Brief for GSDR 2015

Contributions from Future of Reefs in a Changing Environment (FORCE) project towards ecological and social research on coral reef ecosystems

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Most of the functions of reefs, such as the provision of productive fisheries, tourism appeal, and coastal protection from storms, are founded on having a complex reef structure that keeps accreting (growing). A structurally complex reef provides habitat (and hiding places) to support high levels of biodiversity (Gratwicke and Speight 2005). If a reef is to continue functioning then it must at least have net growth – i.e., that the deposition of a carbonate skeleton by corals and calcareous algae must exceed the rate at which the skeleton is removed by physical damage and the erosion caused by a host of taxa including burrowing algae, sponges, and worms. The balance of reef construction and erosion is known as a carbonate budget (Stearn et al. 1977). Perhaps that greatest threat to coral reef biodiversity is the long-term loss of reef habitat that could occur if carbonate budgets become persistently negative (erosive).

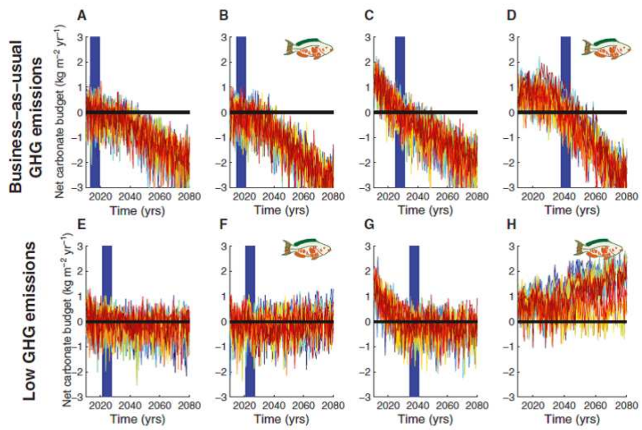

Figure 1. Projected carbonate budgets of a Caribbean reef under climate change and ocean acidification with and without local protection of herbivores (protection denoted by parrotfish symbols), under scenarios of realistic GHG emissions (top) and aggressive reduction (bottom). Initial conditions are either degraded with 10% coral cover (A, B, E and F) or healthier with 20% coral cover (C, D, G and H). Kennedy et al. 2013.

A recent study as part of the FORCE project modelled the trajectories of Caribbean coral reefs under various management scenarios on greenhouse gas (GHG) emission levels (business as usual and low carbon economy), and evaluated their expected carbonate budgets (Kennedy et al. 2013). The study found that positive carbonate budgets could be maintained at least towards the end of this century but only if compelling action is taken to reduce GHG emissions (to the most optimistic scenarios being considered by the IPCC) and if local threats including overfishing and water quality are managed (Fig. 1).

MPAs are now being planned with multiple stressors in mind. Clearly, designation of an MPA will not reduce impacts of climate change or OA, but it is possible to identify regions of the ocean that have a more benign physical environment (West and Salm 2003; McLeod et al. 2012). For example, Mumby et al (2011) used a climatology of satellite-derived sea surface temperature (SST) measurements to identify those areas where corals are likely to be best acclimated to stress and subjected to relatively mild acute bleaching events (Fig. 2). In principle, locating MPAs in the most benign areas allows for a targeted reduction in biological stresses (e.g., restored food webs and less competition from algae) in areas that have relatively low physical stress.

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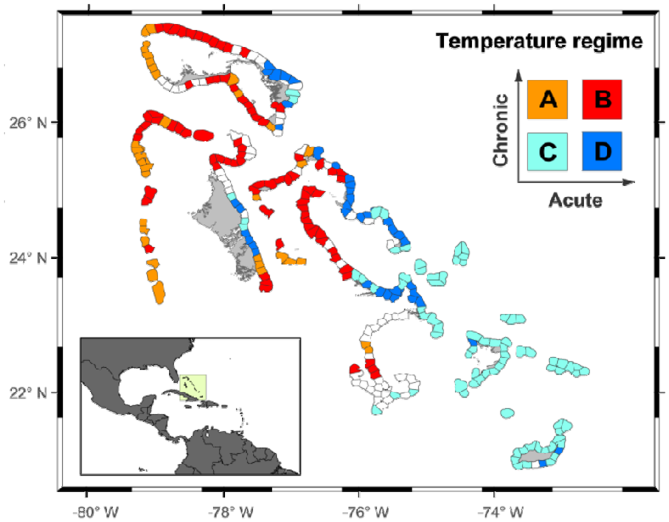

Figure 2. Stratification of coral reefs of the Bahamas based on their thermal characteristics. Two aspects of thermal stress are recognised - chronic stress that represents usual summer temperatures - and acute stress that occurs during episodic bleaching events. Mumby et al. 2011

Given the projected impact of climate change on coral reefs, effective management is vital so that local stressors to reefs, such as pollution, overfishing and physical damage, can be reduced, and the resilience of the reef improved. However in most countries there are considerable constraints to effective management. The FORCE social science team conducted in-depth research in four Caribbean countries (Barbados, St Kitts and Nevis, Honduras and Belize) to examine constraints to management. Results indicated five broad categories of constraints to reef management: non-compliance and a lack of effective enforcement; lack of education and awareness among resource users; lack or resources and capacity for reef management; a lack of political prioritisation of reef management issues; lack of engagement of reef users in reef governance; and weaknesses in policy, legislation and regulations. This work highlights the specific challenges to reef management measures perceived by reef managers and policy makers, and indicates possible areas for improvement that may lead to increased effectiveness of management. (Turner et al. 2014)

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