

Long-term morphological change at an engineered coastal lagoon entrance: an appraisal using GIS depth shading techniques

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Abstract

GIS 'depth shading' analyses of time series (1889-2006) bathymetric digital elevation models (DEMs), derived from an extensive time-series dataset of hydrographic charts for the Entrance and Reeves Channels of the Gippsland Lakes (Victoria, Australia), allows long-term morphological change information to be extracted, visualised, analysed and understood in both 2D and 3D. The Gippsland Lakes are an extensive coastal lagoon system, permanently modified in December 1889 by the opening of an engineered entrance to Bass Strait. Since this time, this entrance has been used to allow shipping access between the Lakes and Bass Strait, initially to supply of the 'opening' of East Gippsland prior to regional railway penetration, and then in support of a large commercial fishing fleet until the present.

The time-series development and consolidation of extensive flood-tide delta 'shoaling' areas (between 0 and -1.5 metres relative to chart datum) at the Gippsland Lakes artificial entrance area, as reported in this paper, has been the result of a combination of factors, including long-term upland catchment hydrology changes, a lack of adherence to initial and subsequent engineering work designs and recommendations, and the introduction of specific on-going maintenance dredging regimes. We report here that long-term flood-tide delta shoaling area development remained limited between 1889 and 1975; and that since this time, the extent of study area shoaling has increased markedly. For instance, between March 1987 and October 2006, GIS-based surface area and volumetric analyses shows that the volume of the Reeves and Entrance Channels flood-tide delta shoaling areas grew from an estimated 68,473.9 m³ to 199,844.1m³, and concomitantly, their surface area from an estimated 98,661.5m² to 233,956.5m².

Deployment of the 2D and 3D DEM visualisations reported here has the potential to promote a high level of integrated coastal zone management (ICZM) stakeholder coastal and catchment process understanding. This consideration is especially pertinent in this case, as the morphometric changes reported in this paper can be viewed as being partly the result of hydrological changes in the contributing Gippsland Lakes catchment since 1889. This contributing catchment is now managed by multiple stakeholders, each possessing differing management jurisdictions. In the future, it is likely that both projected Victorian demographic changes, and potential regional climate change scenarios may combine to place further pressure upon the fresh water resources of the Gippsland Lakes catchment, in terms of its net amount, and its appropriation for regional and inter-regional urban and industrial use.

This being the case, further reductions in the amount of fresh water augmentation of ebb-tides flowing through the Gippsland Lakes artificial entrance area can be expected, creating conditions in which the scope for flood-tide delta nourishment would be further enhanced. Correspondingly, this scenario would place further demands upon maintenance dredging regimes. As such, we claim that this issue holds implications for Gippsland Lakes catchment ICZM. Ultimately, as the sediment delivered to the Gippsland Lakes entrance flood-tide delta originates from Bass Strait, any future 'pro-active' and sustainable sediment management strategies should consider negating sediment inflows to the Entrance and Reeves Channels in the proximity of the outer entrance area.