

## Food for Thought

# Are we sacrificing the future of coral reefs on the altar of the “climate change” narrative?

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Following a series of mass-bleaching events that have seriously degraded coral reefs, notably the Great Barrier Reef of Australia, a common narrative is now dominating the discourse, according to which “the only sure way to save the world’s coral reefs is climate change mitigation”. However, climate change is not a sole stressor. Most coral reefs around the world are threatened by a myriad of local stressors, including overfishing, destructive fishing, untreated sewage, agriculture effluents (nutrients and pesticides), and siltation due to deforestation. Reefs will not survive the severe effects of this plethora of stressors while waiting until we mitigate climate change. In order to safeguard reefs, we need to adopt a new narrative—“there are diverse ways in which we can improve the chances of saving coral reefs”—by acting now to: (i) improve their local protection and marine protected area networks, (ii) alleviate their critical local stressors, (iii) restore degraded and damaged reefs, and (iv) promote reef resilience and adaptation (e.g. adaptation networks, assisted evolution) to the changing conditions, notably climate change effects. It is time for us to move on from the impractical goals of the climate change narrative (“interventions beyond our field of expertise”) to building up resilience and adaptation of social-ecological systems of coral reefs.

**Keywords:** conservation, marine ecosystems, marine protected areas, mitigation, resilience, stressor

### Coral reefs are declining

Climate change is harming the life on our planet. Beyond the creeping global warming, climate change includes frequent extreme storms, droughts, and consequent societal disasters (Knutson *et al.*, 2010; Trenberth *et al.*, 2014). These extreme events have rightly turned the world’s attention to “climate change” as a calamitous environmental stressor (Overpeck and Conde, 2019). One of the major symptoms of climate change is the growing frequency of El Niño events (Gergis and Fowler, 2009) and so-called warm “blobs” (Cornwall, 2019), which manifest as years of elevated water temperature in some oceanic regions. These temperature anomalies induce mass-bleaching of reef-building corals (Hoegh-Guldberg, 1999; Hughes *et al.*, 2017), which, together with diverse other stressors, devastate coral reefs (Ban *et al.*, 2014), the richest (in biodiversity and productivity) life system of the ocean, and the one that holds the greatest economic value (per unit area) to humans (de Groot *et al.*, 2012,

Costanza *et al.*, 2014). Along with the loss of these essential ecosystems, we are also losing the vital ecosystem services they provide for over half a billion people, such as food, livelihood, a rich source of medicines, and the protection of coastlines (Burke *et al.*, 2011; Cinner, 2014).

Despite our efforts to reverse the decline of these valuable marine ecosystems, they are continuing to degrade at an accelerating pace (Burke *et al.*, 2011, 2012; De’ath *et al.*, 2012; Jackson, 2014; Hughes *et al.*, 2017), raising the critical question: “Are we, human society, the coral-reef scientists and conservationists, marching on the right path to safeguard these essential ecosystems for humanity?”

### The “climate change” narrative

A common narrative among many coral-reef scientists says that in order to rescue the world’s coral reefs we need to deal with “climate change”. According to this common narrative, there is

“one single most important stressor, which is the human-driven climate change”; and by mitigating this major stressor (i.e. dramatic reduction in greenhouse gas emissions), we can rescue the reefs (Normile, 2017; Bruno *et al.*, 2019).

We frequently see assertions such as: “The only sure way to preserve the world’s coral reefs will be to take drastic action to reverse global warming” (Normile, 2017); or that the emphasis on conservation “needs to shift substantially from dealing with local stressors to tackling the more fundamental problem of curbing atmospheric CO<sub>2</sub> emissions” (Côté and Darling, 2010), or more recent decisive statements, such as—since global warming is manifestly the foremost current threat to coral reefs, and since local management and marine protected areas (MPAs) are ineffective, “it is time to face reef degradation head-on, by directly addressing anthropogenic climate change—the root cause of global coral decline” (Bruno *et al.*, 2019; Williams *et al.*, 2019). Similar messages are released to the public—“Transitioning the global economy to renewable energy sources, . . . will not only save coral reefs—it will remove the threat to the rest of the world’s ecosystems and species as well. . . . the only way this [safeguarding coral reefs] ends well is if we radically reduce our carbon emissions” (“How to save the ‘tropical rainforests’ of the ocean”; *The Washington Post*, 9 January 2018); or “We’ve gotten to the point now where local solutions for the reef are almost pointless—the only thing that matters is action on climate change” (“Great Barrier Reef: Mass decline in ‘coral babies’, scientists say”; *BBC News*, 4 April 2019).

### Unfavourable outcomes of the “climate change” narrative

*Is action on climate change the only sure way to preserve the world’s coral reefs?* Probably “Not”. Coral-reef scientists and conservationists need to do more than simply focusing on calls for climate change mitigation, and as Mumby (2017a) argues: “messages like ‘reef management is futile unless climate change is mitigated’ may be misleading and harmful” (Mumby, 2017a, p. 1009). Regardless of the scientific validity question about the “climate change” narrative, there is a practical issue of addressing goals that are not only unachievable but may also contribute to loss of hope. One potentially unintended outcome of the climate change message is that the means and responsibility for taking care of the reefs are a large, global problem that is beyond the scope of local coral-reef practitioners, and such large problems without solutions can lead to despair, apathy, and lack of engagement and action (Knowlton, 2017; Lubchenco and Gaines, 2019). In the same vein, there is a recent growing movement, “Ocean Optimism”, which is gaining supporters with the idea that “the best way to encourage conservation is to share our success stories, not to write obituaries for the planet” (Knowlton, 2017). This may well be true, but for optimism, we also need “achievable goals”; and if climate change mitigation is indeed the “only solution”, then we, the coral-reef practitioners, seemingly can do very little to help the reefs, if anything at all.

Worse yet, the climate change narrative, beyond overshadowing local manageable stressors and the harmful actions taken by stakeholders, provides justification for environmentally irresponsible actions and lack of management by local decision-makers. During the last 10 years, I have visited many reef-dependent coastal communities around the world. In most of these places, the reefs have been exposed to years of overfishing and

destructive fishing, siltation due to deforestation, and untreated sewage, but the community leaders often embrace “climate change” as an excuse to explain their depleted fish stocks, devastated reefs, and extreme poverty, not the impacts of their local actions.

In addition, the climate change narrative overlooks three noteworthy facts related to climate science, environmental management, and coral-reef health. First, according to climate scientists, global temperatures will remain elevated for decades to centuries, even after a complete halt to greenhouse gas emissions (Solomon *et al.*, 2009, 2010; Frölicher *et al.*, 2014). Therefore, while climate change mitigation is indeed of utmost importance for future reefs, it is not a realistic solution for *present-day* reefs. That is, climate change effects will continue to harm the present reefs even if we were able to halt all greenhouse gas emissions today. Moreover, the climate recovery time-scale implies that in focusing on climate change mitigation, even if proves successful, by the time it takes effect, the interim reef destruction and species extinction by local stressors will have left very little for rehabilitation under “mild climate” conditions.

Second, pointing to a single stressor, when there are diverse, high impact stressors, is a fundamentally flawed approach. Diamond (2005) raises this issue by asking: “What is the single most important environmental problem facing the world today?”. His answer is that “The single most important problem is our misguided focus on identifying the single most important problem”. To justify his seemingly flippant answer, Dr Diamond explains that if any one of a dozen problems he lists (including habitat destruction, overfishing, pollution, and soil erosion) remains unsolved, it would do us “grave harm”. A similar attitude has been conveyed by Bonebrake *et al.* (2019), who define the question, “What is the biggest threat to biodiversity?”, as an oversimplified, illegitimate question that ignores the growing evidence that multiple stressors interact in myriad ways to impact biodiversity. These views are pertinent to coral reefs, which are exposed to and threatened by a myriad of local stressors in addition to climate change.

These diverse local stressors are frequently being overlooked or downplayed, especially if not represented by adequate data. A recent example is that of a review by Bruno *et al.* (2019), which analysed 18 MPA studies (incorporating 66 MPAs and 89 unprotected control sites). Based on their literature review, Bruno *et al.* (2019) explain the ineffectiveness of MPAs by “the effects of localized stressors [that] are swamped by ocean warming”, and/or “because interactions between local and global stressors are often antagonistic”. Their conclusion, beyond putting the reefs at risk by potentially supporting resistance from resource extractors and removing the encouragement to improve management, overlooks local stressors (Bruno *et al.*, 2019 and references therein). Their approach is based on the notion that insufficient data on local stressors (e.g. nutrient load, sewage, siltation) imply that these stressors can be dismissed from their analyses, as if they cannot undermine the protection benefits of MPAs. However, such local stressors can play an important role in impacting coral reefs (e.g. Fabricius, 2005; Richmond *et al.*, 2007; Zaneveld *et al.*, 2016; Wear, 2019), and therefore, can mask the potential achievements of protection. In other words, whereas many MPAs are undeniably ineffective, this is not necessarily due to the swamping effects of global stressors, but rather due to their inadequate planning, management, and enforcement (Jameson *et al.*, 2002; Mora *et al.*, 2006; Steneck *et al.*, 2009).

Third, we might be able to save some reefs by protecting them from local anthropogenic stressors. Studies show that despite climate change, protection and local management can maintain healthy reefs (Edgar *et al.*, 2014; Jackson *et al.*, 2014; Cinner *et al.*, 2016, 2018; Gill *et al.*, 2017). For example, much of the massive degradation of recent decades in Caribbean and Hawaiian reefs has been mainly due to local stressors (Gardner *et al.*, 2003; Jackson *et al.* 2014, Smith *et al.* 2016). Having held on to the notion of “climate change as the single major stressor”, the media and scientists alike have been “surprised” to find newly discovered healthy reefs, like the thriving reefs at Bikini Atoll and Cuba’s “Gardens of the Queen” reefs. A common denominator of these and diverse other healthy reefs is that although they too are subjected to climate change, they are either sufficiently far from local human impacts or safeguarded from them by effective management (e.g. Jackson *et al.*, 2014; Cinner *et al.*, 2016, 2018; but see Cerutti *et al.*, 2019), or certain circumstances (e.g. González-Díaz *et al.*, 2018). Ironically, the radioactivity from 23 atomic bombs has protected the Bikini reefs from humans, and the saviour of the “Gardens of the Queen”, beyond strict protection, has been the lack of fertilizers and pesticides in Cuba due to the embargo (Galford *et al.*, 2018). These healthy reefs challenge the notion of “climate change” as the sole dominant stressor. On the other hand, the “climate change” narrative also misses many “under the radar” degraded reefs that are neither protected nor intensively studied, as scientists tend to study natural processes in the healthiest reefs available (Mumby, 2017a). These overlooked reefs are exposed to diverse local stressors, notably overfishing and destructive fishing, untreated sewage, agriculture effluents, and deforestation, which rapidly degrade them long before they are affected by climate change.

Coral reefs are not alone in facing a myriad of competing threats. Rapid declines are commonplace in all coastal marine ecosystems, some of which, e.g. salt marshes, mangrove forests, and seagrass beds, are degrading at rates even higher than that of coral reefs (e.g. Waycott *et al.*, 2009; Polidoro *et al.*, 2010; Deegan *et al.*, 2012). We tend to underestimate the colossal impact of the millions of fishermen (Teh *et al.*, 2013) who visit the reefs on a daily basis, over-exploiting and often destroying them (by dynamite and cyanide fishing practices); the millions of farmers whose excess fertilizers and pesticides end up in the reef (e.g. Smil, 2011; King *et al.*, 2013; Risk, 2014; Wenger *et al.*, 2015); the billions of people who release their untreated wastes into the sea (Wear, 2019); the exponentially growing coastal tourism impact (Spalding *et al.*, 2017); and the gigantic quantities of sediments from vast areas of cleared forests in water catchments of coral reefs and other coastal ecosystems (e.g. Fabricius, 2005; Richmond *et al.*, 2007; Risk, 2014; Wenger *et al.*, 2015). Focusing our attention solely on climate change mitigation, while these manageable local stressors go unheeded and continue to harm them, is a strategy certain to fail.

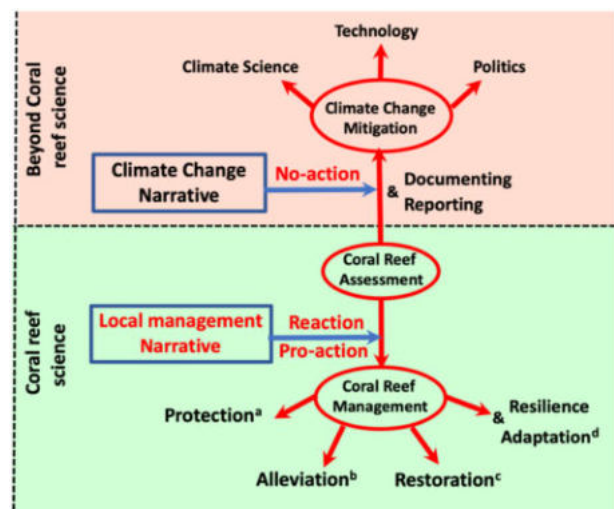
Climate change is indeed a major stressor that humanity needs to address by applying deep mitigation pathways (e.g. lifestyle change, additional reduction of non-CO<sub>2</sub> greenhouse gases, and rapid transfer to renewable energy; van Vuuren *et al.*, 2018), as well as “negative emission” technologies (e.g. Haszeldine *et al.*, 2018). However, regardless of our climate mitigation efforts, the present-day coral reefs will continue to decline in the coming decades, and our best efforts at mitigating climate change now offer no realistic hope for these reefs.

## Promoting coral-reef resilience and adaptation

To save our coral reefs and the other marine ecosystems, we have to make many simultaneous changes from local to global scale (He and Silliman, 2019; Morrison *et al.*, 2019). For this, we have to start by adopting the notion that local stressors are not a local problem of a lesser importance, but rather a global challenge that needs collective action to achieve mitigation of the harm and adaptation to the consequences, globally, in numerous locations.

To build and sustain hope we have to adopt a different narrative: “there are diverse ways we can elevate the rescue chances of coral reefs by local management” (Figure 1); or to adopt and rephrase Barange’s (2019) statement on climate change and fishery: “It could be argued that climate change provides one of the most powerful arguments to improve [coral reef] and environmental management”. Our approach has to shift from focusing on calls for mitigation of the planet’s climate, to a focus on drastically reducing the local stressors on coral reefs and improving their protection and adaptation; or as Lubchenco and Gaines (2019) have framed it “Now is the moment for more scientists to pivot from simply documenting the tragedy underway to also creating scalable solutions”.

The pivot should target the creation of a better, more responsive management (Mumby *et al.*, 2017), which combines four coral-reef management directions (Figure 1): (i) Expansion of coral-reef MPAs with adequate investment in human and financial capacity, and improving the effectiveness of the MPAs by closing gaps of global coverage and effective policy (Mora *et al.*, 2006; Lubchenco and Grorud-Colvert, 2015; Gill *et al.*, 2017); (ii) Alleviation of critical local stressors, such as eutrophication and siltation (e.g. Fabricius, 2005; Bartley *et al.*, 2014; Abelson *et al.*,



**Figure 1.** Schematic diagram illustrating a shift from a common coral-reef narrative focusing on calls for mitigation of the planet’s climate (“climate change narrative”) to a more practical coral-reef narrative: “there are diverse ways we can elevate the rescue chances of coral reefs” (“local management narrative”), targeting four reaction and pro-action coral-reef management directions: expansion and the improvement of coral-reef MPAs (a); alleviation of critical local stressors (b); restoration of degraded and damaged reefs (c); and promotion of reef resilience and adaptation to the variable and unpredictable conditions of the Anthropocene (d).



2016b; He and Silliman, 2019); (iii) Restoration of degraded and damaged reefs (Anthony *et al.*, 2015; Abelson *et al.*, 2016b); and (iv) Promotion of reef resilience and adaptation to the changing conditions (from regional to global), notably climate change effects (e.g. Mumby and Anthony, 2015; Webster *et al.*, 2017; Anthony *et al.*, 2017; Mumby, 2017b; Roberts *et al.*, 2017; Cinner *et al.*, 2018; Darling *et al.*, 2019; He and Silliman, 2019; NAP, 2019a, b; Walsworth *et al.*, 2019). For management efforts to produce tangible results, the human dimension needs to be integrated into all four management directions to establish adaptive social-ecological systems (Kittinger *et al.*, 2012; Abelson *et al.*, 2016a; Bodin, 2017; Darling *et al.*, 2019).

Climate change will remain for many more years. Let us hope, however, that the climate change narrative will not continue as the dominant approach to saving the reefs. If it does, the reefs will have to wait for a new generation of scientists to appear and highlight the colossal harmful effects of local stressors. Most reefs would not survive until then.

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