

ARTICLE

The Control of Nutrient Run-Off from Agricultural Areas: Insights into Governance from Australia's Sugarcane Industry and the Great Barrier Reef

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Abstract

Many parts of the world rely on nutrients like nitrogen and phosphorus to improve farming production and increase yields. There are significant food security as well as socio-economic issues at stake. However, it is also clear that fertilizer loads are particularly damaging to aquatic environments, including lakes, rivers, coral reefs, and wetlands. This article explores governance approaches to fertilizer practices that impact on aquatic environments (eutrophication) by examining a case study of the Great Barrier Reef. Governance involves any and all forms of state and non-state control over a given set of issues. It can include, but is not limited to, rule-based approaches like regulation, although it can also involve market-driven measures like nutrient trading schemes, government grants and other financial incentives. So, which approach to governance works best to combat this particular policy question? What other insights into the design of effective regulation and governance can be gathered? In this article, the authors make three broad arguments for change: firstly, it is crucial that regulation features within government strategies; secondly, there must be a rigorous systematic evaluation of the strategies to ensure that the desired behavioural change is achieved along with the desired outcomes; thirdly, and most importantly, the strategies and the evaluation methods must be appropriate for the culture of the industry they are designed to regulate.

Keywords: Governance, Regulation, Eutrophication, Great Barrier Reef, Sugarcane, Nutrients, Queensland

1. INTRODUCTION

Aquatic pollution from agricultural industries associated with fertilizer usage, and related farming practices, is a global problem. Organic nutrients from fertilizers are essential for

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improving farming production and increasing yields. However, it is well known that fertilizers are particularly damaging to aquatic environments, including lakes, rivers, coral reefs and wetlands. This process of nutrient loading, referred to as ‘eutrophication’, has been known for decades.¹ This article explores governance approaches for controlling practices that cause eutrophication. Behavioural change is a crucial component of these approaches.

In this article we are fundamentally concerned with how best to achieve behavioural change through governance of (and with) farming communities. The difficult research question we take up is how to most effectively control the run-off of nutrients that affect aquatic environments – an issue that increasingly impacts on many of the world’s coral reefs, lakes, wetlands, and river systems. As Smith and his co-authors have pointed out, the restriction of nutrient loading on farms has become an ‘essential cornerstone of aquatic eutrophication control’.² It is an issue that affects the United States,³ Japan,⁴ New Zealand,⁵ China⁶ and many other parts of the world. Although this problem is global, our main aim in this article is to demonstrate that an intimate understanding of the relevant industry culture is a crucial component in the development of robust governance frameworks. Further, we suggest that regulatory and policy initiatives by government must be continually and rigorously monitored through ongoing evaluation and analysis.

The article is structured in two parts. The first part considers the case study of the Great Barrier Reef in Australia, introducing the extent of the problems and the ways in which governments have sought to confront them. In the second part, we highlight the need for three elements in particular: (i) regulation should be a part of the governance mix; (ii) government must continually and rigorously evaluate its own approaches; and (iii) any strategies must be ‘culturally appropriate’ to have the best chance of success. Although each of these elements is essential, the primary contribution from this research is the emphasis on the need for culturally appropriate governance strategies. In this regard, we seek to highlight the unique socio-economic challenges faced by the sugarcane industry in Australia and apply the learnings from this case study to broader governance issues. In particular, we draw attention to the fact that any form of government intervention associated with farming practices must be carefully introduced, with a clear understanding of what is likely to drive regulatory pushback, such as complexity and higher administrative and financial burdens.

¹ J.H. Ryther & W.M. Dunstan, ‘Nitrogen, Phosphorus, and Eutrophication in the Coastal Marine Environment’ (1971) 171(3975) *Science*, pp. 1008–13.

² V.H. Smith, G.D. Tilman & J.C. Nokolac, ‘Eutrophication: Impacts of Excess Nutrient Inputs on Freshwater, Marine, and Terrestrial Ecosystems’ (1999) 100(1–3) *Environmental Pollution*, pp. 179–96.

³ D.J. Sobota, J.E. Compton & J.A. Harrison, ‘Reactive Nitrogen Inputs to US Lands and Waterways: How Certain Are We about Sources and Fluxes?’ (2013) (11)(2) *Frontiers in Ecology and the Environment*, pp. 82–90.

⁴ K. Nakagawa et al., ‘Spatial Trends of Nitrate Pollution and Groundwater Chemistry in Shimabara, Nagasaki, Japan’ (2016) 75(3) *Environmental Earth Sciences*, pp. 1–17.

⁵ M. Duhon, H. McDonald & S. Kerr, ‘Nitrogen Trading in Lake Taupo: An Analysis and Evaluation of an Innovative Water Management Policy’, Motu Working Paper 15-07, Motu Economic and Public Policy Research, June 2015, available at: http://motu-www.motu.org.nz/wpapers/15_07.pdf.

⁶ A. Sharpley & X. Wang, ‘Managing Agricultural Phosphorus for Water Quality: Lessons from the USA and China’ (2014) 26(9) *Journal of Environmental Sciences*, pp. 1770–82.

2. THE GREAT BARRIER REEF

2.1. *Background and Context*

The Great Barrier Reef, off the coast of the state of Queensland in Australia, is the world's largest coral ecosystem. It is the world's third largest World Heritage site, most of which has been protected by a federal government-declared Marine Park, which was formally established by legislation in 1975.⁷ At the same time, a separate federal government authority was established to manage the Marine Park and now controls most of the day-to-day offshore activities.⁸ The onshore activities remain under the control of the state of Queensland, with the exception of a few hundred islands which also form part of the site. The Great Barrier Reef is actually a collection of close to 3,000 reefs and is home to several hundred species of coral, fish and other marine life found nowhere else on the planet. The site is an important economic driver for the state and federal economy and was recently valued at approximately USD 42.6 billion.⁹ In addition, tourism at or near the site supports the employment of around 70,000 full-time workers.¹⁰

Over the past decade, the health of the Great Barrier Reef has increasingly come to the attention of the international community, particularly given its status as a World Heritage site.¹¹ Coastal development, including that which supports fossil fuel export, has increased considerably along the coastline.¹² This is combined with increased shipping, fertilizer run-off from sugarcane farming (among others), and sediment and effluent flow from cattle grazing, causing tremendous strain on water quality at the site.

Second to climate change, the run-off of nitrogen and phosphorus from sugarcane production is the most significant threat facing the Great Barrier Reef.¹³ The impacts of these nutrients on the aquatic environment, chiefly from fertilizer use, have been reported for decades. They were first discovered during the 1970s as a 'critical limiting factor to algal growth and eutrophication in coastal marine waters'.¹⁴ The impacts of external loads on marine systems have since been gradually and better understood through the

⁷ Great Barrier Reef Marine Park Act 1975 (Cth), Pt V, in particular, s. 30.

⁸ The authority is called the Great Barrier Reef Marine Park Authority. It was established at the same time as the Marine Park and under the same legislation: *ibid.*

⁹ Deloitte Access Economics, *At What Price? The Economic, Social and Icon Value of the Great Barrier Reef* (Deloitte Tohmatsu Ltd, 2017), available at: <https://www2.deloitte.com/au/en/pages/economics/articles/great-barrier-reef.html#> (the report's quoted figure is AUD (Australian dollars) 56 billion).

¹⁰ *Ibid.*

¹¹ E. Hamman, 'The Role of Non-State Actors in Promoting Compliance with the World Heritage Convention: An Empirical Study of Australia's Great Barrier Reef' (PhD thesis submitted to Queensland University of Technology, Brisbane, Qld (Australia), 2017), Ch. 1, available at: https://eprints.qut.edu.au/114125/2/Evan_Hamman_Thesis.pdf.

¹² Queensland has 15 ports along its coastline. Five of these are known as 'priority port areas' – Gladstone, Abbot Point, Townsville, Hay Point/Mackay – and are heavily used for the export of agricultural goods and fossil fuels.

¹³ B. Schaffelke et al., *Scientific Consensus Statement 2017. A Synthesis of the Science of Land-based Water Quality Impacts on the Great Barrier Reef, Chapter 1: The Condition of Coastal and Marine Ecosystems of the Great Barrier Reef and Their Responses to Water Quality and Disturbances* (State of Queensland, 2017), pp. 25–6, available at: <http://www.reefplan.qld.gov.au/about/assets/2017-scientific-consensus-statement-summary-chap01.pdf>.

¹⁴ Ryther & Dunstan, n. 1 above.

1980s,¹⁵ 1990s¹⁶ and 2000s.¹⁷ The ‘external load’ of nitrogen into the aquatic environment is essentially an accumulation of ‘a wide variety of sources, including groundwater, fluvial, and atmospheric inputs’.¹⁸ The main pollutant is actually known as dissolved inorganic nitrogen (DIN).¹⁹ The majority of DIN entering the Great Barrier Reef comes from the farming of sugarcane, which has been a dominant industry in the catchment areas for over 150 years.²⁰ As noted by a recent Queensland government report:

Pollution loads from reef catchments have increased substantially since European settlement. It is estimated that sediment and nitrogen loads have increased by 600 per cent and phosphorus loads by 900 per cent in the reef as a result of land-based human activities within the reef catchments.²¹

The impacts of sugarcane farming have been directly linked to ‘outbreaks of the coral eating crown-of-thorns starfish, and excessive algal growth that outcompetes corals and increases the susceptibility of corals to disease’.²² It is an enormous industry in the Great Barrier Reef catchments. Over 95% of Queensland’s sugarcane production occurs within the coastal zone of the Great Barrier Reef.²³ It presently covers close to 900,000 hectares of land, and is growing every year.²⁴ During the 1900s, the Queensland government released large tracts of land (known as Crown Leasehold) for agricultural and pastoral purposes, with a view to stimulating the state’s economic activities.²⁵ Today, up to 90% of Australia’s sugarcane is grown in Great Barrier Reef

¹⁵ R.E. Hecky & P. Kilham, ‘Nutrient Limitation of Phytoplankton in Freshwater and Marine Environments: A Review of Recent Evidence on the Effects of Enrichment’ (1988) 33(4) *Limnology and Oceanography*, pp. 796–822.

¹⁶ I. Valiela et al., ‘Transport of Groundwater-Borne Nutrients from Watersheds and Their Effects on Coastal Waters’ (1990) 10(3) *Biogeochemistry*, pp. 177–97; P.M. Vitousek & R.W. Howarth, ‘Nitrogen Limitation on Land and in the Sea – How Can it Occur?’ (1991) 13(2) *Biogeochemistry*, pp. 87–115; Smith, Tilman & Nekolac, n. 2 above.

¹⁷ C.P. Slomp & P.V. Cappellen, ‘Nutrient Inputs to the Coastal Ocean through Submarine Groundwater Discharge: Controls and Potential Impact’ (2004) 295(1) *Journal of Hydrology*, pp. 64–86.

¹⁸ Smith, Tilman & Nekolac, n. 2 above.

¹⁹ *Ibid.*

²⁰ C.R. Moore, ‘Queensland Sugar Industry from 1860 to 1900’, in B.J. Dalton (ed.), *Lectures on North Queensland History* (James Cook University, 1974), pp. 29–48, available at: https://nqheritage.jcu.edu.au/77/1/DU270_J3_1974_v1.pdf.

²¹ Queensland Government, Department of Environment and Heritage Protection, ‘Enhancing Regulations to Ensure Clean Water for a Healthy Great Barrier Reef and a Prosperous Queensland’, Discussion Paper, Mar. 2017, p. 8, available at: <http://www.ehp.qld.gov.au/assets/documents/reef/gbr-discussion-paper.pdf>.

²² Queensland Government, Department of Environment and Heritage Protection, ‘Broadening and Enhancing Reef Protection Regulations: Consultation Regulatory Impact Statement’, Sept. 2017, p. 17, available at: <http://www.ehp.qld.gov.au/assets/documents/reef/enhancing-reef-protection-regulations-ris.pdf>.

²³ Queensland Government, Department of State Development, Infrastructure and Planning, ‘Great Barrier Reef Coastal Zone Strategic Assessment 2013: Strategic Assessment Report’, Nov. 2013, p. 34, available at: <http://www.statedevelopment.qld.gov.au/resources/report/gbr/full-report-chapters-1-5.pdf> (Queensland Government, Strategic Assessment 2013).

²⁴ M. Westcott, *Great Barrier Reef Protection Amendment Bill 2009 (Qld): Regulating Sugar Cane Growing and Cattle Grazing in the Great Barrier Reef Catchment Area* (Queensland Parliamentary Library, 2009), p. 4, available at: <http://www.parliament.qld.gov.au/documents/explore/research/publications/researchbriefs/2009/rbr200922.pdf>.

²⁵ For a discussion of Crown Leases in Queensland, see A. Wallace, M. Weir & L. McCrimmon, *Real Property Law in Queensland* (Thomson Reuters, 2015), pp. 26–40.

catchments. It is one of Australia's largest agricultural exports (alongside cattle, wool, and wheat), making Australia the second largest exporter of sugar in the world.²⁶

At present there are estimated to be around 4,000 sugarcane growers in Queensland,²⁷ the majority of whom are sole proprietors or family partnerships, rather than large farming organizations or conglomerates. The biggest problems for nutrient run-off are in the Herbert, Haughton, Russell-Mulgrave, Johnstone, Tully, and Plane catchment areas,²⁸ which are located in the mid-to-lower part of the Great Barrier Reef catchment.

There are over two dozen sugar mills in the region, along with many other stakeholders associated with the ongoing operations of this industry. The financial viability of the sugar industry hinges on cooperation between the growers combined with the work of the mills.²⁹ Sugarcane, in its raw state, cannot be sold on either the international or domestic market. The industry is therefore dependent on the ongoing profitability and operation of the mills.³⁰ Once harvested, sugarcane 'must be treated within 16 hours' or 'its commercial value deteriorates'.³¹ Accordingly, sugarcane farms must be geographically co-located near a mill, and if a particular mill shuts down, then potentially all the farming operations within that area will also close. Just as growers are dependent on mills, the mills are dependent on production volumes, and therefore crop yields. Mills have relatively high operating costs, which include a combination of a large equipment base and a number of salaried employees.³² Because of the significant costs of operating sugar mills, specific levels of revenue are necessary to maintain financial viability.

2.2. Governance Approaches to Nutrient Run-Off (2003–17)

Responsibility for environmental governance of the sugarcane industry lies predominantly with the Queensland government. The Australian government may, in theory, have jurisdiction over the eutrophication issues associated with sugarcane, although to date it has never sought to exercise regulatory control. The two options for federal regulation, if control at this level were to be exercised, would be, firstly, section 24B of the Environment Protection and Biodiversity Conservation Act 1999 (Cth), which creates the offence of undertaking activities that have a significant impact on the Great Barrier Reef 'World Heritage Area' without approval; and secondly,

²⁶ Australian Government, Department of Agriculture and Water Resources, 'Sugar', updated 15 Sept. 2017, available at: <http://www.agriculture.gov.au/ag-farm-food/crops/sugar>.

²⁷ Parliament of Australia, The Senate, Rural and Regional Affairs References Committee, *Current and Future Arrangements for the Marketing of Australian Sugar* (Commonwealth of Australia, 2015).

²⁸ J. Waterhouse et al., *2017 Scientific Consensus Statement: Land Use Impacts on Great Barrier Reef Water Quality and Ecosystem Condition* (Queensland Government, 2017), p. 15, available at: <http://www.reefplan.qld.gov.au/about/assets/2017-scientific-consensus-statement-summary.pdf>.

²⁹ C. Hildebrand, *2002 Independent Assessment of the Sugar Industry* (Australian Government, Department of Agriculture, Fisheries and Forestry, 2002).

³⁰ *Ibid.*

³¹ D. Mackintosh, 'Sugar Milling', in M. Hogarth & P. Allsopp (eds), *Manual of Canegrowing* (Bureau of Sugar Experiment Stations, 2000), pp. 369–78.

³² Hildebrand, n. 29 above.

section 66 of the Great Barrier Reef Marine Park Act 1975 (Cth), which allows the Australian government to make specific regulations for the protection of the reef.

Although the run-off issues from sugarcane were known as far back as the 1970s and were raised by non-governmental organizations (NGOs) at the time,³³ the 2003 Reef Water Quality Protection Plan (Reef Plan) was the first real attempt to confront the issue.³⁴ The Reef Plan was jointly created by the Queensland and Australian governments. It recognized that ‘there [was] an overwhelming case for halting and reversing the decline in water quality in the waterways entering the Reef’.³⁵ The Reef Plan set out 65 specific actions over a ten-year period, including governance approaches such as ‘self-management’, ‘education and extension’ and ‘economic incentives’. The scope of the Reef Plan was to ‘address non-point source pollution from broad-scale land use’, including, in particular, combating the flow of nutrients, sediment and chemicals in the Great Barrier Reef.³⁶ Although the concept of regulation was raised, the Reef Plan offered no significant regulatory approaches in terms of either legislative or rule-based actions, or punitive measures.

The Reef Plan was ambitious and forward-looking. However, it was not underpinned by robust scientific evidence or empirical evidence into what previous approaches worked, or what did not. The source of the pollution was understood reasonably well (at least, why it was happening in a general sense), but with several thousand farms in the region – covering close to one million hectares – it was not widely known which farms or practices were creating the greatest threats. By 2009 (over half way through the ten-year plan) it was clear that, despite the best intentions, ‘management actions [of the Reef Plan were] not addressing the problem effectively’.³⁷ In particular, the Reef Plan lacked ‘clear and measurable targets’, as well as effective mechanisms for monitoring, evaluation and enforcement.³⁸ In 2009, an amended Reef Plan was introduced, recommending that financial incentives, extension services and regulation all needed to be tightened if the goals of water quality improvement were to be fully achieved.³⁹ At the same time a Reef Rescue funding package was introduced, which saw AUD 200 million in grants distributed (mainly to Natural Resource Management groups) to investigate novel approaches to land management and improving water quality. That funding has since been added to through initiatives such as the Reef Trust and, since 2008, has totalled close to AUD 500 million.

³³ Hamman, n. 11 above, p. 135.

³⁴ State of Queensland and Commonwealth of Australia, *Reef Water Quality Protection Plan: For Catchments Adjacent to the Great Barrier Reef World Heritage Area* (Queensland Department of Premier and Cabinet, 2003) (Reef Plan), available at: <http://www.reefplan.qld.gov.au/about/assets/reefplan-2003.pdf>.

³⁵ *Ibid.*, p. 4.

³⁶ State of Queensland, Department of the Premier and Cabinet, *Reef Water Quality Protection Plan 2009: For the Great Barrier Reef World Heritage Area and Adjacent Catchments* (Reef Water Quality Protection Plan Secretariat, 2009), p. 8, available at: <http://www.reefplan.qld.gov.au/resources/assets/reef-plan-2009.pdf>.

³⁷ *Ibid.*, p. 3.

³⁸ *Ibid.*, p. 5.

³⁹ *Ibid.*, p. 20.

In terms of regulation, a Reef Regulatory Package was to be developed under the plan by 'mid-2009' and 'fully implemented' by 2010.⁴⁰ The Queensland government kept this promise and regulation was introduced by way of a new chapter (Chapter 4A) in the Environmental Protection Act 1994 (Qld). These amendments were designed to reduce the impact of agricultural activities on the quality of water entering the site by focusing on (nitrogen and phosphorus from) sugarcane farming and (sediment from) cattle grazing. Only the largest commercial operations were targeted by the regulations.⁴¹ Specifically, Chapter 4A required commercial sugarcane growers in three 'high risk reef catchments' (the Wet Tropics, Mackay-Whitsunday, and the Burdekin) to limit fertilizer application and maintain records to ensure that the application of nitrogen and phosphorus was able to be monitored and verified.⁴² Contributing close to three quarters of the total dissolved nitrogen pollution to the site, these areas were justifiably targeted by the regulation.⁴³ Section 78 of the Environmental Protection Act 1994 (Qld), which is still current (but not enforced), makes it an offence to 'over-apply' nitrogen or phosphorus to soil, unless the farmer has complied with an approved environmental management plan, or has otherwise complied with an alternative authorized method for measuring fertilizer loads. The maximum penalty for breaching the allocation limits in 2009 was USD 7,643.70; in 2017 that figure had increased to USD 9,642.53.⁴⁴

The introduction of regulations in the form of Chapter 4A was welcomed by some in the sugarcane industry. Others, however, rejected the increased oversight into farming practices by the Queensland government.⁴⁵ As an alternative to regulation, the sugarcane industry continued to develop its own voluntary codes for land management, known as Best Management Practices (BMPs). The BMP measures were designed to cover all areas of cane farming: soil, nutrients, irrigation, drainage, weeds, pests, disease, crop production, harvesting, farm business, natural systems, workplace health and safety, managing people and the environment.⁴⁶ Within each of the 'modules' there are numerous aspects of the practice in which the farm must attempt to reach, or exceed, the outlined industry standard. For example, 'Calculating optimum nutrient rate' under the 'Soil Health and Nutrient Management' module requires soil tests and adherence to the 'Six Easy Steps' methodology.⁴⁷

⁴⁰ *Ibid.*, p. 21.

⁴¹ Environmental Protection Act 1994 (Qld), s. 75.

⁴² State of Queensland, Queensland Audit Office, 'Managing Water Quality in Great Barrier Reef Catchments', Report 20: 2014–15, available at: <https://www.qao.qld.gov.au/reports-parliament/managing-water-quality-great-barrier-reef-catchments>. In particular the Environmental Protection Act 1994 outlines the fertilizer application requirements and creates an offence of applying more than 'the optimum amount' of nitrogen and phosphorus to soil on the property: Environmental Protection Act 1994 (Qld), Ch. 4A, ss. 78, 80. Further the Act specifies that fertilizer containing nitrogen or phosphorus cannot be applied if it would cause more than this optimum amount to be applied to the soil: *ibid.*, s. 82.

⁴³ Queensland Government, Strategic Assessment 2013, n. 23 above, p. 136.

⁴⁴ Environmental Protection Act 1994 (Qld), s. 78. These figures are the USD equivalent of AUD 10,000 and 12,615 respectively.

⁴⁵ Westcott, n. 24 above, p. 1.

⁴⁶ Canegrowers Association, 'Smartcane BMP Home', 2016, available at: <https://www.smartcane.com.au/home.aspx>.

⁴⁷ *Ibid.*

The process for farm accreditation includes a self-assessment by the grower in relation to the industry standard, module training (including the provision of evidence of diary records, and management practices) for certification of meeting/exceeding standards and auditing by a local BMP facilitator.⁴⁸ In order to obtain a final certification and become BMP accredited, an audit will be conducted by a BMP facilitator from another district.⁴⁹ If a grower has carried out a BMP self-assessment, the regulatory agency – the Queensland Department of Environment and Heritage Protection – will allow the grower a year in which to complete the accreditation. In terms of results, there has been a relatively poor take-up of BMPs over the last decade. A recent report by the Queensland government noted:

At 31 August 2017, there are [only] 206 sugarcane growers out of approximately 3700 growers [around 5.5%] ... that have been accredited as implementing best practice for water quality under government supported industry-led Best Management Practice (BMP) programs. A re-invigorated compliance program has found high non-compliance with the current nutrient application standards. However, there has been notable improvements in compliance in follow-up inspections.⁵⁰

The poor take-up of BMPs coupled with weak water quality results has forced the Queensland government to revisit the idea of regulation chiefly in the form of an expanded version of the Chapter 4A provisions.⁵¹

3. DISCUSSION

The discussion which follows sets out our key insights or lessons derived from the governance of eutrophication issues affecting the Great Barrier Reef between 2003 and 2017. By and large, successive governments in Australia have failed to take a central and controlling position on this issue and failed to introduce sufficiently strong policies supported by legislation and resourcing. This has meant that there has been little progress in meeting the desired environmental objective of improving the water quality of the site. That is not to say, however, that the expenditure of AUD 500 million or so in ‘non-regulatory’ initiatives (and millions more on policy development and analysis) represents a failure, for a great deal more is now known about land management practices and fertilizer application than was known before. Nevertheless, now is certainly the time to capitalize on the experiences learnt over the last two decades, and devise renewed approaches that deliver real environmental outcomes.

In terms of funding and the allocation of resources to implement necessary reforms, Brodie and Pearson estimate that to truly ‘save the reef’ close to AUD 10 billion is needed – about 1% of Australia’s total gross domestic product

⁴⁸ Ibid.

⁴⁹ Ibid.

⁵⁰ Office of the Great Barrier Reef, ‘Broadening and Enhancing Reef Protection Regulations: Consultation Regulatory Impact Statement’, Sept. 2017, Executive Summary, p. 4, available at: <http://www.ehp.qld.gov.au/assets/documents/reef/enhancing-reef-protection-regulations-ris-summary.pdf>. At the time of writing a second round of consultation on the proposed regulations had begun.

⁵¹ Ibid.

(GDP) and some 20 times the current investment in the area.⁵² There is certainly a resourcing issue facing the site as well as other managerial aspects that need to be carefully considered.⁵³ In the next section, however, we set out three factors that are likely to have relevance not only to the Great Barrier Reef and sugarcane, but other eutrophication situations across the world. The first two insights are reasonably clear-cut and are drawn from the best practice regulatory and governance literature: (i) the need for more rigorous and consistent evaluation of governance, and (ii) the need for regulation as a part of government strategies. The third point we make, concerning ‘culturally sensitive’ interventions, is something that has not been fully explored within academic literature. Indeed, it is the third point that forms the substantial contribution of this article. Of course, the importance of other measures in governance (such as transparency, community engagement, and access to information) should not be overlooked, but they are matters for another contribution of broader scope than the present article.

3.1. *Ongoing Evaluation of Governance*

One of the clearest problems demonstrated by the Great Barrier Reef-sugarcane example has been that neither the government nor industry (nor civil society for that matter) has sufficiently invested in rigorous and systematic evaluation of its governance approach. A 2017 Scientific Consensus Statement about water quality entering the Great Barrier Reef recently found that ‘[t]here has been little investment in social, economic and institutional research, or monitoring, evaluation and reporting of indicators related to Great Barrier Reef water quality management, and this constrains the ability to improve the effectiveness of programs’.⁵⁴

Elsewhere in the same report, the authors noted that ‘[t]here has been a lack of systematic evaluation of program design and implementation, and limited use of social, economic and institutional research to find and test new solutions and improve program delivery’.⁵⁵

Systematic evaluation of environmental governance in Australia is precisely the type of activity that needs to be carried out more carefully. As Martin and his co-authors state, for example:

Traditional legal instruments for rural environmental governance ... tend to emphasise individual stewardship by private landholders. They also tend to focus on specific governance instruments, rather than the determinants of the performance of the governance system as a whole. Many fundamental strategic challenges are [therefore] overlooked.⁵⁶

⁵² J. Brodie & R.G. Pearson, ‘Ecosystem Health of the Great Barrier Reef: Time for Effective Management Action based on Evidence’ (2016) 183(Part B), *Estuarine, Coastal and Shelf Science*, pp. 438–51.

⁵³ For other arguments, see *ibid.*

⁵⁴ Waterhouse et al., n. 28 above, p. 16.

⁵⁵ *Ibid.*, p. 14.

⁵⁶ P. Martin, A. Kennedy & J. Williams, ‘Effective Law for Rural Environmental Governance: Meta-Governance Reform and Farm Stewardship’, in R. Levy et al., (eds), *New Directions for Law in Australia: Essays in Contemporary Law Reform* (ANU Press, 2017), pp. 263–71, at 264, available at: <http://press-files.anu.edu.au/downloads/press/n2641/pdf/ch23.pdf>.

To a certain extent, a Strategic Assessment of the Great Barrier Reef released in 2014 attempted to address this ‘evaluative drought’.⁵⁷ The impetus for the Strategic Assessment (and resulting Long-Term Plan) was the result, however, not of an initiative of the Australian or Queensland governments, but of the World Heritage Committee’s oversight of the Great Barrier Reef with regard to port development back in 2010.⁵⁸ The Strategic Assessment was approved under the Environment Protection and Biodiversity Conservation Act 1999 (Cth). The Queensland component of the assessment (the coastal zone component) focused in particular on the sites of World Heritage value. In any event, and to its credit, the Queensland component of the assessment (the onshore component) described the terrestrial activities that impacted on the site (grazing, sugarcane, coastal development), including an evaluation of its current programmes. It concluded, wrongly in our view, that the Reef Plans (2003, 2009 and 2013) had been ‘very effective’ and their implementation was ‘demonstrating a clear trend towards halting and reversing the decline in water quality from broadscale agriculture’.⁵⁹ When benchmarked against the relevant science, this evaluation is puzzling and appears, without an appropriate explanation, to be contradictory to the science and the government’s own ‘report card’ system, which ranked water quality in the priority catchments in 2015 as ‘poor’ to ‘very poor’.⁶⁰ Nonetheless, the Strategic Assessment and Long-Term Plan for the site now give both Queensland and the federal government the guiding ‘cumulative’ framework to construct a more thorough and honest approach to the water quality-sugarcane issue.

3.2. *Regulation as Part of the Mix*

Many Western democracies, including Australia, have quite deliberately shied away from the creation and imposition of rules (through legislation) in recent years. Indeed, in Australia at the national level it resembles a practice of last resort.⁶¹ The control of human behaviour affecting the environment, however damaging its impacts may be on natural resources (or ‘the public interest’), has been heavily influenced by neoliberal economic agendas and the idea that regulation might harm economic progress. These myths have been dispelled, including through a vast collection of theoretical and empirical evidence from leading regulatory scholars such as Ayres and Braithwaite,⁶²

⁵⁷ Australian Government, Great Barrier Reef Marine Park Authority, ‘Strategic Assessment and 25-Year Management Plan’, 2017, available at: <http://www.gbrmpa.gov.au/managing-the-reef/strategic-assessment>.

⁵⁸ Hamman, n. 11 above.

⁵⁹ State of Queensland, ‘Chapter 10: Recommended Changes and Forward Commitments’, in *Great Barrier Reef Coastal Zone Strategic Assessment Report*, p. 332, available at: <http://www.statedevelopment.qld.gov.au/resources/report/gbr/chapter-10-changes.pdf>.

⁶⁰ State of Queensland, ‘Great Barrier Reef Report Card 2015, Reef Water Quality Protection Plan’, 2016, available at: <http://www.reefplan.qld.gov.au/measuring-success/report-cards/2015/assets/gbr-2015report-card.pdf>.

⁶¹ Australian Government, *The Australian Government Guide to Regulation* (Commonwealth of Australia, Department of the Prime Minister and Cabinet, 2014), available at: <https://www.cuttingredtape.gov.au/handbook/australian-government-guide-regulation>.

⁶² I. Ayres & J. Braithwaite, ‘Tripartism: Regulatory Capture and Empowerment’ (1991) 16(3) *Law and Social Inquiry*, pp. 435–96. On responsive regulation and the ‘tit for tat’ relationship between the

Gunningham and co-authors,⁶³ Grabosky,⁶⁴ and Black and Baldwin.⁶⁵ More responsive and smart approaches to regulation have been around for years now and there exists a healthy space for regulatory endeavours in between state-centric regulation, on the one hand, and *laissez-faire* market systems on the other.

The Great Barrier Reef-sugarcane scenario presents what might be explained as a considerable fear of regulatory oversight. The sugarcane industry's pushback of the regulatory reform package in 2008–09 has meant that the provisions (which set minimum enforceable standards for fertilizer loads) in Chapter 4A of the Environmental Protection Act 1994 (Qld) have never been utilized. The argument for regulation as part of the mix of approaches is now urgent and the case for it is long overdue. Even the original 2003 Reef Plan highlighted a role for regulation of the industry:

Regulation is an efficient and effective way of affirming the minimum acceptable performance, providing certainty to all stakeholders and ensuring that the efforts and competitiveness of good performers are not undermined by those who do not initiate action themselves. Some regulatory actions should be implemented immediately. Others should be implemented at a later date where there is a risk that voluntary approaches will fail to deliver significant water quality improvements.⁶⁶

In our view, the abovementioned 'later date' has now arrived. Expert scientists following the Great Barrier Reef agree. In 2016, for instance, Brodie and Pearson argued for 'a regulatory approach [to the Reef] in conjunction with other non-regulatory policy approaches', suggesting that '[r]eviews of the use of voluntary mechanisms to implement catchment management to reduce pollutant loadings to downstream waterbodies consistently show that such mechanisms are not effective when used without a regulatory component'.⁶⁷

The case for regulation is most clear in the failure of the self-regulatory models that have been negotiated and pursued by the government and the industry. It is apparent, on any set of indicators, that self-regulation through the BMPs has not delivered the necessary results in terms of improvement in water quality and a drastic reduction in nutrient loads. Accordingly, governments at both the state and federal levels in Australia must adopt and apply regulation to enforce minimum standards of behaviour. Notably, the existing provisions in Chapter 4A of Queensland's Environmental Protection Act 1994 are and always have been sufficient for this task. The provisions of the Australian

regulator and the industry, see I. Ayres & J. Braithwaite, *Responsive Regulation: Transcending the Deregulation Debate* (Oxford University Press, 1992).

⁶³ N. Gunningham, P.N. Grabosky & D. Sinclair, *Smart Regulation: Designing Environmental Policy* (Clarendon Press, 1998); see also Gunningham's publications more generally.

⁶⁴ P. Grabosky, 'Beyond the Regulatory State' (1994) 27(2) *Australian and New Zealand Journal of Criminology*, pp. 192–97; and P. Grabosky, 'Beyond Responsive Regulation: The Expanding Role of Non-State Actors in the Regulatory Process' (2013) 7(1) *Regulation & Governance*, pp. 114–23.

⁶⁵ J. Black & R. Baldwin, 'Really Responsive Risk-Based Regulation' (2010) 32(2) *Law and Policy*, pp. 181–213.

⁶⁶ Reef Plan, n. 34 above, p. 21.

⁶⁷ Brodie & Pearson, n. 52 above.

government's Environment Protection and Biodiversity Act 1999 and its Great Barrier Reef Marine Park Act 1975 are also capable vehicles for regulatory oversight.

Such regulation does not need to be implemented in isolation from other governance measures, and indeed this is what the Queensland government is considering.⁶⁸ The current thinking around governance suggests that a mixture of approaches works best: regulation, industry codes, incentives and market mechanisms. In actual fact, it was always envisioned that the Chapter 4A regulations would complement the BMP (self-regulation) approach as well as other industry incentives and government grant schemes, like the Reef Rescue package, between 2008 and 2013. The main problem has been the Queensland government's reluctance to apply the rules for fear of industry backlash. Without adequate enforcement of Chapter 4A to drive a culture of accountability and a sense of urgency, it comes as little surprise that the good intentions underpinning the BMPs – including the development of innovative land practices – are going unfulfilled.⁶⁹

There will, of course, be costs to the industry (and government) of regulatory oversight. It is well documented that any change in agricultural practice will ultimately result in a series of costs to participants.⁷⁰ The regulation of sugarcane growers and their fertilizer use is certainly no exception to this. These costs will be both direct and indirect, and in some instances substantial, requiring financial and personal commitment from the growers and significant investment in monitoring and enforcement by the regulator. Moreover, as noted in the previous section, evaluation of governance approaches, including regulation, needs to be continuous and rigorous. Evaluation cannot begin and end with a snapshot of the potential costs of regulation to the industry at the point at which they are introduced (which is what a regulatory impact statement essentially provides). Evaluation must go over and above this and follow the socio-cultural and costs impacts of regulation as it is rolled out into the industry. The principles of adaptive management call for nothing less. As Martin and his co-authors explain:

Current regulatory review [in Australian rural communities] is minimal and focused only on business cost. It does not address risks of implementation failure, nor of social spill overs. A more comprehensive approach is needed to: (firstly) objectively review plans for implementation, including consideration of commitments from government to funding and other implementation requirements for the laws that they propose to create; and (secondly) consider the likely outcome effectiveness and distributional effects of proposed laws, and canvass how possible inadequacies and perverse impacts will be addressed.⁷¹

The social implications of (re)introducing regulation on tight-knit and existing communities are likely to be considerable. If poorly implemented, regulatory

⁶⁸ Queensland Government, Department of Environment and Heritage Protection, n. 22 above.

⁶⁹ Queensland Audit Office, n. 42 above.

⁷⁰ A. Coggan et al., 'Private Transaction Costs of Participation in Water Quality Improvement Programs for Australia's Great Barrier Reef: Extent, Causes and Policy Implications' (2015) 59(4) *Australian Journal of Agricultural and Resource Economics*, pp. 499–517.

⁷¹ Martin, Kennedy & Williams, n. 56 above, pp. 269–70.

intervention has the potential to upend entire communities through cost and other behavioural pressures. As recently noted in a Queensland government report:

In most circumstances, the [sugarcane] industry is the sole reason for the development of regional townships [in parts of Queensland], which means cane growing and sugar production underpins the economic stability of many of the GBR coastal zone's communities.⁷²

Regulation of the industry thus challenges the fundamental structures of communities in rural areas, far more than it might in urban or metropolitan centres. These issues cannot be ignored in any attempt to change behaviour for environmental gain through regulation, whether or not other incentives, moratoriums, lag times, or tax breaks are also available. The need for culturally appropriate strategies of regulation and other forms of government-led intervention are discussed in the following section. We highlight the need for both state and federal governments to carefully consider the socio-economic vulnerabilities of the sugarcane community, including their considerable history of farming activities; the close-knit nature of sugarcane supply chains; the vulnerability of the industry to extreme weather events (cyclones, droughts, floods); the susceptibility of growers to foreign currency fluctuations; and the uncertainty around supply contracts with multinational agribusinesses.⁷³ All of these vulnerabilities contribute to industry resistance to further regulatory oversight, including in relation to an issue as globally significant as the health of the Great Barrier Reef.

3.3. *The Need for Culturally Appropriate Strategies*

The sugarcane industry in Australia has existed since the 1850s. For several generations farmers have created large communities around this practice. They have established commercial and personal networks that include mills, employees, local businesses, and other parts of the supply chain. A close connection was highlighted in Section 2.1 above, for instance, between the growers and the mills because of the need to efficiently process the raw cane and have it ready for export. The commercial nature of these relationships needs to be better understood, as well as the effects that regulation or other forms of intervention will have on the farming population.

Parts of the literature have begun to tackle this problem by seeking to better understand 'the factors that influence cane farmer behaviour'.⁷⁴ Pickering and colleagues, for example, have argued that social norms are a major factor in whether behavioural change can be implemented. They point out that 'a decision a grower makes about what farming practices to adopt might be influenced by the norms of the

⁷² Queensland Government, Strategic Assessment 2013, n. 23 above, p. 35.

⁷³ On the topic of the dispute between Queensland industry, the Australian government and Singaporean-based Wilmar Sugar, see C. Packham, 'Australian Government Intervenes in Wilmar Sugar Row', *Reuters World News*, 30 Mar. 2017, available at: <https://www.reuters.com/article/us-australia-sugar-politics/australian-government-intervenes-in-wilmar-sugar-row-idUSKBN17105H>.

⁷⁴ J.A. Pickering et al., 'Applying Behavioural Science to the Queensland Sugar Cane Industry and Its Relationship to the Great Barrier Reef (2017) 13(2) *Rural Extension and Innovation Systems Journal*, pp. 1–10.

social group the grower belongs to'.⁷⁵ They also argue, as we did above, that 'although guidelines, targets and regulations can be effective augmentations to a behaviour change strategy, they are rarely fully effective in their own right'.⁷⁶ One point of difference, however, between our 'regulatory mix' argument (above) and theirs is that they suggest that self-regulation must be a 'priority' for governments. The clear evidence of poor take-up of voluntary BMPs severely undermines this point. As we suggested above, the balance ought to be skewed away from voluntary regulation approaches, particularly given the urgency of the crisis faced by the Great Barrier Reef and the failure of past self-regulatory approaches introduced to effect change. That said, we echo their final recommendations about the need for '[i]nvestment in a population-level behaviour change strategy for the Queensland cane industry [which] would enable every farmer in the community to have access to evidence-based behaviour change strategies regardless of their circumstances'.⁷⁷

This population-level strategy should focus on the socio-economic vulnerabilities of the cane farming community. It should be recognized, for instance, that sugarcane farmers are under increasing pressures as a result of changing climatic conditions that affect crop yields (and extreme weather events such as cyclones), as well as volatile commodity prices and uncertain contractual negotiations with overseas buyers. It was reported recently, for instance, that the uncertain contractual conditions for approximately 1,500 farmers in the region (about a third of the industry) is particularly stressful. Two sugarcane farmers in the region were reported in the media as saying:

Without a contract, we have no guarantee of return on what we've spent so we've put a stop to it. We won't be doing any more significant investment until there's a decent outcome.

and

Mentally this situation does get you down, it is affecting us personally, but we have to run our business and find the best outcome in the scenario that we're faced with. For us, that means looking at growing other crops because we have to remain profitable.⁷⁸

The Australian and Queensland governments must therefore devise approaches to rural governance in such a way that it is culturally acceptable, at least to the predominant numbers of farmers in the region who are doing 'the right thing' in terms of fertilizer loads. At the same time, they must also be cognizant of the economic vulnerabilities that the industry currently faces (such as price fluctuations, uncertain supply contracts, and extreme weather events). Allied to this is a need to respect, as far as possible (while still meeting the goals of nutrient reduction), the history and continuity of farming culture. Initiatives must acknowledge that fast-tracked changes

⁷⁵ *Ibid.*, p. 5.

⁷⁶ *Ibid.*, p. 9.

⁷⁷ *Ibid.*

⁷⁸ Australian Cane Farmers, 'Can Families Pay Price of Contract Dispute', 1 Feb. 2017, available at: <http://www.acfa.com.au/cane-families-pay-price-contract-dispute>.

without appropriate support will be met with immediate resistance and low levels of compliance. The farmers themselves have a particular view of the industry, which needs to be heard. As one farmer reflected: ‘The underlying principle [should be] of backing the judgement of a farmer; a farmer can make changes to on-farm practices, cultural practices, with financial support from government.’⁷⁹

That is not to say that self-regulation (or industry regulation) should form the core component of the way forward. Rather, our arguments above set out the need for state-sanctioned regulation to play a major part. The point is simply that governments need to closely understand the pressures the industry is facing in terms of contracts, commodity prices and climatic conditions. This requires an understanding of the ‘vulnerability’ of rural communities. As Martin and his co-authors remark, the challenge in many rural communities (in Australia) is not to burden them with laws with which they have little chance of complying:

As many farmers argue, farm financial vulnerability and volatility, limited human resources and the relatively poor socioeconomic status of rural communities create conditions in which it is not feasible for them to meet the stewardship expectations that the law and (urban-based) public opinion place upon them.⁸⁰

By way of example, one of the biggest drivers of vulnerability in sugarcane communities seems to lie in the marginal profits associated with many of the smaller farming operations in the region. When we examine the culture of the sugarcane industry in Australia, it is apparent that there are several small farms. There are around 4,000 farms, each averaging approximately 100 hectares in size.⁸¹ The bottom 2% in size are, on average, around 36 hectares, while the average of the top 25% is around 216 hectares. It is estimated that 70% of the farms are less than 125 hectares in size, and account for 30% of total production. Rates of return on capital (excluding capital gains) for the smallest 25% of farms are around a negative 9%.⁸² Moreover, small-area sugarcane growers typically derive a large proportion of their income from off-farm activities. Farm businesses with less than 50 hectares of planted sugarcane have had cash operating margins of close to zero, with income from other sources – crops, beef cattle, and contracting – providing a small positive average farm cash income of USD 11,430 per business.⁸³

Under these circumstances, it is not surprising that small-scale sugarcane growers – whose operations are only marginally profitable – are highly reluctant to spend the time and effort adopting self-regulatory initiatives like the BMPs. In all probability, some 30% or more of sugarcane growers do not have the ready financial resources to

⁷⁹ S. Baker, ‘Government Extends Reef Rescue Program’, *ABC*, 25 Apr. 2013, available at: <http://www.abc.net.au/news/rural/2013-04-25/nrn-reef-rescue/4650818>.

⁸⁰ Martin, Kennedy & Williams, n. 56 above, p. 267.

⁸¹ Parliament of Australia, ‘Current and Future Arrangements for the Marketing of Australian Sugar’, Parliamentary Report, Ch. 3, para. 3.10, available at: https://www.aph.gov.au/Parliamentary_Business/Committees/Senate/Rural_and_Regional_Affairs_and_Transport/Sugar/Report/c03.

⁸² Sugar Research Australia, ‘SRA Performance Report 2015/16: Executive Summary’, available at: https://sugarresearch.com.au/wp-content/uploads/2017/03/SRA_Performance_Report_2015_2016_-_Executive_Summary.pdf.

⁸³ This equates to approximately AUD 14,900: Sugar Research Australia, *ibid*.

devote to following BMP (self-regulation) procedures. Moreover, they have little incentive to do so even if resources were available, simply because there is no direct motive linked to this investment. That is, given the required outlay in time and resources,⁸⁴ the adoption of BMPs may not greatly increase their overall income. This means a voluntary approach is unlikely to achieve desired outcomes, and rather it is important to recognize that some of these small-scale operations may not be financially viable over an extended period of time.

These points lead to important implications for the way in which a governance (and regulatory) regime might be designed. Firstly, the lack of voluntary uptake of BMPs by small growers indicates that persuasion alone has not been successful for this group of growers. This may be because growers do not readily accept that BMPs will provide a worthwhile increase in revenue. Thus, given the overall lack of profitability of smallholder sugarcane farming, and the entrenched long-standing farming habits and traditions among some growers, there appears to be good reason why persuasion has been less than successful. That failure can equally be attributed to the lack of active and consistent intervention in support of BMP uptake by third parties, although some regions have responded better than others, which may be attributed to superior extension models.⁸⁵ Economic theories of path dependence and lock-in may also explain why this uptake has been less than optimal, particularly as Chapter 4A has not been enforced.

That said, there is evidence that adopting BMPs as an approach for mitigating agricultural externalities is sound in principle, although the introduction needs to be complemented by other measures in the form of incentives or ‘nudges’. Arguments for this need are supported by the current poor uptake of BMPs in the sugarcane industry. This may be explained in part both by the complicated nature of these standards, the costs associated with any transition to them, and the economic arguments associated with lock-in theory, noted above. One of the key findings of this study is that, without proportionate incentives, any voluntary programme is unlikely alone to deliver the scale of change required to improve water quality in the Great Barrier Reef catchment area in the time frame required.⁸⁶ At the time of writing, the Queensland government had indicated that the response to water quality issues in the Great Barrier Reef catchment area would be adjusted to provide more direct incentives to growers.⁸⁷

Overall, our point is that regulatory and governance frameworks never operate within a social vacuum.⁸⁸ The desired outcomes may be the reason for the regulation,

⁸⁴ Coggan et al., n. 70 above, p. 501.

⁸⁵ Superior extension models are generally the result of appropriate personnel and dedicated resources. Superiority is often demonstrated through grower engagement with these extension services.

⁸⁶ M.E. van Grieken et al., ‘Integrating Economic Drivers of Social Change into Agricultural Water Quality Improvement Strategies’ (2013) 180 *Agriculture, Ecosystems & Environment*, pp. 166–75.

⁸⁷ Office of the Great Barrier Reef, n. 50 above.

⁸⁸ J. Borck & C. Coglianese, ‘Beyond Compliance: Explaining Business Participation in Voluntary Environmental Programs’, in C. Parker & V.L. Nielsen (eds), *Explaining Compliance: Business Responses to Regulation* (Edward Elgar, 2011), pp. 139–69. These authors suggest that social pressures can in some instances lead to voluntary compliance with environmental programmes.

but it is the steps to achieve those desired outcomes that are quite often overlooked. Where the object of a framework is to modify the individual behaviour of participants who collectively operate in the same industry, the promotion of a healthy industry culture should be a central principle. As noted by Thaler and Sunstein, social influences can affect beliefs, which in turn will impact on behaviour.⁸⁹ In the instance that systemic behaviours of an industry are to be addressed through regulatory measures this principle becomes all the more important and, at the same time, increasingly complex. In addition, it is important to consider the predominant structure of the operations that will be the subject of regulation. In this regard, a crucial distinction to make is between small and large enterprises. The activities, supply chains, pressures, and behaviour are very different between these groups. As Gunningham and Sinclair note in their analysis of the regulation of small businesses: ‘Arguably the key, at least for [smaller enterprises] with less than 50 employees, is to focus on simple, accessible improvements in management practices, rather than the introduction of formalised, administratively complex [systems of compliance]’.⁹⁰

4. CONCLUSION

Agriculture is and will continue to be one of the greatest environmental challenges for the planet. Estimates vary, although there are studies that suggest that it contributes up to 30% of the world’s GHG emissions. Further, it appears that agriculture is a major cause of decline in the world’s wetlands, 50% of which have been lost since the 1900s.⁹¹ The conversion of land (vegetation and wetland clearing) for intensive agriculture and pastoral purposes has been particularly devastating for biodiversity. The world’s insatiable appetite for more and better meats, cotton, rice, corn, soybean, sugar and other crops places tremendous pressure on ecologically sensitive areas, including aquatic systems.

In this article we have conducted a brief study of the governance of Australia’s sugarcane industry – over 95% of which is located in the catchments of the Great Barrier Reef. While further socio-legal research is indeed required, our study found that there are challenging legacies to address, such as existing land-use rights and complex socio-economic factors, which need to be far better understood. Efforts to combat the problem of eutrophication have shunned regulation in favour of self-regulation and government incentive schemes. These measures have simply not been able to reduce the massive nutrient loads affecting water quality in the Great Barrier Reef. The situation is now at desperate stages. As Brodie and Pearson wrote in 2016: ‘Given the parlous state of the Great Barrier Reef a complete refocus and strengthening of management is required’.⁹² We need to drastically rethink and

⁸⁹ R.H. Thaler & C.R. Sunstein, *Nudge: Improving Decisions about Health, Wealth and Happiness* (Penguin Books Ltd, 2008), p. 68.

⁹⁰ N. Gunningham & D. Sinclair, *Leaders and Laggards: Next-Generation Environmental Regulation* (Greenleaf, 2002), p. 22.

⁹¹ N.C. Davidson, ‘How Much Wetland Has the World Lost? Long-Term and Recent Trends in Global Wetland Area’ (2014) 65(10) *Marine and Freshwater Research*, pp. 934–41.

⁹² Brodie & Pearson, n. 52 above, p. 447.

double-down on our governance efforts for the protection and rehabilitation of the site. Fortunately, the Queensland government has returned to the idea of regulation as a tool for driving behavioural change.⁹³ Its planned approach to implementing strict rules (along with fines and other penalties) alongside grant programmes and voluntary codes is encouraging, but we (governments and academics) also need to do a better job of evaluating current mechanisms of control. The Reef Report Card⁹⁴ is one example of this, and the Strategic Assessment of 2014 was another.⁹⁵ The analysis needs to be more systematic, rigorous, and honest.

However, there is also a more important insight to be gained from the Great Barrier Reef example, and that is the importance of culturally appropriate environmental governance. We have argued in this article that government-led interventions that seek to drive behavioural change, including stricter forms of regulation, must take careful account of the history and operating culture of the industry. Governments must be prepared to invest in understanding the socio-economic vulnerabilities and ‘pressure points’ faced by cane growers, such as fluctuating commodity prices, uncertain supply contracts, and the climatic risks of droughts, floods and cyclones. Emerging research from the behavioural sciences has started to unpack some of these factors, and in this article we have echoed their call for state and federal governments to invest in a ‘population-level behaviour[ial] change strategy’.⁹⁶ In the end, a systematic failure to take account of the unique operating culture of the Queensland sugarcane industry will only lead to continued grower resistance and, in turn, further demise of the Great Barrier Reef.

⁹³ Office of the Great Barrier Reef, n. 50 above.

⁹⁴ State of Queensland, ‘Reef 2050 Water Quality Improvement Plan: Report Cards’, updated 27 Oct. 2017, available at: <http://www.reefplan.qld.gov.au/measuring-success/report-cards>.

⁹⁵ Queensland Government, ‘Great Barrier Reef Strategic Assessment Reports’, available at: <http://www.statedevelopment.qld.gov.au/regional-development/regional-priorities/gbr-strategic-assessment.html>.

⁹⁶ Pickering et al., n. 74 above.