear to have no association with local wind conditions.

Recent sediment transport field studies have concentrated within the surf zone leaving the inner continental shelf area from the outer surf zone to the 25-30m depth edge of the photic seabed less-well understood. To investigate this inner shelf region, Griffith University has deployed a number of focused monitoring campaigns with a moveable offshore monitoring platform moored at depths ranging between 20 and 30m. The developing offshore monitoring stations comprise an evolving suite of oceanographic instruments measuring a multitude of environmental parameters and have contributed to a comprehensive and long-term (effectively continuous) time series dataset.

Since the start of the project in 2005 with the Tugun de-salination background study, the large volume of data that has been collected has been used by various researchers to investigate a number of different coastal phenomena in the region. In particular, the large amount of data provides an opportunity to apply sophisticated statistical approaches for exploratory assessments. For example, non-parametric statistical methods such as locally weighted scatter plot smoothing and Seasonal Mann-Kendall test are often used to provide insights into potentially nonlinear and multivariate relationships between response and predictor variables of interest. One such approach, generalised additive modelling (GAM), appears to be, in particular, an effective methodology for disentangling causal relationships from the data emerging from the inner-shelf monitoring. To date, GAMs have been applied sparingly to the coastal zone but their track-record in air quality studies and their ability to account for nonlinear confounding effects of seasonality, trends and weather variables makes them appear very suitable for the task of evaluating and exploring large water quality datasets.

To highlight the relationship between data collection and assessment, this paper also describes the development of an ‘instrument’ through a case study where repeatable and accurate measures of turbidity were sought. The context for this data collection was the evaluation of a candidate location to be used as a tourist dive site and therefore turbidity is an important (and measureable) indicator of water visibility. There is also interest in the physical processes occurring at, and within close proximity to, the candidate site because these potentially influence turbidity and also the ability to access and utilise the candidate site for diving. To further emphasise the utility of the data collection, we present and discuss the findings of a GAM-based assessment of the turbidity data, in particular the functional relationships that emerged between turbidity and the predictor variables. The outcome of this study can be used to guide local government policy decisions and provide a better understanding of the inter-relationships between various coastal and oceanic processes.

Keywords: Ocean observatory, sediment transport, GAM analysis.