NITROGEN CYCLING PROCESSES IN LAKE ILLAWARRA, A INTERMITTENTLY CLOSED/OPEN ESTUARY IN SOUTH-EAST AUSTRALIA

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The LOICZ budgets can indicate the biogeochemical functioning of an estuary, and thus assist understanding the dominant natural processes within the system, which is the basis to developing cost-effective management strategies. In this study, nutrient budgets for Lake Illawarra, a typical intertidal coastal barrier lagoon in New South Wales, Australia, were firstly examined utilizing the LOICZ modelling. The LOICZ budget classified this lake as a heterotrophic ecosystem, producing carbon through net respiration. The budget results also showed Lake Illawarra to be a net denitrifying and nitrogen limited system.

Benthic flux measurements of O_2, TCO_2, NH_4^+, NO_2^-+NO_3^- and N_2 were then made at selected stations over four seasons in this lake to compare the characteristics of benthic biogeochemical processes (benthic metabolism and nutrient fluxes) for different primary producers (seagrass or microphytobenthos (MPB)) and/or sediment types (sand or mud), and thus to verify the reliability of LOICZ budget approach.

The seagrass meadows exhibited significantly higher gross primary productivity than MPB in shallow sandy or deep muddy regions of the lake. Net CO_2 effluxes and O_2 uptake were generally observed for all sites, indicating the lake was an overall net-respiratory system, which means more organic carbon was decomposed than produced. This is in line with the calculated photosynthesis/respiration (P/R) ratios (<1), and both supported the LOICZ modelling conclusions.

In general, nutrient fluxes displayed typical diurnal variation, with an efflux (release) in the dark and uptake or reduced efflux in the light. Dissolved inorganic nitrogen (DIN) net fluxes were directed from the sediments towards the water column and dominated by the NH_4^+ fluxes. In addition, based on the measured benthic fluxes, N_2 flux rates were estimated using carbon and nitrogen stoichiometry, which gave an average net denitrification rate of 0.47 mmol m^{-2} day^{-1}. This was of similar magnitude as the rates measured using the N_2/Ar technique (0.90 mmol m^{-2} day^{-1}) or estimated using LOICZ budget modelling (0.79 mmol m^{-2} day^{-1}).