

Island resort runoff threatens reef ecosystems: An isotopic assessment of the extent and impact of sewage-derived nitrogen across Redang Island, Terengganu, Peninsular Malaysia

Lachs Liam¹, Dung Le Quang², Bachok Zainudin², Kochzius Marc² and Shirai Kotaro³

¹ Marine Biology, Ecology and Biodiversity, Vrije Universiteit Brussel (VUB), Room F 8.12, Pleinlaan 2 1050 Brussels, Belgium

E-mail: liamlachs@gmail.com

² Institute of Oceanography and Environment (INOS), Universiti Malaysia Terengganu, Kuala Terengganu, Malaysia

³ International Coastal Research Center, Atmosphere and Ocean Research Institute, The University of Tokyo, 2-106-1, Akahama, Otsuchi, Iwate 028-1102, Japan

Coral reef resilience is widely accepted to be driven by a site-specific combination of controls, the bottom-up control of nutrient availability and the top-down control of herbivory, which both directly affect algal growth and competition with coral. The herbivorous fish community on Redang is assumed to be less affected by fishing, the primary source of variation to herbivory, due to national marine park fishing restrictions. Development of island tourism since 1995 in marine parks of Terengganu has resulted in an increase in the number of visitors from 22,725 to over 244,762, contributing to enhancement of pollution and sewage runoff which may present an ecosystem scale threat to the coral reefs across the islands. The aim of this in-situ study is to assess nitrogen uptake by coral reef organisms from around Pulau Redang in order to discern the ecological extent and impact of sewage-derived nitrogen. The expected trend is of higher isotopic $\delta_{15}\text{N}$ values near sewage pollution. Combined with $\delta_{13}\text{C}$ values allows the estimation of the effect of sewage pollution on coral food web structure. Due to differential rates of $\delta_{15}\text{N}$ fractionation between algae (short-term, days), herbivorous gastropods or bivalves (long-term, weeks or months) we hope to determine the most suitable functional group for use as a bio-indicator. Enrichment of $\delta_{15}\text{N}$ values are expected in anthropogenically influenced fringing reefs on the eastern side of Redang compared to more pristine reefs on the uninhabited northern side. These northern sites may provide an isotopic baseline for monitoring where new resort developments are planned. The results of this study may contribute to the elucidation of an ecosystem threshold of resort pollution, above which coral reef communities become degraded, which would be of great use as a tool for the sustainable management of these vulnerable ecosystems.

Keywords: coral reef ecology; pollution; food web structure; resilience; bio-indicator: tourism; isotopic techniques