

**An approach for adaptive and integrated agricultural planning to deal with uncertainty
in a Great Barrier Reef Catchment**

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ABSTRACT: *There has been a growing trend towards integrated regional ecosystem approaches in theory and practice to (1) better understand the behaviour of complex social-ecological systems, (2) for holistic state-of-the-environment monitoring of social, economic, institutional and environmental conditions and trends to adapt governance towards achieving resilience, and (3) as the basis for multi-scalar policy collaborations between government and non-government sectors to find solutions to sustainability problems. Drawing on the Authors' regional NRM expertise, this paper presents the ABCD framework for adaptive and integrated agricultural planning to deal with uncertainty developed in the Wet Tropics region within the Great Barrier Reef (GBR) in Northern Australia. The paper briefly describes collaborative efforts led by the regional NRM body to translate complex, unclear, and overlapping institutional arrangements for environmental sustainability into a simple practice-based framework that defines the environmental duty of care for agriculture as well as the forward actions necessary to secure improved environmental outcomes. The framework integrates regional stakeholder interests and values horizontally within the region to overcome issues of science and policy uncertainty. Vertically, the framework integrates government environmental policy across jurisdictional scales within the GBR including initiatives of the Australian and Queensland Governments and global environmental policy for the eco-accreditation of sugar cane products. The framework has also positioned the region's farmers as global leaders in environmental management.*

We propose that this approach has utility within agricultural systems and beyond to (a) identify and implement on-ground solutions to sustainability problems within a context of uncertainty, (b) support scalable monitoring and modelling of environmental, social and economic conditions and trends, and (c) evaluate the efficacy of solutions and governance arrangements and identify adaptive strategies and approaches as necessary.

Keywords: *Agricultural practice classification, multi-scalar governance, adaptive planning, integrated natural resource management*

Introduction

There has been a growing trend towards integrated regional systems approaches for natural resource planning and management. Integrated systems perspectives have emerged globally within the scientific literature to better understand the complex nature of environmental sustainability problems (Folke 2006). Complex natural and human systems require interdisciplinary scholarship to understand the relationships between environmental and social problems and their effects on social and ecological resilience (Holling 1995, Young et al. 2006, Folke 2006). There has also been a growing recognition, particularly among natural resource management (NRM) practitioners that sustainability assessments, which have predominately focussed on biophysical dimensions, actually need to take a more holistic view to measure and monitor sustainability (Hezri and Dovers 2009). Scholars and practitioners alike are working towards integrated social, economic, and environmental monitoring and assessment systems. These systems aim to support the evaluation of planning and policy actions at multiple jurisdictional scales as well as horizontally across a range of government and non-government initiatives. Integrated approaches are essential to effect the principles and requirements of adaptive planning in situations characterised by uncertainty, where assumptions and hypotheses about environmental problems and solutions require policy 'experiments' that are trialled and evaluated, and adapted based on learning's (Mobbs and Dovers 1999).

Regional integrated approaches for NRM have also emerged as a policy solution to problems of institutional complexity. The Brundtland Report (World Commission on Environment and Development 1987) first sparked the evolution of a complex array of governmental and non-governmental programs and initiatives across a range of public policy sectors to deal with issues of sustainability. These mechanisms initially failed to deliver better environmental outcomes due to issues of poor coordination and poor integration across tiers of government, across sustainability issues, across public and private interests, and public policy dimensions, and citizens were often isolated from the process (Grinlinton 1992, Morrison et al. 2004, Lane and Robinson 2009). Originally regional NRM planning focussed on the devolution of planning and management responsibilities from state and national tiers to more localised decision-making bodies. As the arrangements have matured, regional and cross-regional partnerships have emerged to build capacity for change, procedural systems have been developed to manage aspects related to the flow of priorities, finance and information up and

down devolved systems. More recently a new regional approach has emerged within NRM boundaries which is:

“characterised by the evolution of regionalism away from government (State)-centred approaches towards regions that operate internally in relation to some issues (such as economic growth and environmental issues), and externally to build networks” (Wallis, 2006 cited in Peterson et al. 2010:298).

Recognising that conventional policies of governments are insufficient in resolving complex environmental sustainability challenges, contemporary approaches seek to engage government and non-government stakeholders via partnerships in the planning process across several scales (Margerum 1997, Bellamy et al. 1999, Bellamy et al. 1998, Peterson et al. 2007). They emphasise integrated approaches to science and knowledge (Robinson et al. 2010), and seek to build integrated solutions to overcome the multi-dimensional faces of NRM problems (Peterson et al. 2007).

Collaborative regional approaches however are not necessarily a panacea for NRM (Heuer 2011, Ballet et al. 2007) because regional institutions face tremendous challenges achieving integration, making better decisions and putting effective programs into place (Heuer 2011, Saravanan et al. 2009, Lockwood et al. 2009). As described by Eberhard et al,

“The capacity of decentralised institutions to deal with the diverse and competing interests that affect resource management priorities and activities remains a challenge. The pressure for rigorous and collaborative approaches to adaptive management is high.” (Eberhard et al. 2009:1192).

We draw on regional NRM expertise and present experience from the Wet Tropics region in the Great Barrier Reef (GBR) in Northern Australia. This region developed an ABCD framework, a hierarchical classification of farming practices according to their effects on NRM assets (biodiversity, water, soils, people, and communities, cultural heritage). Emerging initially as a bottom-up approach it expanded into a multiple stakeholder collaborative to translate complex, unclear, and overlapping institutional arrangements into a simple practice-based framework which defines the environmental duty of care for agriculture as well as the forward actions necessary to secure desired environmental outcomes. The framework has provided a mechanism for regional NRM bodies to integrate institutional arrangements and management actions at multiple scales. It integrates regional stakeholder interests and values horizontally within the region to overcome issues of science and policy uncertainty. Vertically, the framework integrates government environmental policy across jurisdictional scales within the GBR including initiatives of the Australian and

Queensland Governments and global environmental policy for the eco-accreditation of sugar cane products. It has also provided a framework to structure agricultural practice monitoring and policy evaluation to deal with issues of uncertainty. This regional approach has positioned the region's farmers as global leaders in environmental management.

Problem Definition

Ecosystem health in the iconic Great Barrier Reef (GBR) is under considerable threat as a result of climate change, catchment runoff, coastal development, and extractive use (Baker 2008, Great Barrier Reef Marine Park Authority 2009). Since the early 1990s there has been growing focus on the impact of catchment land use activities on declining water quality, particularly the growing impact of diffuse sources of water borne sediments, phosphorous, nitrogen, and pesticides from agricultural landscapes on the GBR (Great Barrier Reef Marine Park Authority 2001, Productivity Commission 2003, Mitchell et al. 2009).

In response, local Government, the Queensland Government and the Australian Government in growing partnership with non-government stakeholders, sought to conserve, restore and enhance coastal wetlands and river systems and reduce the environmental impacts of agriculture landscapes on the quality and quantity of water entering the GBR lagoon. Strategies have ranged from development control through planning schemes and impact assessment procedures, through to statutory provisions relating to environmental management, and voluntary catchment planning initiatives such as Landcare. Chief among these was the Reef Water Quality Protection Plan introduced in 2003, and revised in 2009, which focused on multi-level stakeholder cooperation, low cost measures, and promoted voluntary landholder adoption of best management practices (Queensland Government 2009, Emtage and Vella Forthcoming).

There was a very strong perception by environmentalists and the Queensland Government in particular that landholder uptake of sustainability practices was lower and slower than required to halt and reverse the decline of water quality in the GBR. This was despite the fact that:

1. Environmental management by landholders had never been systematically assessed;
2. Land management practices had never been classified according to desired resource condition outcomes; and

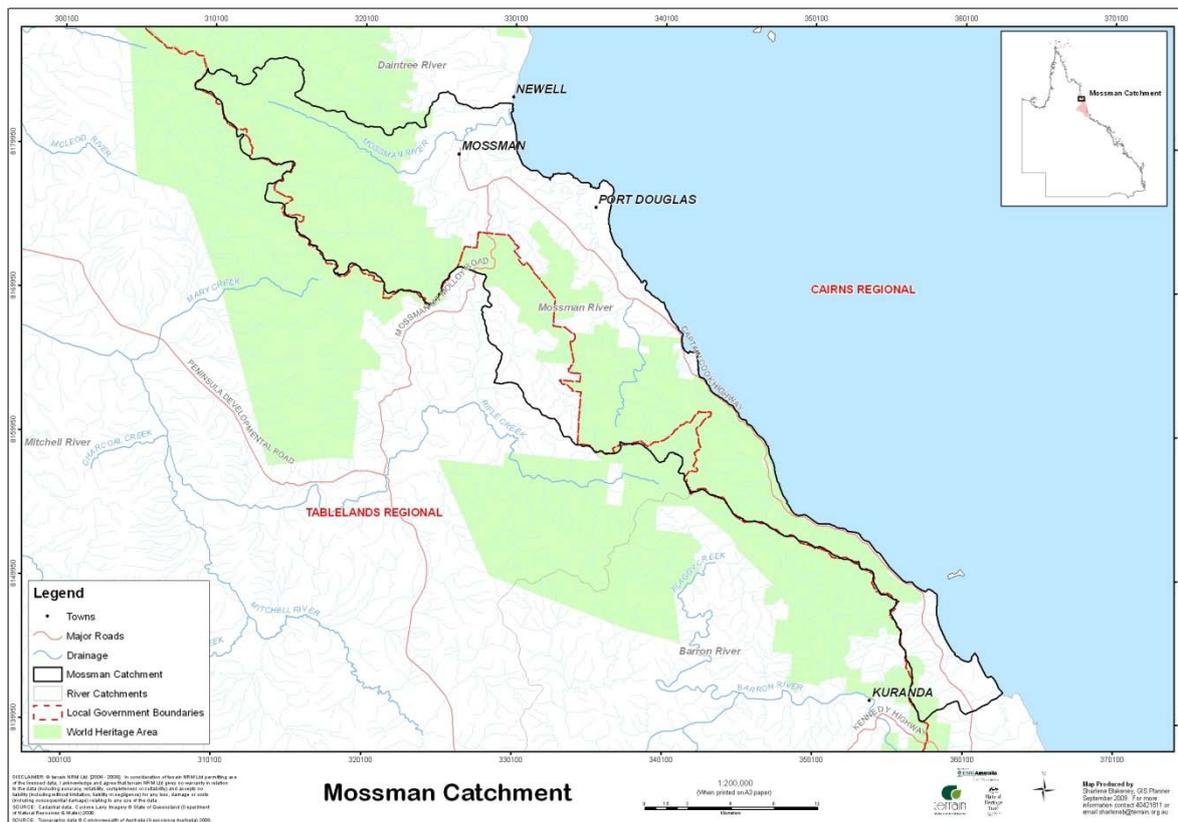
3. The 'duty of care' expectations for landholders in terms of their management practices and desired environmental outcomes were not clearly defined despite the plethora of institutional arrangements and ongoing public discourse about environmental rights, roles and responsibilities from cane production.

Regulatory change aimed at grazing and cane industries under the auspices of the Reef Water Quality Protection Plan was not grounded in evidence about baseline environmental conditions or the social, economic, biophysical or institutional barriers or bridges to improved outcomes. There had also been very limited investment by government into supporting voluntary practice change. The low cost measures proposed in the Reef Plan actually meant that the financial costs to government of this strategy would be low because the changes would be absorbed by industry but it did not take into account the prolonged and serious economic viability issues confronting the cane industry from the early 1990s through most of the first decade in the 21st century (Danzi et al. 1997, Drummond 1996) or the economic costs involved in implementing BMPs (Roebeling et al. 2009). The next phase of policy change promised even more stringent controls and potentially high social, economic, and environmental transaction costs.

Methods

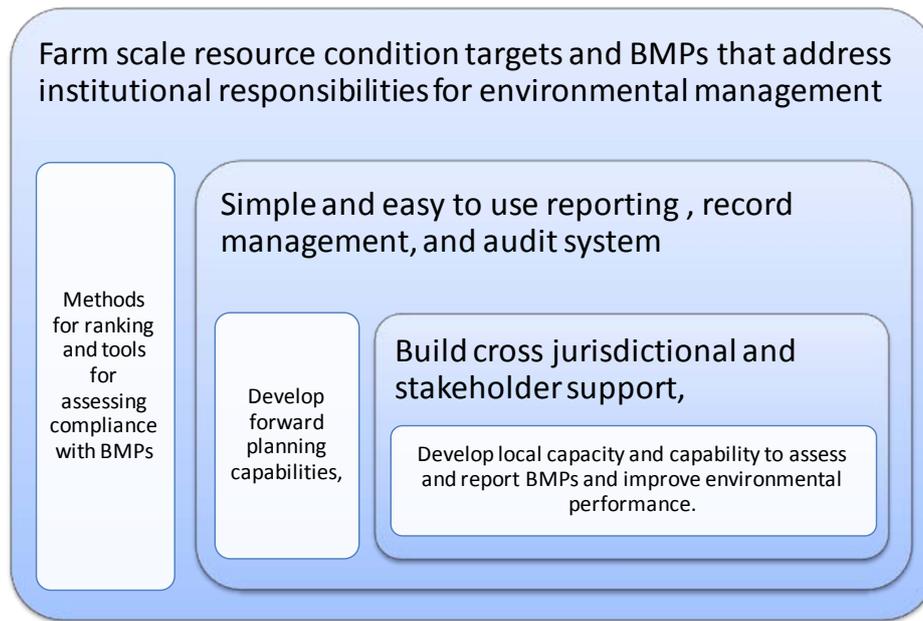
In 2006, Terrain NRM, the regional NRM body, in partnership with cane farmers, millers, agricultural extension providers, and cane product manufacturers in the Mossman District (Refer Map 1) sought to find a socially and economically viable solution to improve on-ground management practices. It originally sought to provide a bottom-up extension process for BMP uptake with and for Mossman cane farmers. As this progressed, the focus grew towards developing a framework and an associated system for eco-accreditation and continual improvement which would demonstrate commitment to the environment and provide a market-based mechanism to deliver financial incentives through premium payments to landholders in return for continual improvement in land management practices.

Map 1: The Mossman Catchment within the Wet Tropics NRM Region, Queensland, Australia



Eco-accreditation required a clearly defined cane farming environmental duty of care, based on existing institutional requirements as the basis for awarding market payments. Cane farmers would receive payments in return for meeting agreed standards of management plus progressive on-ground management actions by landholders for ongoing accreditation. Systems and procedures to report, monitor, and evaluate progress towards adaptive management also had to be developed. Information needed to be collected at an individual landholder level for accreditation and to identify the future actions landholders needed to implement to improve their environmental performance. The system also had to be scalable at catchment and regional levels so that the regional NRM body could identify conditions and trends in practice change and use this to further investigate barriers and bridges towards continual improvement (financial, technical, environmental). The system also required strong local ownership and considerable cross-jurisdictional stakeholder support to provide the necessary capacity to make the system work (Figure 1).

Figure 1: An overview of the requirements of the eco accreditation system



The collaborative approach adopted involved regional and broader stakeholders in the planning and implementation process. Strong local champions formed a core-planning group. This group was engaged in detailed discussions and the technical development of the environmental management system. The core-planning group also provided a critical link between local and regional stakeholders and this was essential to achieving ongoing strong engagement of regional stakeholders (Table 1).

Table 1 Key stakeholder roles and functions in developing the eco-accreditation system

Engagement Mechanism	Key Stakeholders	Roles
<p>Project driver</p> <p>Lead and manage partnerships between the core planning group and regional stakeholders (<i>horizontal integration</i>) and between regional and broader stakeholders (<i>vertical integration</i>).</p>	Terrain NRM	<ul style="list-style-type: none"> • Partnership development and ongoing management • Technical expertise (institutional requirements for sugar cane production, sustainable agriculture BMPs) • Project management • Implementation support • Ongoing management role (audit and compliance, continual system improvement)
<p>Core planning group</p> <p>AND</p> <p>Regional stakeholder group</p>	<p>Douglas Shire Council (DSC)</p> <p>Mossman Agricultural Services (MAS)</p>	<ul style="list-style-type: none"> • Technical expertise (sustainable agriculture BMPs) • Implementation support • Technical expertise (farming operations, soil analysis interpretation, GIS, farm maps, extension services) • Support for system development • Implementation agents (support to growers to

		assess and record BMPs)
	Local Farmers	<ul style="list-style-type: none"> • Key implementation agents for the system (implementation of BMPs and environmental reporting)
Regional Stakeholder Group	Commercial Partners	<ul style="list-style-type: none"> • Market incentive payments
	Mossman Central Mill (MCM)	<ul style="list-style-type: none"> • Commercial partner • Potential conduit for market premium payment
	Department of Employment, Economic Development and innovation (DEEDI)	<ul style="list-style-type: none"> • Technical expertise (sustainable agriculture BMPs) • Advice on extension services
	Far North Queensland Area Consultative Committee (FNQ ACC)	<ul style="list-style-type: none"> • Support for system development and implementation
	The Great Barrier Reef Marine Park Authority	<ul style="list-style-type: none"> • Support for system development and implementation
Broader stakeholder group	WWF - Australia	<ul style="list-style-type: none"> • Support for system development and implementation and partnership to deliver environmental accreditation through the 'Better Sugar Initiative' (BSI)
	Better Sugarcane Initiative (Bonsucro)	<ul style="list-style-type: none"> • Ecosystem service payment
	Queensland Department of Environment, Resources and Mines (DERM)	<ul style="list-style-type: none"> • Support for system development and implementation
	Department of Environment and Water (DEW)	<ul style="list-style-type: none"> • Support for system development and implementation

The review of laws, policies and legislation governing sugar cane environmental management, including some twelve to sixteen potentially relevant laws found that despite the substantial number of potentially relevant legal arrangements (Refer Table 2), no clear minimum requirements for environmental management existed which could be used to define the basic environmental duty of care. The review highlighted considerable duplication, overlap, and lack of integration of institutional arrangements to manage environmental assets, which showed that there was little of substance directing environmental management despite the growing national focus and efforts towards harmonisation. There was also a complete disconnect between the institutional arrangements and the resource management systems for which regulation was attempted. These findings are especially problematic for eco-certification, which requires at the very least a set of minimum standards against which to audit and certify producers.

Table 2: Legal arrangements relevant to sugar cane systems (2006-2008)

Regional Assets	Relevant Heads of Power	Potentially relevant, but not enforced Heads of Power
a) Water	Environmental Protection Act 1994 (Qld)	Water Act 2000 (Qld)
	River Improvement Trust Act 1940 (Qld)	
	Reef Water Quality Protection Plan (Reef Plan) (Qld)	
b) Productive Resources	Land Protection (Pest and Stock Route Management) 2002 (Qld)	Sugar Industry Act 1999 (Qld)
		Soil Conservation Act 1986 (Qld)
c) Biodiversity	Integrated Planning Act 1997 (Qld)	Coastal Protection and Management Act 1995 (Qld)
	Nature Conservation Act 1992 (Qld)	
	Vegetation Management Act 1999 (Qld)	
	Environment Protection and Biodiversity Conservation Act 1999 (Aust)	
	Fisheries Act 1994 (Qld)	
d) Social	Workplace Health and Safety Act 1995 (Qld)	
	Dangerous Goods Safety Management Act 2001 (Qld)	
e) People and Country	Aboriginal Cultural Heritage Act 2003 (Qld)	
All Assets	Regional NRM Plan for the Wet Tropics	

The core planning group developed a set of land management activities as proxies for the environmental duty of care and desired future environmental management practices for each of the regional assets (water, productive resources, biodiversity, social, people and country) along a continuum (Table 3). Originally a numeric scale, stakeholders renamed into an A-D classification where:

- D practices were classified as being old, outdated and unacceptable;
- C practices approximated the minimum duty of care;
- B practices included desired BMPs which met industry and regional NRM management targets; and
- A practices are aspirational, advanced practices, potentially delivering additional ecosystem services, potentially involving higher costs, and requiring validation and additional evaluation.

A and B class practices were linked to the Management Action Targets (MATs) for all assets in the Regional NRM Plan and the Douglas Shire Water Quality Improvement Plan (DSWQIP) to reduce pollutant loads. The framework integrates farm-scale resource

condition targets and Best Management Practices (BMPs) to address legislative responsibilities and achieve regional NRM plan outcomes. Stakeholders also identified methods for ranking and tools for assessing producer compliance with BMPs and developed a practical, sustainable agriculture and resource condition auditing system. Unlike ISO 140001 and other environmental management systems approaches, the ABCD sets an implied performance standard where C practices are unlikely to achieve acceptable resource condition goals but B practices are likely to achieve acceptable resource condition goals.

Table 3 A definition of the practice classifications used in the ABCD framework (Vella 2008)

Class	Description of practice	Community and Industry Standard	Effect on resource condition	Effect on profitability
A	Practice exceeds Best Management Practices, providing society with additional ecosystem services.	When validated is an acceptable practice for the long term (may not be universally endorsed as feasible by industry and community).	When validated, practice likely to achieve long term resource condition goals if widely adopted.	When validated, some practices may improve profitability in the medium to long term. (May reduce profitability during the transition). Other practices may reduce profitability and will require financial support in the transition in the short term and require ongoing external income (e.g. eco-accreditation for market premium payments, or ecosystem service payments) in the medium and long term.
B	Practice meets agreed industry and community Best Management Practices.	Acceptable practice for the medium term.	Practice likely to achieve medium term resource condition goals if widely adopted.	Improves profitability in the short to medium term.
C	Practice meets minimum industry and community standards and regulatory obligations.	Acceptable practice today but may not be acceptable in medium term.	Practice unlikely to achieve acceptable resource condition goals if widely adopted.	Decline of profitability in the medium to long term.
D	Practice unacceptable by industry and community standards.	Superseded or unacceptable practice today.	Practice likely to degrade resource condition if widely adopted.	Decline of profitability in the short to medium term.

Analysis

Over the past two decades, there has been a substantial increase in the complexity of the governance arrangements guiding and regulating the use and management of natural resources and substantial growth in the range of government and non-government stakeholders with interests, roles, and responsibilities for environmental management (Morrison, *et al* 2004). The literature on governance approaches advocates for integrated and collaborative approaches between government and non-government groups in the private sector and civil society to deal with ‘wicked’ environmental problems (Lockwood *et al.* 2010, Morrison *et al.* 2004). Scholars call for interaction and coordination to ensure that diverse information, knowledge and perspectives are included into the design of management approaches and to build social capital, networks and political will to enhance their implementation (Margerum 1997, Margerum 1999, Margerum and Born 2000, Robinson *et al.* 2010). Scholars and practitioners also call for “institutional and policy cocktails” (Osborn and Datta 2006:576) matched to environmental problems, stakeholders and populations, and other related instruments at multiple-scales within governance systems (Osborn and Datta 2006, Taylor 2010).

The diverse nature of water pollution problems and their sources in intensive agricultural landscapes means that no single water pollution regulatory strategy can be applied across the board, and policymaking must be more nuanced and context specific (Gunningham and Sinclair 2005). As Gunningham and Sinclair argue, intensive agricultural systems require a:

“combination of performance standards, technology standards and process standards tailored to the needs and circumstances of intensive agriculture. Because there is a high degree of commonality in the production practices and procedures used within individual intensive agricultural sectors, intensive agriculture is well suited to the application of technology-based standards - standards that require the sector-wide implementation of a prescribed set of pollution abatement technologies. But there will also be important roles for industry based BMPs, farm environmental plans or other 'process-based' approaches, to 'fill in the cracks' where more detailed and prescriptive standards are not practicable” (Gunningham and Sinclair 2005 p230).

The Mossman ABCD classification scheme provides a simple yet integrated framework of management practices linked to institutional requirements. Although designed to facilitate the assessment and independent eco-accreditation of sugar cane farmers, the framework has been scaled-across agricultural industries within the Wet Tropics Region, across other GBR regions and used at state and national jurisdictional scales to structure:

1. Landholder practice benchmarking, risk assessment and action planning;
2. Priority setting and government investment in grants, incentives, and change management programs (including tougher legislation) to improve management practices;
3. Global certification of Australian cane farmers, who are leading world best practice in environmental management;
4. Monitoring and reporting of farm practices;
5. Research into expected resource condition outcomes resulting from different practice classifications;
6. Evaluation of the efficacy of institutional arrangements in resolving sustainability problems and solution design (Table 4).

The impetus for this system emerged from the bottom up. Later developments were added by involving stakeholders at the regional and higher levels but the system as a whole retained its integrity and was able to provide the capacity and a mechanism to resolve persistent economic, social, and institutional problems facing the cane industry and deliver outcomes. It still retained enough of the bottom level of development for the growers to identify the system as something they had helped develop and it engaged stakeholders at broader scales to secure the institutional support needed for implementation. Legislation introduced independently and without consultation by the Queensland Government off the back of the ABCD framework to prohibit D and some C practices was an unintended consequence. It very seriously threatened the partnerships, trust, and local participation in the suasive measures negotiated by the regional NRMs with agricultural bodies and the Australian Government. It emerged that stakeholders had built enough goodwill through the process to maintain grass roots support. More than this, incentive measures, training and education programs provided critical capacity to local cane farmers to progress into B and A practices, thus meeting and exceeding their legislative requirements under Queensland law.

Table 4 Examples of the use of the ABCD Framework to support integrated NRM at multiple scales

Applications	Scale of Application in Reef Planning System	Direction	How	Who	Examples
1. Benchmark Existing Practice	<ul style="list-style-type: none"> ↓ Farm ↓ River Basin/Industry Catchment Districts ↓ NRM Region 	Scales up	Land managers record practices along A-D continuum. Data aggregated at different spatial scales	<ul style="list-style-type: none"> • Regional NRM • Industry Groups • Individual Land Managers (Producers) 	Reef Rescue self-assessment Regional verification surveys Regional, industry and cross-GBR practice benchmarks
2. Action Planning	<ul style="list-style-type: none"> ↓ Region ↓ Catchment ↓ Farm 	Scales down	Regional management action targets identified Landholder forward actions identified following risk assessment.	<ul style="list-style-type: none"> • Regional NRM • Industry Groups • Individual Land Managers (Producers) 	Collaborative processes to define sub-regional action priorities Reef Alliance cross-regional partnership Action priorities identified for individuals based on risk assessments
3. Change management	<ul style="list-style-type: none"> ↓ Regions ↓ Reef-Regional Partnership ↓ Queensland and Australian Government <p>AND</p> <ul style="list-style-type: none"> ↓ Regions ↓ Industry districts/ River basin ↓ Landholders 	Scales up and down	Regional brokerage of resources and capacity to develop action plans. Programs to secure on-ground action for practice change Regional partnerships with industry and landholders for practice change	<ul style="list-style-type: none"> • Australian Government • Queensland Government • Regional NRM • Industry Groups • Catchment Associations 	Reef Rescue water quality incentive program Farm legislation
4. Eco-Accreditation	<ul style="list-style-type: none"> ↓ Farm ↓ Mill ↓ International <p>AND</p> <ul style="list-style-type: none"> ↓ International ↓ Farm 	Scales up and down	Eco-Accreditation of practices that meet international duty of care requirements	<ul style="list-style-type: none"> • Regional Bodies • Industry • Private Certification Companies • Consumers 	The Better Sugar Cane Initiative 'Bonsucro' Implement accreditation (self-assessment, evidence gathering, and independent verification).

				<ul style="list-style-type: none"> • Global Environmental 	
5.Reporting and Communication	<ul style="list-style-type: none"> ↓ Farm ↓ Catchment ↓ Industry ↓ Region ↓ GBR-wide 	Scales up and down	<p>ABCD framework forms the basis for communication to industry about duty of care.</p> <p>ABCD framework provides the basis for annual reporting of progress. The framework provides the basis for presenting the following:</p> <ul style="list-style-type: none"> Benchmark current practice Targets and Action Plans Investments in practice change (incentives, programs, initiatives) Areas of actual practice change and reasons why change has or has not occurred 	<ul style="list-style-type: none"> • Communication from Regional Bodies and Industry to grass roots cane farmers, government, and community stakeholders. 	Impact reporting Annual program reporting
6.Research, Monitoring and Evaluation	<ul style="list-style-type: none"> ↓ Industry ↓ Region ↓ GBR-wide 	Scales up	<p>Monitoring and Evaluation linked to the ABCD framework of practices. ABCD framework will support:</p> <ul style="list-style-type: none"> Integrated data hubs where existing and new research activity is linked across research domains (e.g., ecological, social, economic, institutional) Research activity aligned towards validating ABCD practices More targeted management of research activity to support annual reporting of progress towards practice change More targeted management of research activity to support the evaluation and refinement of practices, programs, and delivery mechanisms. 	<ul style="list-style-type: none"> • Australian Government • Queensland Government • Researchers • Regional Bodies • Industry 	<p>Practice benchmark</p> <p>Paddock to reef integrated modelling of resource condition</p> <p>Research into:</p> <ul style="list-style-type: none"> • the effects of BMPs on water quality, • the financial costs and benefits of BMPs, and • the efficacy of capacity building programs and other governance arrangements.

Conclusion

The Mossman ABCD classification scheme delivered a simple yet integrated duty of care framework of management practices linked to institutional requirements. Conceived originally as a bottom up approach for BMP extension it articulated into a regional approach to facilitate the assessment and independent eco-accreditation in sugar cane environmental systems. Faced with multiple uncertainties (about current practice, current environmental impact, environmental benefits of changed practices, cost of implementing change, social barriers to change, and policy ambiguity) local cane industry stakeholders in collaboration with others categorised practices on a continuum from D practices that were considered universally to be old, outdated and unacceptable through to A practices that were aspirational practices, potentially delivering ecosystem services but requiring validation, financial support, and additional evaluation. The resulting framework provides a practical structure for regional planning organisations to work collaboratively with multiple government and non-government stakeholders to:

- (a) identify and implement on-ground solutions to overcome policy, science, economic and social uncertainties,
- (b) support scalable monitoring and modelling of environmental, social and economic conditions and trends, and
- (c) evaluate the efficacy of solutions and governance arrangements and adapt strategies and approaches as necessary.

The framework has subsequently been scaled-across agricultural industries in the Wet Tropics Region and combined with similar approaches in other GBR regions and scaled up to support planning, monitoring and research functions at state and national jurisdictional scales. We believe it has potential in other environmental management contexts, including urban contexts or for climate change where governments and others must participate in broad-scale change management programs in order to achieve a desired public policy outcome.

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Attachment 1