Moving sea level:

Unearthing estuarine muds buried below Bulli Beach shifts when sea-level last rose a metre by a millennium

Evidence of past sea levels is a critical piece of the puzzle in predicting how much sea level could rise in the future and its impact on our coastal communities. In Australia, an excess of A$200 billion worth of infrastructure is at risk from a 1 metre rise in sea level. The latest global projections indicate that this rise could be reached by around 2050. However, there is great uncertainty on these projections because the future rate of melt from polar ice sheets is uncertain.

Sea level is as complex as it is important. For example, sea level is not uniform globally, requiring accurate measurements of the varying elevations around the world and detailed models in order to determine a *mean sea level* (https://www.youtube.com/watch?v=q65O3qA0-n4). This complexity increases as we add a temporal component because not only do changes in sea level vary over space and time, but so too does the elevation of the land. The last time global sea-level rose rapidly was during deglaciation (~21,000 to 7,000 years ago) when melting glaciers and ice sheets caused 120 metres of sea-level rise. Along coasts located far from glaciers and ice sheets, like Australia, evidence from the end of this rapid rise can be preserved above present-day sea level by a relative "highstand" resulting from land adjusting to the unloading of ice and loading of melt water (https://skepticalscience.com/print.php?n=1605).

Considerable research has been done on sea level in Australia, yet debate has continued about the timing and extent of a relative sea level highstand along the East Coast. Records constructed for southeast Australia show that relative sea level reached its maximum elevation 8,000 years ago. However, this is anomalously early compared not only to what is recorded elsewhere around the continent, but also globally. This earliest evidence of the highstand comes from research conducted 40 years ago along the coast near Bulli, NSW. The ages were first published in 1979 by a team of UOW scientists and have subsequently been recalibrated for more recent use in revised sea level records but have not been redated until now.

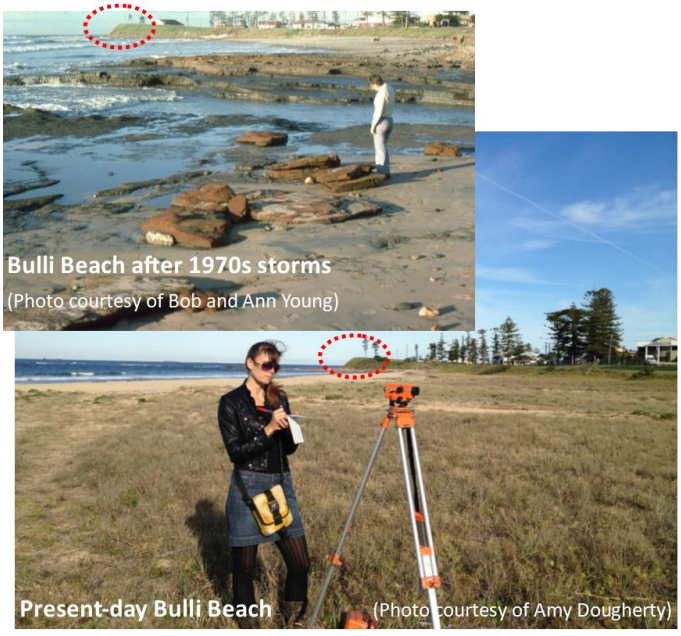
This initial work came courtesy of a series of large storms in 1970s that uncovered elevated estuarine deposits exposed as erosion stripped away the overlying beach sand. Since the sand returned after the last large storm in 1978, these deposits have largely remained buried just below the beach and dunes. Given the importance of the site, researchers from several institutions had been revisiting the beaches after storms in the hopes of re-examining the deposits. After a storm in 2013 re-exposed a small part of the deposits, GeoQuEST scientist form UOW collaborated with researchers from several institutions to re-examine this benchmark deposit.

This new study led by Amy Dougherty, performed this re-analysis using aerial photographs and remote sensing technology such as light detection and ranging (LiDAR) and ground penetrating radar (GPR), to map the elevation and lateral extent of the same deposits dated at Sandon Point Beach 40 years ago. Then sediment cores were collected, along with surface samples of wood and charcoal (similar to those originally dated), which were exposed after a significant storm in 2016 eroded sand from the beach. Using more sophisticated sampling methods and analysis, this allowed a more accurate date of the timing of the last metre rise of relative sea level up to the relative highstand from ~7,300 to 6,900 years before present, approximately a millennium later (younger) than reported in contemporary literature (https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0218430).

The new ages are consistent with dates of the highstand extending north to the Gulf of Carpentaria and are synchronous with the timing of formation of the oldest beach ridges in Tasmania. This refined younger age aligns with major ice mass loss from Northern Hemisphere and Antarctic ice sheets, supporting previous studies of the relative highstands that suggest on-going melt after rapid deglaciation ceased. Implications of this study are that continued work along the Australian coast will provide a better idea of how the last 1 metre rise in sea level influenced shoreline evolution, offering some insight on how best to prepare our communities and infrastructure for a similar increase within this century.

Ultimately, looking back at Australia's unique relative highstand provides a window into future changes in sea level and how the coasts might respond.

Press release: (https://www.uow.edu.au/media/2019/new-study-puts-old-dates-to-rest-.php?fbclid=IwAR0TnNlVgJ3q8Bx53UnhBRLLzyZml-oB8DWKsmD6G-KrtZMw141nUhQIE2A)



Bulli Beach after 1970s storms
(Photo courtesy of Bob and Ann Young)

Present-day Bulli Beach (Photo courtesy of Amy Dougherty)