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Corresponding Author : Prof. Jia-Jang Hung (hungjj@mail.nsysu.edu.tw)

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Title: Biophysical Controls on Carbon and Nutrient Budgets in two Small Lagoons with Different Eutrophic Conditions

Abstract:

The Chiku and Tapong Lagoons are two small semi-enclosed systems on the southwestern coast of Taiwan with different eutrophic conditions. Chiku Lagoon receives freshwater mainly from the Chiku River ($2.62 \times 10^5 \text{ m}^3 \text{ d}^{-1}$), whereas the Tapong Lagoon receives brackish wastewater from the Linpan Dike ($1.72 \times 10^5 \text{ m}^3 \text{ d}^{-1}$). Although the external input of nutrients and organic carbon were much greater in the Chiku Lagoon than in the Tapong Lagoon, the eutrophic level was much higher in the Tapong Lagoon than in the Chiku Lagoon. This difference of eutrophic level was caused primarily from high gross productivity in both lagoons ($\sim 90 \text{ g C m}^{-2} \text{ yr}^{-1}$) but a longer residence time of lagoon water in the Tapong Lagoon (10 d) than in the Chiku Lagoon (5.0 d). Lagoon water was well mixed in the shallow Chiku Lagoon but stratified in the inner Tapong Lagoon during warm seasons. As a result, the Chiku Lagoon was oxygenated throughout the year, but the Tapong Lagoon was oxygen-deficient in the bottom water of inner lagoon during warm seasons. With the exception of location near the river outlet, nutrient distributions were relatively homogeneous and higher in the Chiku Lagoon than in the Tapong Lagoon. However, a strong gradient between the tidal inlet and inner lagoon was observed in the Tapong Lagoon for salinity, nutrients and gross productivity. Temperature, solar radiation and turbidity, rather than nutrients, appeared to control seasonal variations of primary productivity that also determined POC inventory in both lagoons. Partition ratios between DOC and POC ($[\text{DOC}]/[\text{POC}]$) are inversely correlated with Chl *a* and are relatively low compared to those of blue water, which are also characteristics of eutrophic (Chiku Lagoon) and hypertrophic (Tapong Lagoon) conditions. Despite the fact that both lagoons are densely farmed with oysters and their waters display a significant calcification phenomenon, the net ecosystem production (photosynthesis \diamond respiration, NEP) derived from LOICZ biogeochemical model is positive showing that both lagoons are autotrophic systems. NEP value is greater in the Chiku Lagoon ($11 \text{ mol C m}^{-2} \text{ yr}^{-1}$) than in the Tapong Lagoon ($5.8 \text{ mol C m}^{-2} \text{ yr}^{-1}$). The tidal flushing condition is likely to be responsible mainly for different carbon and nutrient biogeochemistry and eutrophic levels in both shallow lagoons.

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