

Reef Rescue Research & Development

Technical Report

Regulations versus voluntary mechanisms to improve adoption
of best management practices in GBR catchments

RRRD039



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Regulations versus voluntary mechanisms to improve adoption of best management practices in GBR catchments (RRRD039)

An output of RRRD039 Integrated assessment of BMP cost-effectiveness and decision tool for regions and landholders

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The Reef Rescue Research and Development Program (Reef Rescue R&D) was funded under the Australian Government's Caring for our Country program, and consisted of 18 projects. The Reef Rescue R&D is designed to improve our understanding of the link between land management practices and environmental impacts, and improve water quality across the Great Barrier Reef by informing on-ground projects to reduce the amounts of nutrients, pesticides and sediments reaching the Reef from agricultural lands.

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Contents

Contents	i
List of Figures.....	ii
List of Tables.....	ii
Acronyms.....	iii
Acknowledgements	iv
Executive Summary	1
1. Introduction.....	3
2. Background to policy for improving water quality entering the Great Barrier Reef lagoon	5
3. Theoretical Framework	10
3.1 Policy mechanisms to support adoption	10
3.2 Choosing the most appropriate policy tool	12
4. Economic assessment of voluntary approaches to improving agricultural water quality into the GBR	17
5. Economic assessment of regulatory approaches to improving agricultural water quality into the GBR	21
6. Discussion and conclusions	22
References.....	24

List of Figures

Figure 1. Priority pollutants, pollutant loads and priority areas in the GBR catchments	4
Figure 2. Potential burdens of regulation	12
Figure 3. Efficient policy mechanisms for encouraging land use on private land refined to account for lags to adoption, learning costs and transaction costs	13

List of Tables

Table 1. Examples of best management practices for improving water quality	5
Table 2. Agri-environmental policy initiatives for water quality into the GBR in past 25 years	6
Table 3. Summary of First Report Card Indicator: Adoption of Improved Management Practices for Sugarcane and Graziers in Great Barrier Reef Catchments	8
Table 4. Proportion of landholders required to move to at least improved practice B by 2013 compared to 2009 baseline data	9
Table 5. Mechanisms to improve adoption of BMPs	11
Table 6. Policy selection matrix.....	15
Table 7. GBR conditions and policy matrix policy recommendations	16
Table 8. Public and private benefits and costs of BMPs – Sugarcane.....	18
Table 9. Public and private benefits and costs of BMPs – Grazing	19

Acronyms

DSEWPac	Department of Sustainability, Environment, Water, Population and Community
GBR	Great Barrier Reef
GBRMPA	Great Barrier Reef Marine Park Authority
NRM	Natural Resource Management
QDAFF	Queensland Department of Agriculture, Fisheries and Forestry
RRRC	Reef and Rainforest Research Centre Limited
RRRD	Reef Rescue Research & Development

Acknowledgements

This report contributes to a two year project that is focused on estimating the costs to landholders of changing their management toward practices reducing the loss of sediment and nutrients to the GBR. The project is being performed through collaboration between CSIRO Water for a Healthy Country Flagship, the Queensland Department of Agriculture, Fisheries and Forestry and Central Queensland University. It is funded by the Australian Government, through Caring for Our Country's Reef Rescue Program along with contributions from each of the collaborating partners. Review comments from external reviewers are gratefully acknowledged.

Executive Summary

Research on water quality improvements available from the adoption of improved management practices indicates that there is potential to generate both private and public benefits for agricultural industries in the Great Barrier Reef (GBR) catchments and the health of the GBR respectively. Both voluntary and regulatory mechanisms have been used to increase adoption of improved practices, with the introduction of the *Great Barrier Reef Protection Amendment Act 2009* marking the introduction of regulatory approaches for cane and grazing in high risk catchments. However these regulations are currently on hold and have been replaced by industry best management practice programs. A key question for management of agricultural runoff for improved water quality is: Are regulatory mechanisms needed for agricultural management because voluntary approaches are not delivering sufficient or timely adoption of improved practices?

As part of the Reef Rescue R&D project RRRD039, we used a net benefits framework and a policy assessment matrix to analyse the application of voluntary, economic and regulatory instruments to meet the objective of improving the quality of water entering the GBR. Voluntary instruments include information and extension services, regulatory mechanisms include regulations, permits and other controls, while economic instruments include taxes and charges, grants and subsidies and tradeable emissions permits.

The selection of policy instruments needs to be tailored to the problem characteristics; for example extension and positive incentives can be appropriate when there are private net benefits available from changing management practices, economic mechanisms can be more efficient when there is large variation in the costs of making changes, and regulatory mechanisms can be more appropriate when there are large numbers of nonpoint source polluters or heterogeneity in damage costs. As the drivers of water quality issues in the GBR catchments are diverse, multiple instruments may be necessary. The key findings and recommendations from the report can be summarised as follows.

- Not all actions that generate environmental damages should be addressed, or some may require only low level intervention. Management actions that generate private benefits in excess of public costs should be allowed to continue. When the additional transaction costs of making changes are considered, then many other potential controls over actions become uneconomic. The main actions where some form of intervention is justified is where the public benefits that can be gained are higher than the private costs or losses involved.
- Where action is justified, there are a range of different policy mechanisms that are available to encourage landholders, with varying levels of intensity, to change management practices. While different classifications are possible, they have been categorized in this report into three key groupings: information and extension mechanisms, economic instruments, and regulatory mechanisms. Economic

instruments can be further divided into three broad areas of taxes and charges, grants and subsidies, and market based mechanisms.

- Each policy instrument has different advantages and disadvantages. As well, many instruments have flow-on effects on incentives and landholder returns and motivations, and can cause crowding-in or crowding-out effects. This means that policy makers need to take care in selecting policy mechanisms.
- The instruments that are available are not very substitutable. The available policy instruments meet different goals, and relate to different tradeoffs between public and private costs and benefits (Figure 3). Policy makers choosing between instruments need to consider the type of problem and conditions that exist to select the appropriate mechanism for the situation.
- Where there are private benefits to be gained from changing management practices, the use of information and extension mechanisms is recommended. However, these are not sufficient when private net costs are involved, requiring the transition to more economic instruments.
- Many studies in the region into the adoption of improved practices have consistently found that landholders are heterogeneous in their pollutant abatement costs, risk perceptions and motivations for farming. This provides a strong justification for the use of economic instruments to facilitate the selection of landholders and projects that have lower costs. However, grants and subsidies are not very efficient relative to other types of economic instruments.
- Regulatory instruments can be optimal in some situations. Governments will often prefer non-voluntary mechanisms over voluntary ones because of their administrative simplicity in applying uniform requirements on all farms being regulated and the certainty in outcomes provided. However regulatory instruments come with large hidden costs because of their compliance requirements and lack of flexibility, and can impose substantial adverse impacts.

1. Introduction

Declining water quality from terrestrial run-off has been identified as a priority issue in protecting the Great Barrier Reef (GBR)¹ (Furnas, 2003; Fabricius, 2005; GBRMPA De'ath and Fabricius, 2010). While much of the GBR has been protected in-situ² for some time, agricultural management practices on adjacent catchments have contributed to poor water quality entering the GBR lagoon (Furnas, 2003; GBRMPA, 2009). This issue can be characterised as a diffuse or nonpoint source pollution problem, where there are many landholders contributing to the decline in water quality to the GBR lagoon and the contribution of any particular landholder is not identified due to the huge cost this would involve.

The two major industries that generate emissions contributing to the decline of water quality are beef cattle (mostly sediments) and sugarcane (mostly nutrients) (Waterhouse and Brodie 2011) (Figure 1). Catchments with highest priorities for addressing water quality issues are those focused on sugarcane production in the Wet Tropics, Burdekin and Mackay Whitsunday area, and those focused on grazing in the Fitzroy and Burdekin catchments which have large land areas and high-to-moderate risk rankings (Figure 1).

Different management practices to reduce pollutants entering the GBR have been identified, with varying outcomes and time lags involved (Table 1). For example, management practices to improve water quality leaving sugarcane properties are mainly focused on nutrient and herbicide applications which can be implemented immediately and have flow on effects within months to years. In contrast, the focus of management practices to improve water quality leaving beef grazing properties is on reducing sediment, with changes taking years to decades to be effective.

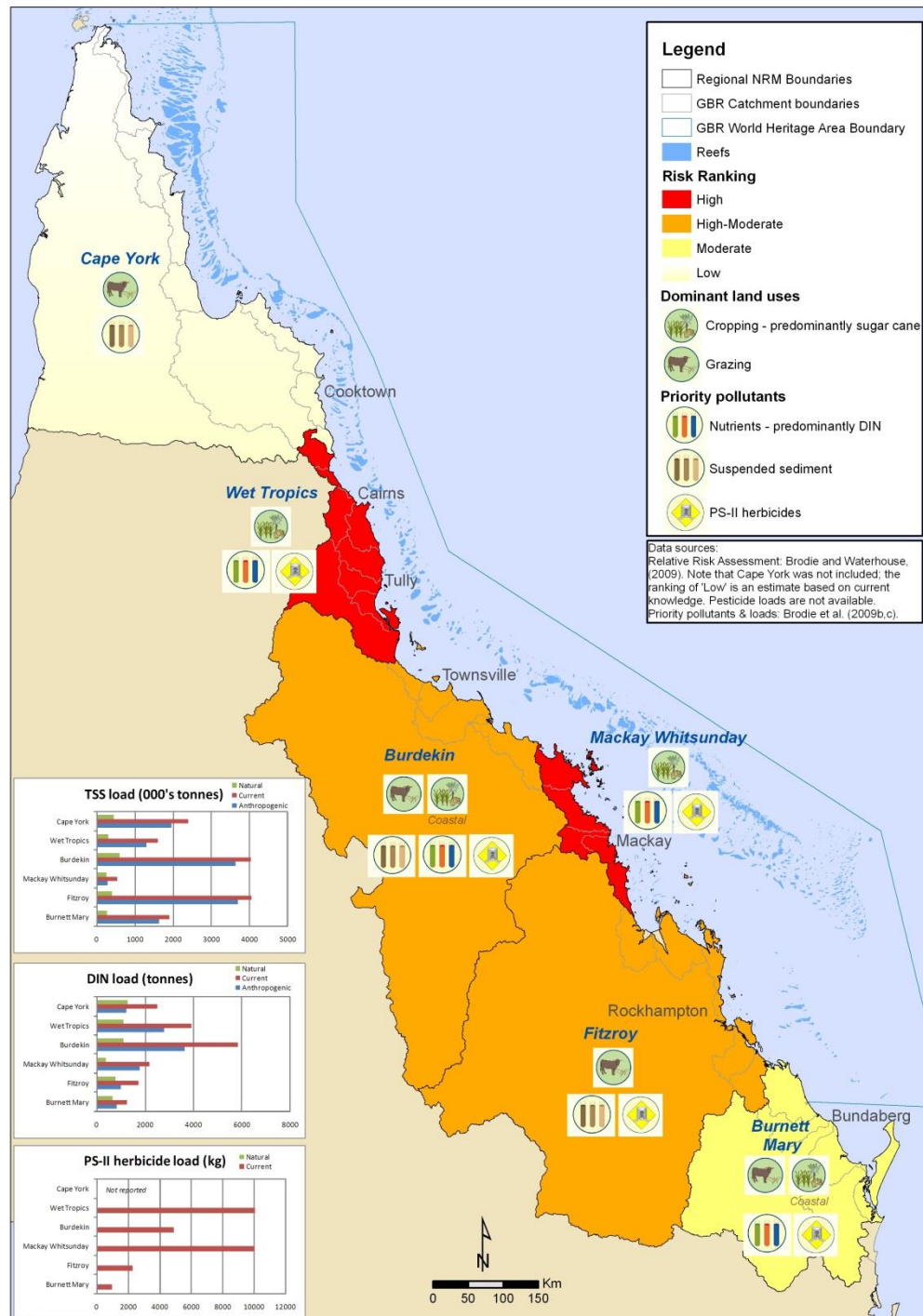
Key policy questions are to identify factors that increase adoption of better land management practices, and the extent to which widespread adoption can be expected. Over the last 25 years there has been substantial variation in policy approaches to improve adoption, where the approaches can be categorised into two broad groups: voluntary and non-voluntary approaches. Most policy has been directed at changing landholder management practices toward those which are often labelled as best management practices (BMPs).

Trends in policy mechanisms have been towards direct incentives (grants), more focus on regional groups rather than local cooperative mechanisms, and increased application of regulatory instruments. As described in the next section, the introduction of direct

¹ The GBR extends for more than 2,000 kilometres along the Queensland coast. It contains not just the most extensive stretch of coral reef system in the world but also large areas of seagrass, mangrove, soft bottom communities and island communities (DEH 2005).

² Initial efforts to protect the reef system have focused on reserve status, with the reef declared a Marine Park by the Commonwealth and Queensland Governments in 1975, and a World Heritage area in 1981. Much of the direct use of the marine area (e.g. fishing, shipping) has been managed through regulatory controls, such as the increase in the area of 'no take' or green zones from 4.6% to 33.3% in 2004.

regulations over some landholder management practices in 2009 and the setting of targets for increased landholder adoption of BMPs followed directly after 2008 reports that identified no improvement in water quality in the GBR and limited improvement in landholder management actions. The timing of and political rhetoric around the introduction of the regulatory measures indicated that these were being adopted because voluntary approaches had failed.



Source: Waterhouse and Brodie (2011).

Figure 1. Priority pollutants, pollutant loads and priority areas in the GBR catchments.

The focus of this report is to analyse the appropriateness of using regulatory and voluntary mechanisms to increase adoption rates. To address these questions from an economic efficiency perspective, a review of the relevant policy is provided in the next section, and the categorisation and selection of policy mechanisms are reviewed in Section 3. Sections 4 and 5 undertake a preliminary economic assessment of voluntary and regulatory policy instruments to influence the adoption of BMPs. Some conclusions on future research needs and directions complete the report.

2. Background to policy for improving water quality entering the Great Barrier Reef lagoon

There has been improving knowledge about the water quality outcomes of different management practices on farms and grazing properties in the GBR catchments and how different management actions can be used to reduce water quality impacts. In grazing where the emphasis is on reducing sediment movement, appropriate management actions are focused on setting stocking rates at levels that maintain ground cover and riparian areas and restricting stocking in fragile zones such as scalded and gullied areas. In sugarcane, appropriate management actions are focused on limiting nutrient and pesticide inputs to specific crop needs to avoid excess losses, and to improve water management so as to avoid runoff into waterways. Examples of best management practices are shown in Table 1.

Table 1. Examples of best management practices for improving water quality

Beef Grazing	Sugarcane
Stocking rate to safe carrying capacity adjusted by observation in wet and dry season	Soil testing to determine appropriate nutrient application by block
Wet season pasture spelling every 3 – 6 years	Nutrients applied sub-surface with respect to crop stage and rainfall
Manage for resilient and less resilient grazing land types	Herbicides applied by block according to pressure, stage of growth, rainfall/irrigation using precision equipment
Maintain 60 – 80 per cent ground cover for break of season	Riparian management to limit erosion and filter runoff
Off-stream watering	Legume fallow and tilled into soil
Fencing of riparian/frontage grazing land types	Controlled traffic permanent beds
	Strategic tillage prior to planting

Source: van Grieken et al. 2010

A timeline of policy approaches implemented to improve water quality entering the GBR lagoon since the late 1980s are shown in Table 2. Agri-environmental policy initiatives for water quality into the GBR in past 25 years. Policies here have been categorised as either voluntary or non-voluntary. Voluntary mechanisms were initially the main policy instruments used to encourage adoption of improved management practices in sugarcane and grazing industries in GBR catchments (see Table 1 for examples). There was a gradual progression from information provision through extension services and environmental groups from the late 1980s to the use of financial incentives in the mid 2000s (Table 2).

Table 2. Agri-environmental policy initiatives for water quality into the GBR in past 25 years

<i>Legislative and prescriptive (Queensland)</i>	<i>Voluntary, cooperative or incentive based</i>
Environmental Protection Act 1994 establishes Environmental Duty of Care (agriculture) Vegetation Management Act (1999) and amendments in 2003 and 2004 controls vegetation clearing activities on rural lands Water Act 2000 enhances planning, allocation and use of water (provision for environmental flows and aquatic ecosystem health) Great Barrier Reef Marine Park Amendment Act 2009 establishes regulatory control over agricultural management practices 2009 Agricultural businesses begin drafting Environmental Risk Management Plans	1989 Decade of Landcare began Early 1990s - Integrated Catchment Management Program launched 1990s - Industries (particularly sugar and cotton) begin to establish Best Management Practices (BMPs) and voluntary codes of conduct 1997-2001 – First round of National Heritage Trust investing in local environmental repair Early 2000s – Regional Natural Resource Management (NRM) groups formalised, and regional NRM plans drafted 2002 – 2008 National Action Plan for Salinity and Water Quality, National Heritage Trust 2, 2003 – Reef Plan signed by Qld and Australian governments^a 2005 MoU between the Queensland Government and Queensland Farmers' Federation relating to Farm Management Systems signed – aims to recognise FMS programs in relevant government policies and programs such as Reef Rescue. 2006 - 08 – Catchment level Water Quality Improvement plans initiated in several catchments 2008 Devolved grants (Transition year) under Caring for Country for priority water quality BMPs 2008 Australian Government announces \$200 million Reef Rescue package over 5 years with \$146 million in funding for landholder actions 2009 Reef Alliance established by industry and regional bodies to share information, resources and skills in delivering the Reef Rescue program 2009 Reef Plan revisited and end of catchment water quality targets and BMP adoption targets introduced 2012 – Queensland government signs BMP agreement with sugarcane industry with a view to replacing regulatory control over agricultural practices with industry led BMP systems

Note: **a:** Important to note here that the Reef Plan identified a diverse range of implementation strategies ranging from partnerships, research and monitoring, extension and information, and, optimising the contribution of existing regulatory controls such as those outlined in the table above. However, at the time it refrained from establishing new controls which subsequently occurred in 2009.

The Landcare movement in the 1990s was based on establishing a network of community groups focused on addressing land degradation on farms, with a major emphasis on communication and encouragement, and some funding for project grants provided by the Commonwealth Government. Over time, the emphasis of voluntary approaches has moved away from cooperation and encouragement towards more direct financial assistance. The National Heritage Trust and the National Action Plan for Salinity and Water Quality were similar to Landcare in the sense that it provided grants to community groups, however, it had a focus on environmental outcomes and funded projects at the regional, state and national level. Most recently the Reef Rescue package by the Commonwealth Government from 2008 included \$146 million in grants directly to landholders for on-ground actions on their private properties.

There was also a shift in focus over this time from localised voluntary networks such as Landcare to regional support groups (the regional natural resource management (NRM) bodies) and better collation of information at regional scales. While the structure of NRM governance may have changed, there is still a strong focus on encouragement and cooperation mechanisms, with major grant programs often generally targeted towards broad landholder groups to maximize interest and participation. The failure to clearly target outcomes for specific grants or to differentiate by cost-effectiveness has meant that the allocation of public funds has not always been effective (Rolfe and Windle 2011), consistent with other environmental programs in Australia (e.g. Pannell and Roberts 2010).

The regulatory approaches have also changed over time from providing frameworks for voluntary and cooperative approaches towards more prescriptive controls. In particular, the Great Barrier Reef Protection Amendment Act 2009 (GBRPAA) legislates for Nitrogen management for sugar cane production in the catchments of the Wet Tropics and Mackay-Whitsunday regions on farms greater than 70 hectares and sediment management in cattle grazing enterprises greater than 2000 hectares in the Burdekin Basin.³

This shift to a more prescriptive regulatory policy approach may have been motivated by a perceived failure of voluntary mechanisms, in particular extension activities such as information provision from field trials, to increase the adoption of BMPs. A survey of 766 landholders in six of the GBR catchment areas at the beginning of the Reef Plan by Lockie and Rockloff (2004) found only one to two percent of respondents reported any involvement in the NRM programs included in the survey. This indicates that the level of engagement between landholders and extension activities for environmental outcomes was very low, even though cooperation and extension activities had been developing since the late 1980s through Landcare and industry groups and the introduction of some positive incentives through the first NHT scheme.

The failure of extension services and voluntary mechanisms to deliver improvements in water quality by 2008 is likely to be directly related to the introduction of the regulations (GBRPAA) in 2009. As well, there has been more explicit targeting of future adoption rates of BMPs in agriculture. Although no targets were set in the initial Reef Plan, the *Scientific consensus statement on water quality in the Great Barrier Reef* (2008) found the quality of

³ The Act requires landholders to prepare an enterprise scale Environmental Risk Management Plan (ERMP) (maximum of 300 penalty units) as well as fertilisation application requirements (maximum of 100 penalty units for over-fertilisation); and document requirements (maximum of 100 penalty units).

the water entering the GBR had not improved in the initial years of implementation (2003-2008). Targets were introduced into the revised Reef Plan in 2009 (State of Queensland 2011) for the adoption of BMPs by 80 per cent of landholders in sugarcane, horticulture, dairy, cotton and grain enterprises and by 50 per cent of grazing enterprises by 2020.

In August 2011, the *First Report Card on the Reef Plan* was released (State of Queensland 2011).⁴ This report will be used as a baseline to measure the progress of meeting the Reef Plan targets for 2013 and 2020. While this report card provides a snapshot of where landholders are in terms of BMP adoption (Table 3), it does not reveal their participation in previous voluntary programs, hence it is not possible to identify which policy approaches have been effective or which management practices have been most improved. Data in the report card shows substantial variation in practice adoption across grazing and sugarcane industries, with large proportions of farmers still using poor (D class) practices (sugarcane) or having poor or degraded land (graziers).

Table 3. Summary of First Report Card Indicator: Adoption of Improved Management Practices for Sugarcane and Graziers in Great Barrier Reef Catchments

<i>Sugarcane</i> ^a			A	B	C	D
Combined management	Number of growers		87 (2%)	781 (18%)	2145 (50%)	1239 (30%)
	Area km ²		94 (2%)	1149 (20%)	2845 (50%)	1564 (28%)
Nutrient management	Number of growers		84 (2%)	1427 (34%)	1279 (30%)	1462 (34%)
	Area km ²		113 (2%)	2091 (37%)	1583 (28%)	1865 (33%)
Herbicide management	Number of growers		51 (1%)	252 (6%)	3625 (85%)	324 (8%)
	Area km ²		57 (1%)	339 (6%)	4805 (85%)	452 (8%)
Soil Mangement	Number of growers		127 (3%)	665 (16%)	1530 (36%)	1930 (45%)
	Area km ²		113 (2%)	1017 (18%)	2148 (38%)	2374 (42%)
<i>Grazing</i> ^{b,c}			A	B	C	D
Number of graziers			542 (12%)	1656 (38%)	1672 (38%)	548 (12%)
Area km ²			24 186	89 489	106 398	31 407

Note: a: A - cutting edge; B - best practice; C - code practice and D - unacceptable practice. b: combined for Burdekin and Fitzroy regions. c: A - practices likely to maintain land in very good condition or improve land in lesser condition; B - practices likely to maintain land in good condition or improve land in lesser condition; C - practices that may maintain land in fair condition or gradually improve land in poor condition; D - practices likely to degrade land to poor condition.

Source: The State of Queensland (2011: 40-41)

⁴ The report involves historical data and trends up to 2009 to identify the status of key indicators.

Major improvements in landholder adoption of BMPs will be required to meet the Reef Plan targets. The proportion of sugarcane growers that will have to move to at least best practice category B by 2013, according to the baseline data, is shown in Table 4 for the GBR overall and by priority catchment. The targets for graziers are a little less obvious, as according to the baseline data reported, 50 per cent of graziers in the Fitzroy and Burdekin regions already had land in A or B class condition, and presumably had A or B class management practices.

Table 4. Proportion of landholders required to move to at least improved practice B by 2013 compared to 2009 baseline data

Management practices of focus	GBR	Burdekin	Wet Tropics	Mackay Whitsunday
	% of landholders	% of landholders	% of landholders	% of landholders
<i>Nutrient</i>	44	35	60	40
<i>Herbicide</i>	73	58	76	77
<i>Soil</i>	61	48	73	56
<i>Improved grazing</i> ^a	0	11	n/a ^b	n/a ^b

Note: **a:** only includes the Fitzroy and Burdekin catchments. **b:** data was not available on grazing practices.

Source: The State of Queensland (2011)

It is not clear that meeting these management targets will actually result in the achievement of end of catchment targets. For example, van Greiken et al. (2011) found that even if all sugarcane growers in Tully-Murray and Pioneer catchments adopted category A practices, they would still fall short of the end of catchment targets for nutrients by 12 and 18 per cent respectively. Given that category A practices are yet to be proven to be technically and economically feasible, the achievability of the Reef Plan targets on nutrients may be difficult. This may reflect the failure in the target setting process to identify the economic and production tradeoffs that landholders may face and the underlying drivers of adoption decisions.

In summary, evidence from the field is indicating that takeup rates of improvement management practices remain relatively low, but much higher adoption rates are required if targets for landholder management and water quality improvements are to be met. At a public policy level, the key issues are to identify which voluntary and regulatory mechanisms are suitable to increase adoption rates, and whether regulation should be used if voluntary landholder adoption of BMPs does not increase to the target levels. To analyse these questions, a better understanding of the drivers of adoption is required.

3. Theoretical Framework

3.1 *Policy mechanisms to support adoption*

Policy mechanisms used to influence behaviour⁵ are usually classified into the categories of: information and extension provision, economic, or non-voluntary (Table 5), with each category including a number of different policy instruments (Rolfe et al. 2008).⁶

Information and extension policies rely on information provision and support networks to persuade landholders to move to more profitable and sustainable practices and to voluntarily adopt BMPs. The programs aim to decrease the costs of information collection and application to an individual farming enterprise by having government agencies fund or undertake this activity. They are often relevant to the non-financial reasons why landholders may be slow to adopt new practices that have net commercial returns.

Economic instruments use monetary incentives to influence landholder adoption of BMPs. This is usually in the form of payments for adoption of desired actions and can be considered as positive incentives to adopt BMPs (Pannell 2008). While legislation is often used to support the implementation of economic policies, landholder behaviour is still voluntary. Trading permit schemes are a hybrid of economic and regulatory, where the number of permits is regulated and having a permit is required for production, but the number of permits and the price paid for them is determined in a market.

In contrast, regulation in environmental policy involves altering landholder behaviour through defining acceptable or unacceptable practices, or defining property rights for a given area or resource in legislation (for example zoning, standards for emissions or technology or management plans) (Collins and Scoccimarro 2008). Regulations are enforced through the use of penalties and administered by a nominated government agency and can be considered as negative incentives to adopt BMPs (Pannell 2008). Quantity based regulations can be input or output based. Input based quantity regulation mandates the level of inputs to production, such as the optimal level of nitrogen under the Reef Regulations. This is often viewed as less effective than regulating output as it is an indirect way of reducing emissions, requires large amounts of information from individuals, resources for monitoring individuals, and can stifle innovation in production technologies (Weimer and Vining 2011).

All policy approaches have varying costs and benefits of implementation and operation. Information and extension policies can address important knowledge gaps and are voluntary, but may be expensive to provide and have limited takeup.

⁵ There is an extensive literature on factors influencing landholder adoption of innovative technology, management and conservation approaches in agriculture (Pannell 2008). This is separate to the focus of this report, and so is not covered further.

⁶ An additional category of direct action is a policy approach where Government does not engage with landholders but directly intervenes to achieve its desired environmental objective. This usually occurs in the form of land or water property rights acquisition to achieve environmental goals but can also be an engineering intervention. For example, implementation of a sediment trap on a river rather than relying on landholder voluntary actions to reduce sediment flow into GBR lagoon).

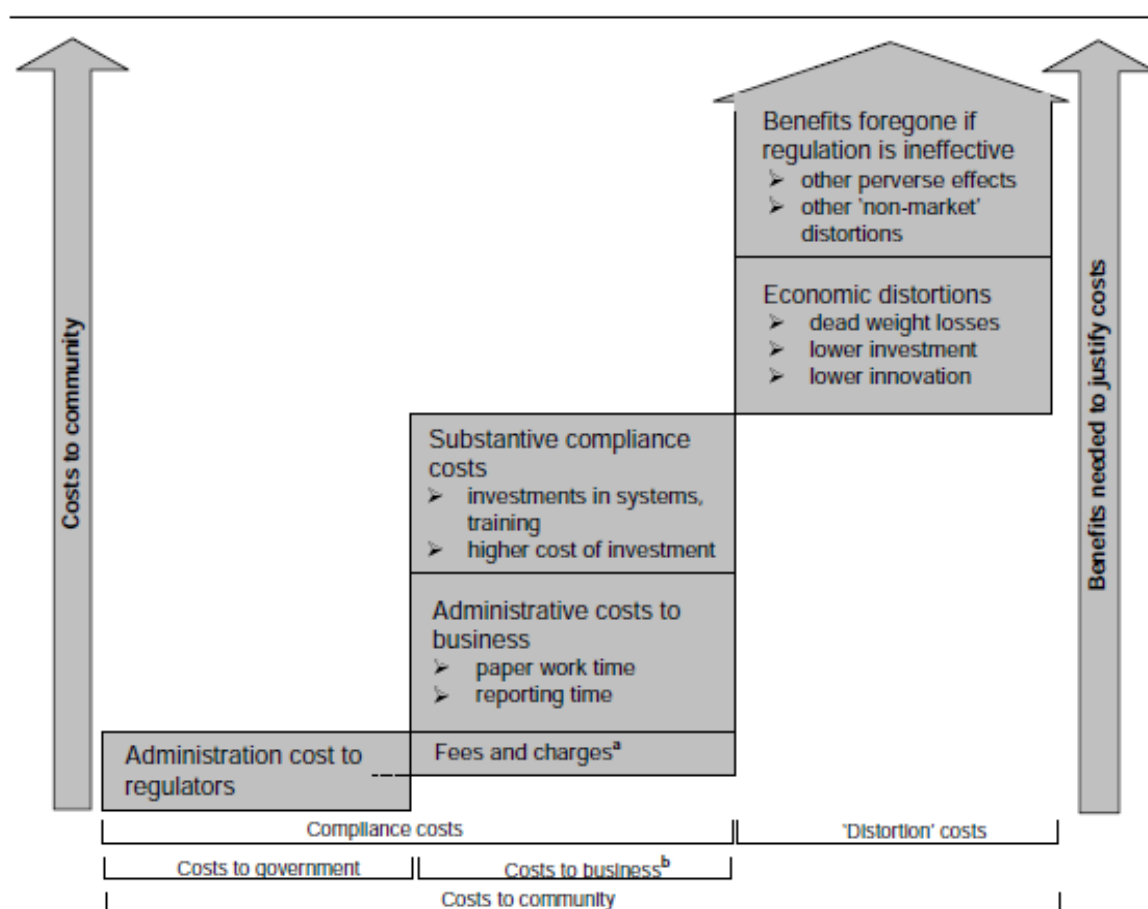
Economic instruments can provide more direct positive (or negative) signals and achieve higher engagement while also being voluntary, but may be more complex and expensive to design and operate. Many economic mechanisms provide flexibility for landholders to meet emission targets at their lowest cost and incentives to innovate to further reduce these costs. Grant based approaches are more limited as they are usually tied to particular practices, technologies or investments being made. Costs associated with implementing economics based mechanisms include high information costs in designing the mechanism, high transaction costs and difficulties in defining or establishing private property rights (Baumol and Oates 1995).

Table 5. Mechanisms to improve adoption of BMPs Source: adapted from Rolfe et al. (2008).

	Group	Type of support	Examples and details
Voluntary	Information and extension	Information provision and education	Used to change information and attitudes to different BMPs
		Encouragement and support mechanisms	Programs to engage landholders and support involvement in BMPs
		Local peer group learning programs	Use participative programs to increase awareness and understanding
		Decision support mechanisms	E.g. development of paddock-scale nutrient management plans
		BMP guides and industry recommendations	Self-regulation by industry
		Technical assistance	Technical support offered to trial new mechanisms
	Economic-based systems	Conditional assistance/Subsidies	Assistance to farmers might be tied to the take up of BMPs
		Grants	Grants offered to trial new mechanisms
		Conservation auctions and ecosystem service payments	Farmers tender for public funds, with most efficient bidders gaining contracts to change management actions.
		Trading with point-source dischargers	System of trading nutrient credits, so industries might contract with farmers to make offset reductions
		Offsets	Farmers might negotiate tradeoffs between different on-farm actions
Non voluntary	Contracts	Legally binding	Contracts between farmers and other industry sectors establish BMPs as a requirement to allow business to occur
	Command and control	Levies	Levy imposed on farm inputs (eg fertilizer) that create emissions
		Licensing/Permits (e.g. registration of chemical use)	Permit system limits farm inputs or certain actions that have water quality impacts
		Input/process controls	Minimum standards (often used in conjunction with permitting).
		Changes to property rights	Property rights are more tightly specified to identify allowable actions (eg Zoning)

Regulation delivers certainty in emission levels or inputs to production, however, come with information costs needed to set the appropriate level of emissions or inputs to production, as well as enforcement costs and compliance costs. As well, regulations tend to be inflexible, and may crowd out intrinsic motivations to adopt best management practices in the future (Figure 2). Regulations are often preferred by policy makers for their clarity and administrative simplicity in that they apply uniform requirements on all firms being regulated. However regulations are unlikely to be the most efficient approach when the enterprises being regulated are very diverse and will incur different costs to meet a certain standard.

Figure 2. Potential burdens of regulation



^a Cost to business depends on fees and charges passed onto business through cost recovery. ^b Some costs are passed through in prices, lower wages or lower returns on capital.

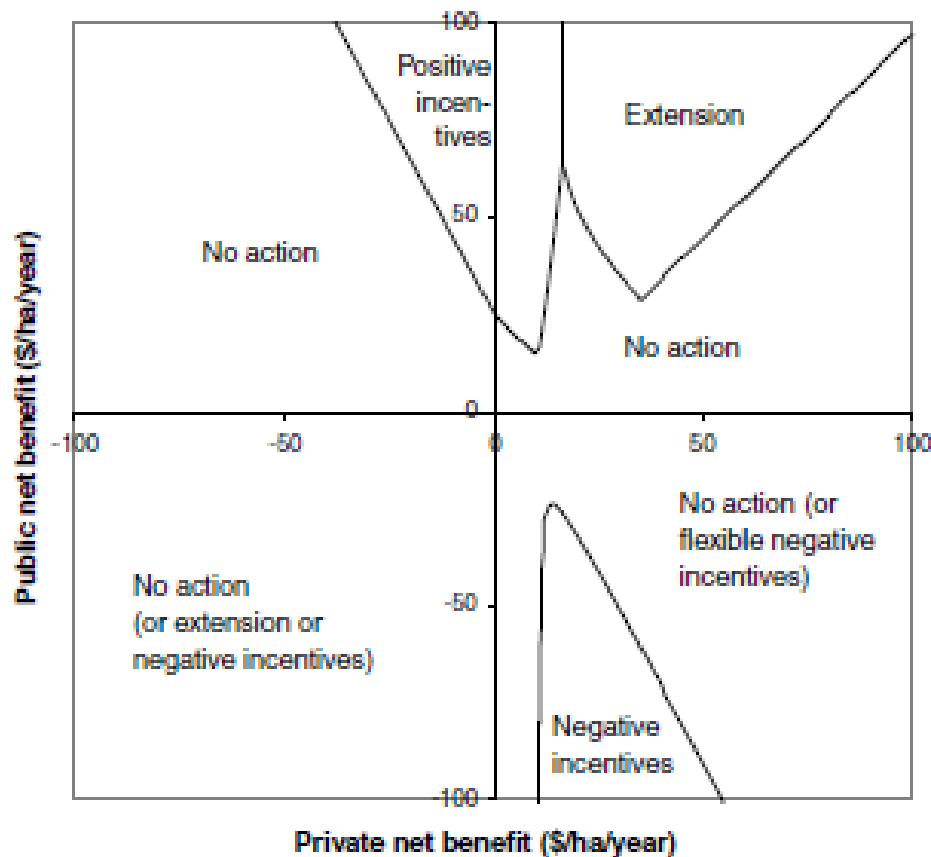
Source: Productivity Commission (2011).

3.2 Choosing the most appropriate policy tool

With so many policy options available and with varying costs and benefits to each, which to choose? Economic principles assert that a policy approach where the marginal benefit equals the marginal cost is most efficient. This is often very difficult to even approximate and the next best approach is for governments to choose the instrument, or mix of instruments

that achieves the desired outcome at least cost. This requires knowing what actions may achieve the desired outcome, their respective costs of implementation (including opportunity and transaction costs), and the actions and investments needed to achieve the necessary level of adoption. Much of this information is unknown a priori or privately held by landholders. Useful guides to the choice of policy mechanisms have been provided by Pannell (2008) and Sterner (2002), with each reviewed in turn.

The framework presented by Pannell (2008) offers broadly scoped guidance based on a simple analysis of the private and public net benefits generated. The three categories of available policies (extension, positive incentives and negative incentives) broadly correspond with the groupings identified in Table 5 (information and extension, economic incentives and regulation). Figure 3 illustrates that positive incentives (e.g. economics based instruments) are appropriate when the BMP in question has marginal private benefits or private costs and large public benefits, and that negative incentives (e.g. regulation) are appropriate when a management practice has moderate private benefits and large public costs. When there are large private benefits relative to public benefits, then extension is appropriate because the private benefits should be enough to drive landholder adoption.



Source: Pannell (2008)

Figure 3. Efficient policy mechanisms for encouraging land use on private land refined to account for lags to adoption, learning costs and transaction costs

Private net benefits of a management practice are only known by landholders, although economic modelling and field experiments can provide valuable insights. When there is heterogeneity in net benefits of management practices it can be seen that reliance on a single policy approach, such as extension in the historical policy context of the GBR, is going to fail to meet the objectives of the policy. However, there are also many different types of instruments that fall within the generic categories of 'positive' and 'negative' incentives (see Table 5) that can be tailored to account for the relevant characteristics of a region/industry/innovation. Even if policy instruments from negative and positive categories are used, if they are poorly designed they can also result in policy failure.

A notable point about

Figure 3 is that there are large areas where no action is required — government action is only justified in very limited instances. It is not expected that landholders will have practices that generate net private losses, and actions that generate more private benefits than public losses should be allowed. Extension as a policy mechanism in

Figure 3 is only suitable in a small part of the space, implying that it should be carefully targeted to a limited group of actions. When private benefits and public costs are more evenly weighted, then additional consideration of the transactions costs involved in change make intervention uneconomic.

Figure 3 also illustrates that policy instruments occupy clearly defined spaces and are not very substitutable from an economic efficiency perspective, as is commonly assumed by policy makers. If a BMP has net private costs, switching from extension to regulation may only result in valuable resources being devoted to lobbying against the regulation and a decrease in welfare by landholders incurring penalties from non-compliance.

Criteria for the choice of policy instruments from Sterner (2002) have been summarized into a policy selection matrix covering the choice between taxes and charges (e.g. emission taxes), payments (e.g. grants and subsidies), tradeable emissions permits (a type of market based instrument) and regulatory instruments (Table 6). This is a narrower field than those covered by Pannell (2008), and is more focused on the major instruments that governments might consider for substantial pollution issues.

Taxes, payments and tradeable emissions permits are all forms of economic instruments in that they provide some flexibility to landholders over the amount of tradeoff involved, although taxes involve negative payments and both taxes and tradeable emissions permits rely on some underpinning regulation to operate.

Table 6. Policy selection matrix

Criteria and conditions	Economic instruments			Regulatory instruments
	Taxes and charges	Payments (grants & subsidies)	Tradable emissions permits	
<i>Static efficiency</i>	Best with heterogeneous abatement costs, Economic instruments save on costs			Costs are high, especially with mandated technology
<i>Marginal costs steep, benefits flat</i>	Best: With flat benefit curves or steep abatement curves, price-type policies are often preferred			
<i>Efficiency with heterogeneity in damage costs</i>	Tax variation is perceived as unfair and impractical. Modern technology may increase feasibility		Ambient permits are difficult	Best: licensing, zoning and regulation are preferred
<i>Marginal costs flat benefits steep</i>	Exact goal fulfilment is difficult because Economic instruments rely on demand estimates. Low fees lead to excessive pollution		Best: aggregate emissions control is achieved	Individual but not aggregate emissions are controlled
<i>Dynamic efficiency</i>	Economic instruments imply cost savings and inter-temporal efficiency. Subsidies distort entry and exit conditions. Attention to details of permit allocation is necessary.			CAC licenses offer no incentive to improve
<i>Distribution and political issues</i>	Taxes are unpopular with polluters; charges may be preferable	Most popular with polluters	Flexibility is related to permit allocation mechanism	Polluters like because they pay only for abatement
<i>Asymmetric information and risk, nonpoint-source pollution</i>	Hard to use without good monitoring. Ambient taxes are difficult	Ultimate policy if no polluter can be found	Hard to use without good monitoring	Mandatory technology is easy to inspect
<i>Small number of polluters</i>	Unsuitable for reasons of administrative efficiency and thin markets			May be best for small numbers
<i>Rent-seeking</i>	Engenders opposition	Bad: leads to rent-seeking	May be used as a barrier to entry	Individual negotiation has risks
<i>Complexity</i>	Technical or ecological complexities put Economic instruments at a disadvantage			License, liability, voluntary agreements or information disclosure may be best

Source: Adapted from Sterner (2002: 214)

Using the terminology from Sterner (2002), criteria and conditions that exist in the GBR catchments for the policy problem of improving water quality entering the GBR and their subsequent policy recommendations are listed in Table 7.

Table 7. GBR conditions and policy matrix policy recommendations

Conditions and criteria	Preferred policy instrument
Large number of nonpoint source polluters	Subsidy or regulation through use of mandatory technology that is easy to inspect
Heterogeneity in private marginal costs	Economics based instruments as these will select the most cost effective proposals
Potentially steep private marginal costs	Economics based instruments – price type policies preferred
Heterogeneity in damage costs/marginal benefits	Licensing, zoning and regulation are preferred or a mix of policy instruments
Steep marginal benefits	Tradeable emission permits control aggregate emissions
Ecologically complex	Licensing, liability, voluntary agreements or information disclosure may be best
Political sensitivities	Subsidies most popular with polluters, polluters often prefer regulation over damage costs (eg taxes/charges)
Asymmetric information and risk (private benefits of adopting BMPs)	Subsidy or use of mandatory technology that is easy to inspect – developments in technology may lower costs of monitoring
Dynamic efficiency – long-term issue, may take generations to improve water quality to acceptable levels	Taxes/Charges or Tradeable emissions permits that encourage innovation in management. Program design should not create barriers to entry and exit

Source: adapted from Sterner (2002)

The review of decision frameworks allows two important recommendations to be made. First, not all actions that generate environmental damages should be addressed. Actions that generate private net benefits in excess of public net benefits should be allowed to continue. In some cases, actions that appear to have higher public net benefits than private net benefits may not be worthwhile when the additional transaction costs of making changes are considered. Care should also be taken that actions do not generate perverse incentives, such as crowding out voluntary measures to protect the environment. The main actions where some form of intervention is justified is where the public net benefits that can be gained are higher than the private net benefits from no intervention, even after transaction costs and potential perverse incentives are considered.

Second, the instruments that are available are not very substitutable. The available policy instruments meet different goals, and relate to different tradeoffs between public and private private costs and benefits (

Figure 3). Policy makers choosing between instruments need to consider the type of problem and conditions that exist to select the appropriate mechanism for the situation.

To demonstrate the issues involved in reducing agricultural emissions into the GBR, economic assessments of both voluntary and regulatory approaches to improving water quality are provided in the following sections.

4. Economic assessment of voluntary approaches to improving agricultural water quality into the GBR

Until 2009, voluntary approaches have been the predominant approach to improving water quality entering the GBR (Table 2). The perception that these approaches have failed and needed replacing with a stronger regulatory approach is assessed in this section. The appropriateness of voluntary approaches to achieve water quality improvements for the GBR is assessed using the Pannell (2008) net benefits framework and a policy matrix drawn from Sterner (2002).

The Pannell (2008) framework requires an estimate of public and private benefits of a given management practice to determine the most appropriate policy approach. Where there are private benefits and large public benefits extension is appropriate, and as private benefits decrease, temporary private incentives may be more effective in influencing landholders to improve their management practices.

Some researchers (e.g. Roebeling et al. 2009, van Greiken et al. 2011) suggest that some improvements in water quality with associated public benefits can be made with no net costs or positive private benefits in sugarcane growing. For example, the study by van Grieken et al. (2011) into the cost-effectiveness of all sugarcane growers adopting best management practices consistent with GBRPAA 2009 found that the net present value (NPV) over 5 years to be \$5.97 million for the Tully-Murray and -\$349 059 for Pioneer, rising to \$18.39 million and \$12.78 million respectively over 10 years. However, the NPV of moving to aspirational practices with smaller pollution impacts was significantly negative for the Tully-Murray catchment in both the 5 and 10 year scenarios, and only marginally positive for the Pioneer catchment in the 10 year scenario (van Grieken et al. 2011).

The strength and direction of private benefits and costs of a number of BMPs promoted using voluntary mechanisms are summarised in Tables 8 and 9, along with strength and direction of public benefits and costs. The high cost associated with infrastructure specific BMPs suggest an economic case for positive incentives, such as for waste water and run-off management and fencing off highly erosive and riparian areas. However, depending on motivation, opportunity costs and risk preferences, influencing the adoption of optimum fertiliser⁷, spelling paddocks in wet season and adjusting stock numbers to pasture condition by a landholder may require positive incentives, extension or no action

⁷ Soil testing not explicitly tested as a BMP here as rather than being a BMP in and of itself it is an input to other BMPs such as optimal fertiliser applications and ERMP

Table 8. Public and private benefits and costs of BMPs – Sugarcane

BMP	Private		Public	
	Benefit	Cost	Benefit	Cost
Optimum amount of N and P application	Reduced input costs to production.	Trial and error over time under different conditions and with other farm management practices. Risk of losses in production through trial and error. May increase yield variability Time consuming to alter application for different soil types	Collectively this will result in reduced N and P discharged into waterways flowing into the GBR.	
<i>Direction of effect</i>	++	-	++	
Waste water and run-off management	Reduced input costs to production (e.g. re-use of water with N and P content, less water required)	Costs of installing appropriate infrastructure (e.g. recycling pits) opportunity cost of land no longer available for production	Collectively this will result in reduced chemicals and sediment discharged into waterways flowing into the GBR.	Voluntary changing of management practices may result in resources in the community shifting, e.g. from nitrogen retailers to agronomy consultants – should be no net costs to the public from this
<i>Direction of effect</i>	+	- -	++	
Record keeping ^c	Can provide valuable information for future decisions.	Time consuming to do and to manage Landholders with limited literacy skills and English as a second language will require resources to undertake	Only in that the BMP can be verified. There are no public benefits in documenting in and of itself	
<i>Direction of effect</i>	+	-		
Environmental Risk Management Plan ^{d,e}	Facilitates the identification, planning and management of environmental issues which are impacting on productivity from a whole property perspective. Provides flexibility to address particular issues when resources become available and when weather/market conditions are appropriate.	Time consuming to do and to manage Landholders with limited literacy skills will require resources to undertake Resources required to identify hazards impacting upon water entering reef, measurable targets and performance indicators Costs of meeting targets and performance indicators.	These benefits from ERMPs are <i>only</i> realised if actually result in improved water quality entering the GBR	
<i>Direction of effect</i>	+	-	+	

Table 9. Public and private benefits and costs of BMPs – Grazing

BMP	Private		Public	
	Benefit	Cost	Benefit	Cost
Documentation ^c	Can provide valuable information for future decisions.	Time consuming to do and to manage Landholders with limited literacy skills will require resources to undertake	Only in that the BMP can be verified. There are no public benefits in documenting in and of itself	
<i>Direction of effect</i>	+	-		
Environmental Risk Management Plan ^{d,e}	Facilitates the identification, planning and management of environmental issues which are impacting on productivity from a whole property perspective. Provides flexibility to address particular issues when resources become available and when weather/market conditions are appropriate.	Time consuming to do and to manage Landholders with limited literacy skills will require resources to undertake Resources required to identify hazards impacting upon water entering reef, measurable targets and performance indicators Costs of meeting targets and performance indicators.	These benefits from ERMPs are <i>only</i> realised if actually result in improved water quality entering the GBR	Voluntary changing of management practices may result in resources in the community shifting, e.g. from nitrogen retailers to agronomy consultants – should be no net costs to the public from this
<i>Direction of effect</i>	+	-	+	
Adjust stock numbers to pasture condition ^a	Meets diet requirements of production targets Improves resilience of pasture, benefiting soil structure and land condition Optimises pasture utilisation	May require increased infrastructure and labour	Collectively this will result in reduced sediment discharged into waterways flowing into the GBR.	
<i>Direction of effect</i>	++	-	++	
Spell paddocks during wet season ^a	Reduces risk of over grazing Encourages plant recruitment	Disruption to stock from the move Possible overgrazing in other areas while paddocks are spelled	Collectively this will result in reduced sediment discharged into waterways flowing into the GBR.	
<i>Direction of effect</i>	+	- -	++	
Fencing off highly erosive and riparian areas	Prevent deterioration of productive land	Cost of fencing and relocating watering points Opportunity cost of land taken out of production Reduced flexibility in managing stock	Collectively this will result in significantly reduced sediment discharged into waterways flowing into the GBR.	
<i>Direction of effect</i>	+	- -	++	

a: sourced from MLA (2011) <http://www.mla.com.au/Livestock-production/Grazing-and-pasture-management/Native-pasture/Grazing-management/Grazing-strategies>

Limited improvement in practice change over the past 20 years in GBR catchments indicates that the private benefits of many BMPs for many landholders are low or incur private costs. While landholders are motivated by a range of factors to adopt different management practices, and are not always economic optimizers, the lack of clear economic drivers is often a powerful explanation of why adoption does not occur (Pannell et al. 2006). Star et al. (2011) demonstrate in analysis of beef grazing enterprises that whether net benefits of improving land condition are positive or negative can depend on the land type and initial land condition, as well as the type of management change involved.

It is expected that many improvements in land management that deliver large net private benefits have already been adopted, rather than the more economically marginal improvements. Research by Rolfe and Windle (2011) and Rolfe et al. (2011) identify that many water quality improvements being targeted in GBR catchments involve losses in private benefits, explaining why there has been a shift from extension mechanisms to incentive mechanisms in voluntary policy approaches. Recent grants available through the Reef Rescue program have provided positive incentives to influence the adoption of many practices, particularly those which required large upfront investments. Relying solely on extension to influence adoption was only going to pick up a proportion of landholders who were most likely to be environmentally motivated, engaged in unprofitable practices, and financially stable enough to sustain losses incurred in trialling or changing management practices. In this sense extension programs administered by regional NRM bodies and government agencies were inappropriate for many landholders.

The application of the policy matrix to the policy problem of improving water quality entering the GBR in Table 5 favours the use of a mix of different instruments, depending on the specific conditions at hand, with some policies overlapping each other given the complexity of the policy problem.

In conclusion, there is an economic case for many of the voluntary mechanisms that have been and are being used in the GBR catchments to improve water quality where the BMP has both public and private net benefits. The voluntary mechanisms implemented to date may have influenced the adoption of BMPs where landholders have net private benefits, environmental motivations, are financially sound and are relatively risk neutral or risk taking. However, the level of uptake using pull factors has been far short of policy expectations and in meeting participation targets. If most actions involve tradeoffs between private and public benefits, rather than a positive correlation, there is a much stronger case for negative or positive incentives, with regulation one of the options to consider. There may be a slightly stronger case for non-voluntary approaches when we consider heterogeneity in the mix of public and private costs associated with BMPs to improve water quality entering the GBR and some myopic behaviour by landholders about private benefits (the risk and uncertainty issues). In particular, it may be cheaper to regulate low cost BMPs than to design and implement economic incentives to influence adoption across a range of BMPs and landholders.

5. Economic assessment of regulatory approaches to improving agricultural water quality into the GBR

The previous section focused on voluntary approaches, encouraging the adoption of BMPs through positive incentives or extension policy approaches. Heterogeneity of landholders' benefits and costs associated with BMPs in the GBR catchments indicates regulation may be the most appropriate policy instrument for a *group* of landholders who fall into the negative incentive space of the net benefit framework (Figure 3). These are landholders who need to be discouraged from continuing existing or adopting practices which negatively impact on the water quality entering the GBR but have private benefits for their enterprise.

The Pannell (2008) framework focuses on the net benefits of specific actions, but does not consider the costs of implementing policies to influence those actions.⁸ The prescriptive nature and increased administrative costs of non-voluntary approaches may increase the private costs for all BMPs relative to voluntary measures. For example, prescribing Environmental Risk Management Plans (ERMPs) may replicate or duplicate existing farm-based risk management and planning practices in use, creating redundancies and increasing transaction costs. Regulation can also generate a number of perverse outcomes, including crowding-out effects on voluntary actions for environmental protection, increased mistrust of agencies, and reduced involvement in voluntary mechanisms and incentives.

Given the low levels of adoption pre GBRMPAA 2009, prescription may improve water quality entering the GBR by requiring all landholders to apply the optimum amount of N and P, to set targets and performance indicators and to measure progress under ERMPs relative to existing voluntary economic instruments. An improvement in water quality entering the GBR under regulation assumes that the number of landholders who would under-abate is larger than those who over-abate in the absence of any policy mechanisms. This is supported by Emtage and Herbohn (2012b), whose engagement index found only two types of landholders in GBR catchments, approximately 20 per cent of their sample, to be engaged with the surveyed BMPs.

The policy assessment matrix (Sterner 2002) suggests that regulatory instruments are preferred when there is heterogeneity in damage costs, mandatory technology is easy to inspect and ecological complexities are present. The GBRPAA 2009 addresses the heterogeneity in damage costs somewhat as it targeted three out of the six GBR catchments and properties greater than 70 hectares for sugarcane and greater than 2000 hectares for grazing (see Figure 1 for prioritisation by pollutant load). While there are no direct public benefits from documentation, Sterner's (2002) matrix recommends information disclosure may be best in the presence of ecological complexities (see Table 6 for other recommended instruments under complexity). Sabel et al (2000) also describe, in relation to managing point source pollution, how information disclosure improves the self-regulating tendencies of businesses through appealing to reputational concerns. This may also apply for farm or industry scale disclosure in the GBR catchments and supports the use of ERMPs, although they could also be implemented as voluntary agreements if there is uncertainty associated

⁸ Appendix A disaggregates a suite of interdependent management practices or instruments implying that one could have been implemented without the other –

with water quality outcomes. Government-accredited industry developed standards as previously proposed under the Farm Management Systems MoU negotiated in 2005 would arguably have the same effect in these circumstances.

The increased private costs of non-voluntary instruments could be justified if they delivered on the targets set by the revised Reef Plan in 2009 updated version. The analysis provided by van Grieken et al. (2011) indicates that the 2013 Reef Plan targets set appear to be incompatible with regulations and very unlikely to be met; and there is heterogeneity in abatement costs, such that even prioritising by catchment is likely to be too large a scale for regulations to achieve cost-effective improvements to water quality relative to more flexible voluntary mechanisms.

6. Discussion and conclusions

Several important conclusions can be made from this review of mechanisms to improve adoption of best management practices in agriculture.

First, not all actions that generate environmental damages should be addressed, or require only low level intervention. Actions that generate private benefits in excess of public costs should be allowed to continue. When the additional transaction costs of making changes are considered, then many other potential controls over actions become uneconomic. The main actions where some form of intervention is justified is where the public benefits that can be gained are higher than the private costs or losses involved.

Second, where action is justified, there are a range of different policy mechanisms that are available to encourage landholders, with varying levels of intensity, to change management practices. While different classifications are possible, they have been categorized in this report into three key groupings: information and extension mechanisms, economic instruments, and regulatory mechanisms. Economic instruments can be further divided into three broad areas of taxes and charges, grants and subsidies, and market based mechanisms.

Third, each policy instrument has different advantages and disadvantages. As well, many instruments have flow-on effects on incentives and landholder returns and motivations, and can cause crowding-in or crowding-out effects. This means that policy makers need to take care in selecting policy mechanisms.

Fourth, the instruments that are available are not very substitutable. The available policy instruments meet different goals, and relate to different tradeoffs between public and private costs and benefits (Figure 3). Policy makers choosing between instruments need to consider the type of problem and conditions that exist to select the appropriate mechanism for the situation.

Fifth, where there are private benefits to be gained from changing management practices, the use of information and extension mechanisms is recommended. However, these are not sufficient when private net costs are involved, helping to explain the transition to more economic instruments.

Sixth, many studies in the region into the adoption of BMPs have consistently found that landholders are heterogeneous in their abatement costs, risk perceptions and motivations

for farming. This provides a strong justification for the use of economic instruments to facilitate the selection of landholders and projects that have lower costs. However, grants and subsidies are not very efficient relative to other types of economic instruments.

Seventh, regulatory instruments can be optimal in some situations. Governments will often prefer non-voluntary mechanisms over voluntary ones because of their administrative simplicity in applying uniform requirements on all firms being regulated and the certainty in outcomes provided. However regulatory instruments come with large hidden costs because of their compliance requirements and lack of flexibility, and can impose substantial perverse impacts.

A final comment is that the introduction of the GBRPAA 2009 and the resultant regulatory requirements were consistent with the scope of the original Reef Plan, however, the timing of their introduction appeared significantly at odds with other voluntary mechanisms being applied. While some preliminary indication of the likely impact of the new regulations on net public and private benefit is provided above, we suggest a further analytical approach that acknowledges the interdependence between the suite of instruments in use, and the influence of the particular mix of instruments on landholder motivations and perceptions of risk is now required.

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