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## Reef-Scale Assessments of Ecosystem Health Using Bio-Indicators

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### Abstract

Tropical reefs provide a number of important ecosystem services and a resource base for generating fisheries income and act as the food source for island coastal communities. Reef ecosystems in Zanzibar for instance, are currently threatened by local anthropogenic disturbances including: untreated, urban wastewater pollution; increased boating activities; overharvesting of marine resources and the effects of future predicted climate-driven ocean warming. These factors and especially high nutrients and climate-driven warming are deleterious to benthic, marine calcifiers such as corals and large benthic foraminifers (LBFs). Both corals and LBFs possess algal-symbionts, however stressors such as oceanic warming increase mortality, resulting in the expulsion of symbionts and subsequent bleaching. Increased atmospheric CO<sub>2</sub> leads to acidification and a decrease in abundance and richness of species. Large benthic foraminifera (LBFs) are found in high abundance and taxonomic diversity in reefs world-wide. In the past decade they have been increasingly used as a tool for monitoring water quality and in quantifying reef health. Unlike corals, their high sensitivity and fast reproduction results in a fast response to environmental changes. Therefore, LBFs provide a rapid, cost-effective way to assess reef-scale changes crucial for future ecological forecasts due to human disturbance, eutrophication, warming temperatures and ocean acidification. In Zanzibar's reefs, LBFs are prolific calcium carbonate (CaCO<sub>3</sub>) producers contributing to the carbonate budget and stability of reefs. The comparison between communities from impacted and non-impacted reefs shows warning signs of degradation due to local impacts. Long term monitoring is crucial in securing the economic welfare of Zanzibar's reefs.

**Keywords:** Eutrophication, fisheries income, large benthic foraminifers, ocean acidification, overharvesting, tropical reef ecosystems, urban wastewater pollution, Zanzibar