Investigating Sea Level Rise from the Australian Height Datum (AHD) to the AR6 Baseline Mean Sea Level Period Centred on 2005 (1995-2014)

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Summary
Sea levels around Australia have changed since the Australian Height Datum (AHD) was developed in the late 1960s and early 1970s. AHD remains an important water level datum for mapping inundation hazard for the various LiDAR surveys conducted around Australia. IPCC AR6 future sea level rise (SLR) projections are relative to a baseline period centred on 2005 (1995 to 2014), so the amount of SLR from AHD to 2005 must be accounted for. In this study we investigate three approaches to estimate the changes in sea level from AHD to the IPCC AR6 baseline period (2005). *Keywords: climate change, sea level rise, AHD.*

Introduction

Sea level rise, resulting from global climate change, poses a threat to low lying coastal land, including land owned or managed by Australian port authorities. Accurate estimates of the vertical height that water levels will reach are required to identify what land will be impacted to inform effective adaptation to future coastal inundation.

In 1971, AHD was introduced as the official vertical datum of Australia to measure the height of land, and was based on the mean sea level recorded by thirty tide gauges (TG) around Australia in the late 1960s (for mainland Australia) and early 1970s (Tasmania) [4]. While alternative datums to AHD have been proposed [2], based on satellite data, today AHD remains relevant with most land surveys, including airborne LiDAR surveys, using AHD survey markers for ground truthing.

The most recent IPCC AR6 SLR projections provide an indication of how water levels will change globally, relative to a baseline mean period (1995-2014) centred on 2005 [3]. To accurately include future SLR projections in inundation hazard mapping, the amount of SLR from AHD to the baseline period should be accounted for.

While much effort has been made to survey AHD markers, including vertical land movement (VLM) from GPS reference, the resulting inundation level can be subject to inaccurate surveying [8]. Measuring the SLR from the TG record could include the effect of VLM, and other regional effects, which will differ from global mean SLR (GMSL) [10]. In this study we investigate three approaches using publicly available datasets, to develop a preliminary workflow to estimate the AHD to AR6 offset for the entire Australian coastline. It is noted that each method is subject to inaccuracies and requires further analysis of the influencing factors [10].

Data

Hourly TG data were sourced from GESLA3 global dataset [6]. Surveyed AHD values were collected from the Australian Baseline Sea Level Monitoring Project [1], Marine Safety Queensland [9] and Manly Hydraulics Lab [8]. The hourly data from these sources were crosschecked to match up with hourly GESLA3. Correction to TGs were made using the difference between the ANCHORS adjusted and unadjusted datasets [5].

Method

The three methods that were used to analyse SLR from AHD to AR6 at the available TGs are numbered as follows:

1. Mean sea level (1995 to 2014) less (minus) the AHD survey value.
2. Mean sea level (1995 to 2014) less (minus) mean sea level (1967-1969) for mainland Australia and (1971) for Tasmania.
3. The linear trend in TG sea level per year (1976-2014) multiplied by the number of years (2005-1967).

The quality of all three methods was dependant on how complete the TG record was over the analysis period. This was determined as 90% of the record period for method 1, 80% for 2 and 65% for 3.

The estimates were mapped onto a string of coastal points around Australia separated by 5km using the nearest neighbour method in the R package "terra". This was preferred over linear interpolation which would interpolate across the continent (not just capes and peninsulars), and extrapolate to remote islands [7]. At each coastal point, the model representing the median (middle) value was considered to represent a best estimate.

Results

SLR for the three methods are shown in Figure 1, including which TGs were used in each method. In the analysis, method 1 had 37 TGs, method 2 had 30 and method 3 had 36. Method 1 had gauges focused on the QLD and NSW coast, where published publicly available AHD levels were found. The second method had fewer gauges (going back to 1967) but are more evenly spread across the country. The third method brings a few more TGs (that do not quite go back to 1967) compared to the second method.

The first method shows that the 2005 MSL is below AHD for gauges on the WA coast (Hillarys), Gulf of Carpentaria (Karumba) southeast QLD (Mooloolaba) and southern NSW (Eden) and there

has been little change (±2cm) in Tasmania (Burnie and Spring Bay). In general, the north of Australia tends to show a higher 2005 MSL above AHD than the south. The second method shows a lowering sea level along the Victorian coast (Point Lonsdale) and little change on the NSW and southern TAS coastlines. The Gulf of Carpentaria (Weipa) has the largest increase in sea level. The third method shows a negative trend for Northern TAS (Burnie) and Torres Strait (Booby Island).

The method representing the median estimate is shown in Figure 2. The median value estimates SLR almost everywhere, otherwise little change at Mooloolaba, Point Lonsdale and TAS, with largest values in the north (not shown).

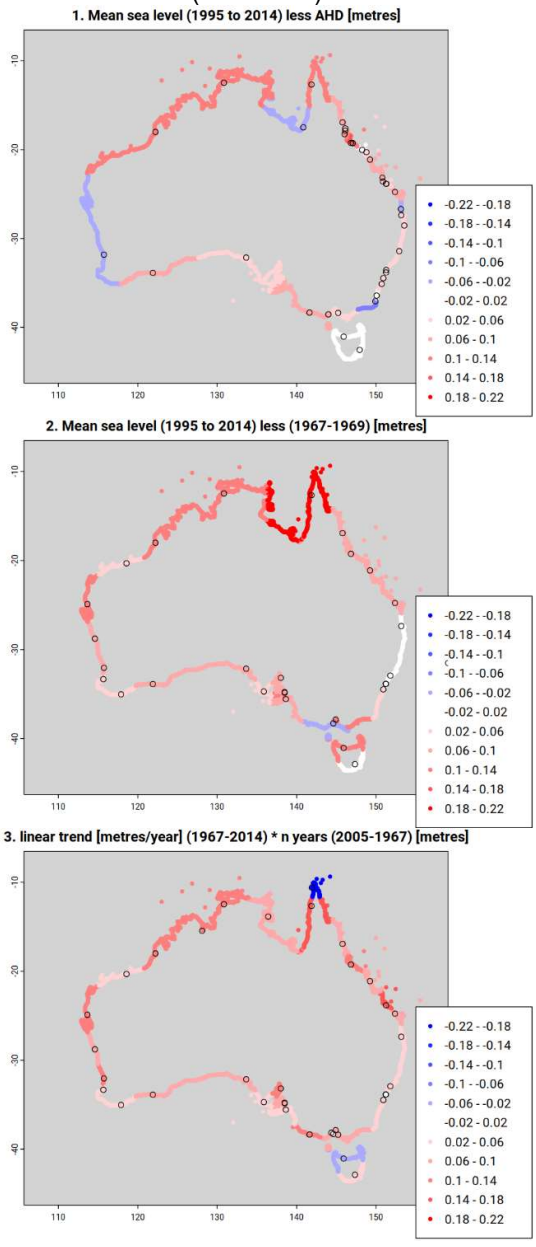

Figure 1 AHD to AR6 SLR estimates for the three methods. Black circles indicate TGs use in method and colour key is metres of SLR.

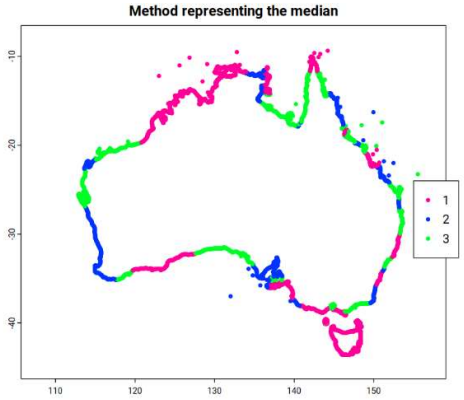

Figure 2 Map indicating which method (1,2 or 3) represents the median of SLR estimates.

Conclusion

While there is an overall picture of SLR around Australia, there are many locations where the three methods disagree (Figure 1). Further investigation is required to identify the influencing factors of this [10]. Taking the median of the three methods, results in different methods for different parts of the coast (Figure 2). Where there is continuous data going back to 1967, methods 2 and 3 match closely. Method 3 was used to bring more tide gauges into the analysis. However due to the rate of SLR increasing over time around Australia [5,10], method 3 becomes less reliable for shorter records. This preliminary and ongoing analysis of public data should be considered suitable for national scale analysis of inundation height, where at the local scale, local knowledge of the AHD offset and VLM should be considered for leveling.

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