# Policy Brief: Improving the Nitrogen Pollution in the Great Barrier Reef Through Accountability Frameworks and Technologies

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Recipient: Queensland Minister for National Parks and the Great Barrier Reef, Stephen Miles MP
Justification: Stephen's ministerial role involves the oversight of policy action, legislation creation that protects and conserves the Great Barrier Reef (GBR). As minister, he has a direct influence on future policies to conserve the reef, thus is an integral political actor to address regarding the GBR.

## Executive Summary

The GBR is a registered World Heritage Area, and is currently facing severe degradation and pollution from anthropogenic practices and climate change (Haynes, et al., 2007, p.993). This report assesses the impact of nitrogen fertilisers and herbicides used primarily in sugarcane and cattle cultivation in the GBR Basin (Queensland Government, 2017, p.1). Nitrogen discharge is damaging the reef in many ways, such as increasing ocean turbidity, affecting the metabolic process of marine organisms and contributing to the Crown of Thorns Starfish outbreak. The degree of land-based nitrogen runoff is a key concern for the reef's health, and one that this report critically analyses.


**Figure 1:** Map of GBR (Lough, 2007, p.4)

The 'Reef 2050 Long-Term Sustainability Plan', 'Reef Trust', and the 'Great Barrier Reef Gully and Streambank Joint Program' (Commonwealth of Australia, 2015, p.2) are considered important initial governmental conservation efforts; however, current policies do not provide sufficient reef protection to achieve the nitrogen reduction aims set out in the 2050 Plan. This report recommends a number of improvements to current policy initiatives that would enhance the protection of the reef, and make the aimed nitrogen reductions achievable. Such recommendations include stricter accountability measurements for farmers to reduce their nitrogen discharge rates, and stronger monitoring programs. In addition, this report proposes a nitrogen-trading scheme that can be adopted as an economically viable option to reduce nitrogen discharge into the reef.

## Empirical Analysis

The GBR spans over 344,400 square kilometres of the northeast Australian coastline (WWF, 2016, p. 1), with an inland catchment area of 18,408 $km^2$ (Gilbert et al., 2001, p.i). The reef supports a complex ecosystem consisting of more than 1400 species of coral and is home to thousands of different organisms (Stokes, et al. 2005, p.3). The reef's rich biodiversity contained within its three ecosystem types: mangroves, sea-grass and coral, are currently under significant stress from many

different degrading factors, one of which is nitrogen fertiliser run-off from agricultural practices (Queensland Government, 2017, p.1).

Nitrogen and phosphorus fertilisers are used in agriculture primarily to increase yields, however studies have shown that only 30% - 50% of applied nitrogen fertiliser is actually absorbed by crops (Tilman, 2002, p.673). The excess run-off drains into one of the 35 major catchments of the GBR, such as the Tully and Fitzroy Rivers (GBRMPA, 2016); "Recent studies have indicated that the total nitrogen load deposited in the GBR has "increased by 5.7 times to 80,000 tonnes/yr" (Brodie, 2012, p.83). Nitrogen run-off entering the reef this way ultimately causes eutrophication.

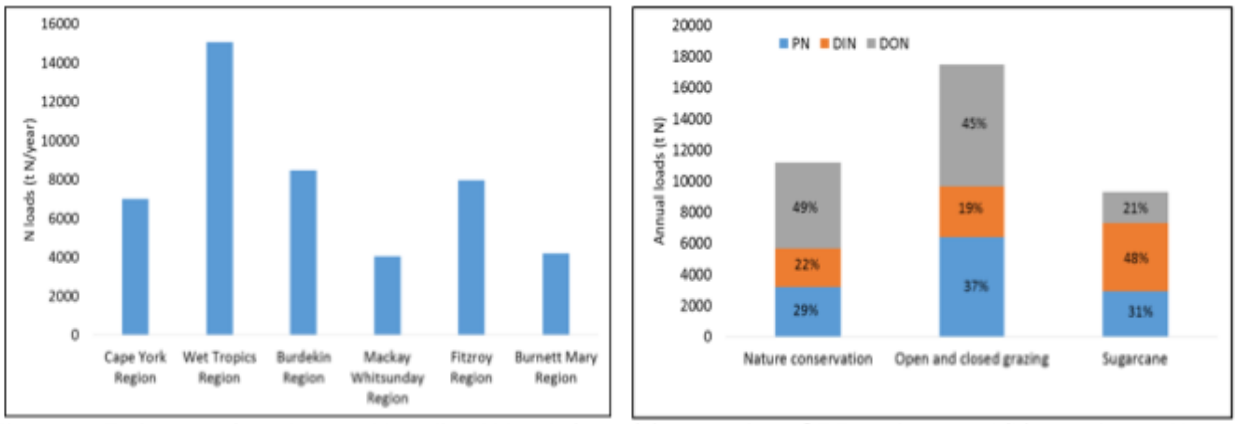


**Figure 2:** Total annual baseline nitrogen loads from (a) GBR locations and (b) different sources of nitrogen from land uses (McCloskey, et al., 2016)

At low levels, dissolved inorganic nutrients such as nitrogen and phosphorus are converted to organic matter by phytoplankton and bacteria in seawater (GBRMPA, 2016). However, at high levels of surface run-off, such as those entering the reef currently, metabolic changes to marine plants and animals are caused (GBRMPA, 2016). For example, there is evidence that indicates coral reproduction processes are inhibited by increased nutrient concentrations (Haynes, et al. 2007, p. 998). Sustained exposure to dissolved nitrogen in the seawater "can interfere with the relationship between corals and their zoooxanthellae and result in decreased calcification rates" (Ferrier-Pages, et al., 2001, p.253), which can weaken the calcium skeleton of coral, making the coral reef more susceptible to damage form cyclones and other extreme weather events (Haynes, et al. 2007, p.998).

Nitrogen herbicides such as Diuron used on sugarcane crops and for cattle grazing, are a main contributor to poor water quality in the GBR basin (Bainbridge, 2009, p.1081) – see Figure 2. Such

herbicides have significant effects on reef ecosystems, including increase in ocean turbidity ultimately causing food-web disruption. (Fabricius, et al, 2013, p.57).

Ocean turbidity reduces light infiltration levels in the reef, which can severely decrease photosynthesis rates of sea-grass, and symbiotic dinoflagellates found in coral (Haynes, et al., 2007, p.999). As can be seen from figure 3, there has been a concerning upwards trends in nitrate concentration and the levels of ocean turbidity in the GBR. In addition, herbicides such as Diuron inhibit electron transfer processes of chloroplasts on photosynthetic marine species, decreasing their photosynthetic efficiency (Haynes, et al., 2007, p. 999). In addition, the Crown of Thorns Starfish outbreak has been attributed, among other factors, to major land run-off from agricultural practices (Yeates, 2014, p.viii).

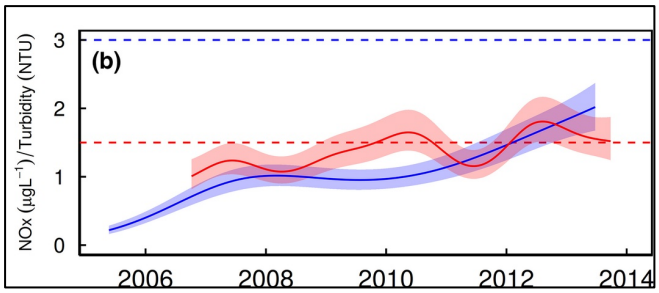


**Figure 3:** (blue line) concentration of nitrate, (red line) turbidity. The dashed lines represent the water quality guideline values for these variables (Thompson, 2014, p.21)

## Assessment of Empirical Evidence

The unsustainable use of nitrogen-based fertilisers and pesticides in agricultural practices is significantly reducing the ecosystem services of the GBR, and is rapidly degrading the reef (Tilman, 2002, p.671). The past loose regulation of nitrogen discharge entering the reef has caused innumerable damage to the reef's health (Smail, 2016). The Queensland government's recognition of this issue has come at a critical time, and it is imperative that as a UNESCO world heritage site (UNESCO, 2017), the GBR's preservation is an ultimate priority.

Main policies and collaborative initiatives created by the Queensland government such as the 'Reef 2050 Long-Term Sustainability Plan', 'Reef Trust', and the 'Great Barrier Reef Gully and Streambank Joint Program' (Commonwealth of Australia, 2015, p.2) have not provides sufficient protection for the reef – as displayed in the government's 2015 outlook report (Commonwealth of Australia, 2015, p.2). GBRMPA's chairman Russell Reichelt stated that: "The [Federal Government's] 2050 reef plan is not perfect. It needs to be improved…" (Smail, 2016)

The Reef 2050 Plan that was released in 2015, and reducing land-based pollution entering the reef is at the core of the plan, that has been enacted since 2003 (Kroon, 2016, p.1990). However, according to Dr Frederieke Kroon at the Australian Institute of Marine Science, the government's plan has set unachievable targets: "such as a 50 per cent reduction in nitrogen run-off by 2018 and an 80 per cent reduction by 2025" (Dorsett, 2016). In addition, within the reef plan there is no indication of reassessing already registered pesticides, based on current guidelines and health and safety impacts (King, et al., 2013, p.61).

The utilisation of the A$140 million trust for conservation measures and the banning of capital dredge material disposal within the reef (GBRMPA, 2015), are important initial measures. Through the Reef 2050 Plan, total nitrogen load has been reduced by 10 per cent, compared to the 2009 baseline (Commonwealth of Australia, 2015, p.3). The trust also provides important monetary incentives and the ability to extend activities to support the voluntary adoption of Best Management Practices (BMP) by farmers (Kroon, 2016, p.1990).

The Great Barrier Reef Gully and Streambank Joint Program aims to reduce erosion of major catchments including the Fitzroy River will reduce nitrogen-containing sediment entering the reef (Frydenberg, et al., 2016, p.1). This is aimed to be achieved through initiatives such an A$8 million investment in gully restoration projects, as well as contributing A$1 million to sediment management projects (Frydenberg, et al., 2016, p.2).

While these are important measures for the government to take, given the extensive empirical evidence available to the government about the health of the reef (Thornburn, et al., 2013, p.192), these measures are still not enough to sufficiently conserve the reef. It is also important to recognise that the effects on the GBR of nitrogen pollution are not exclusive, and could be exacerbated by other factors, such as increasing ocean temperatures, ocean acidification and extreme weather events (Zaneveld, 2016, p.1). All interpretations of empirical evidence and policy solutions must factor this into future planning and monitoring.

## Recommendations

Existing regulations have not been effective enough to sufficiently protect the reef, and to slow its degradation. It is thus imperative that the Queensland authorities adopt stricter regulations and new programs to significantly limit nitrogen run-off from agricultural practices.

In light of the recent cyclone that damaged the Queensland coastline on the 28th of March including areas of the GBR (Robertson, 2017), it is essential that the Queensland government and Marine Park Authority in all future strategy implementation and planning, consider the effects that climate change will have on Queensland weather patterns and conditions. In addition, studies have predicted that the intensity of cyclones that frequent Northern Australian coastline, will increase as a result of climate change (Knutson, et al., 2010, p.157). Thus each future policy must take into account these imperative environmental changes.

While the Reef 2050 Plan is an important step, more needs to be done to protect the reef. One recommendation is to revaluate pesticides and fertilisers currently being used in Queensland agriculture. Most that are being used today were registered on less strict guidelines than is deemed to be appropriate (King, et al., 2013, p.61). The recent proposals by the Queensland government to enhance water quality regulations (Queensland Government, 2017, p.1) is a strong step for the reef; however, there are aspects of the proposal that should be modified to ensure the reef is protected at an adequate level.

To improve the GBR Marine Monitoring Program, the Marine Park Authority could incorporate Coral Reef Early Warning System buoys, like that being used along the American coast and in the Caribbean (NOAA, 2016, p.1). These systems measure changes in environmental factors such as ocean temperatures, and nitrogen concentrations (NOAA, 2016, p.2). This could be utilised for policy improvements, and to tailor action to specific conditions in the GBR.

In order to achieve the targets set out in the Reef 2050 Plan, there needs to be better management and regulation of the source of the nitrogen run-off: agricultural practices. The Paddock to Reef program initiated in collaboration with the 2050 plan requires a review of the adoption of management practices component of the program, as it lacks clear implementation processes and guides (State of

Queensland, 2013, p.16). Reductions thus far have been from voluntary participation in these programs, however, to achieve the desired 2050 targets, the Queensland government must impose compulsory regulations on farms to significantly reduce the nitrogen load on the GBR. One of the main issues is ensuring accountability for changes of management strategies and nitrogen-reducing actions (EPA, 2010, p.8). Introducing an accountability framework that includes monitoring points, and tracking from authorities to ensure that all requirements of the framework are being abided by (EPA, 2010, p.9) is an effective measure to combat this problem in the policy.

Nitrogen fertilisers, and nitrogen containing pesticides need to be phased out and more effectively managed, something that can be achieved through appropriate technologies and management techniques (State of Queensland, 2013, p.16). One method of controlling nitrogen output is through utilising a nitrogen cap and trading scheme, similar to that implemented in Lake Taupo in New Zealand (Duhon, et al., 2011, p.ii). Such a scheme would designate allocations of nitrogen discharge to each farmer, yet still giving them the flexibility to trade units of nitrogen (Duhon, et al., 2011, p.3).

Overall, it is imperative that the Queensland government reviews current GBR policies and understand the utter importance of protecting this complex ecosystem and national treasure. With widespread bleaching occurring throughout the reef, greater protection from all degrading factors is essential.

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