Improving Urban Water Quality in the Dry Tropics Coastal Zone

John Gunn (Earth Environmental for the Creek to Coral initiative)
Chris Manning (Townsville City Council/Creek to Coral initiative)

Abstract

People are increasingly drawn to the Queensland coast to live, work and play with this continuing influx of people increasing the pressure on the environment along the Queensland coastline. One of the main focus areas for addressing environmental pressures, albeit with less waves, is the catchment of the Great Barrier Reef (GBR).

The Coastal Catchments Initiative (CCI) is an Australian Government funded program aimed at achieving targeted reductions in pollution discharges to coastal water quality 'hot spots'. The receiving waters of the Great Barrier Reef lagoon are considered to be one such hot spot.

The CCI supports the development and implementation of Water Quality Improvement Plans (WQIP) based on the National Water Quality Management Strategy and the National Principles for the Provision of Water for Ecosystems. WQIPs will identify the most cost-effective and timely projects to improve water quality outcomes.

Creek to Coral, Townsville City Council's healthy waterways initiative, is the manager of the CCI project for the Black and Ross River Basins and is responsible for the preparation of a Water Quality Improvement Plan (WQIP) for the coastal Dry Tropics between Crystal Creek and Cape Cleveland. The Black Ross WQIP is the first 'urban' based WQIP developed in the GBR catchment.

Developing a WQIP for an urban environment is a different proposition than for a rural catchment WQIP although there are many similarities that are often overlooked. While the land use is obviously different the management principles for improving water quality are essentially the same. We show the similarities and differences between urban diffuse water quality issuesand rural diffuse water quality issues. We discuss the importance of addressing urban diffuse water quality issues in both developed and developing catchments with respect to helping to protect Reef water quality.

Introduction

There are many pressures impacting water quality throughout Australia with some of the more intense pressures arising from the relatively concentrated human population, and associated industry and infrastructure in our coastal areas. To manage water quality in our populated coastal regions requires a collaborative effort across all levels of government in partnership with industry and the community.

The Coastal Catchments Initiative (CCI) is an Australian Government funded program aimed at achieving targeted reductions in pollution discharges to coastal water quality 'hot spots'. Hot spots, in this context are coastal waters with high conservation value and are threatened by pollution from various sources. The receiving waters of the Great Barrier Reef lagoon are considered to be one such hot spot. Land based activities in the catchments of the Great Barrier Reef lagoon are considered to be the threat and the source of pollutants i.e. sediment, nutrients and pesticides.

The CCI supports the development and implementation of Water Quality Improvement Plans (WQIP) in accordance with the Australian Government's Framework for Marine and Estuarine Water Quality Protection. The Framework is based on the National Water Quality Management Strategy and the National Principles for the Provision of Water for Ecosystems; both approved by Australian Government/State Ministerial Councils.

WQIPs will identify the most cost-effective and timely projects for investment by all parties, including the Australian, State and Local Governments, industry and the community. The Australian Government targets projects that are most likely to deliver cost-effective water quality improvements and through an assurance from the respective jurisdictions, ensure that these improvements are sustained into the future.

The development of WQIPs in the Great Barrier Reef catchment will help tate and local governments and regional Natural Resource Management (NRM) bodies determine environmental values and water quality objectives for waterways in their catchment. Once developed, WQIPs will be integrated with regional NRM plans and other relevant planning processes to ensure ongoing implementation and achievement of objectives, including water quality objectives for the Great Barrier Reef.

Background

Townsville and Thuringowa City Councils (since amalgamated and now called Townsville City Council) established the Creek to Coral initiative in 2003 in partnership with the Queensland Environmental Protection Agency (EPA) and supported by the Great Barrier Reef Marine Park Authority (GBRMPA).

The Creek to Coral initiative is a locally adapted version of the South East Queensland (SEQ) Healthy Waterways Program and emphasises local concerns and issues in an environmental context that is relevant to the coastal catchments of the Townsville Dry Tropics, adjacent to the Great Barrier Reef.

The Creek to Coral concept is simple and all encompassing whereby creek applies to the top of the catchment and relates to freshwater, all the way through to estuarine waterways which ultimately lead to the Great Barrier Reef, hence the choice of the word coral. Creek to Coral adopts a catchment management approach to total water

cycle management in north Queensland's largest urban centre adjacent to the Great Barrier Reef.

Creek to Coral is the manager of the CCI project for the Black and Ross River Basins and, with the assistance of its many partners, is responsible for the preparation of an urban-based Water Quality Improvement Plan (WQIP) for the coastal catchments between Crystal Creek and Cape Cleveland, and including Magnetic Island.

The Black and Ross River Basins are part of the Burdekin Dry Tropics NRM region. Burdekin Dry Tropics (BDT) NRM has also prepared a WQIP for the Burdekin and Haughton Basins, which are predominantly rural catchments with cattle grazing and sugar cane growing land uses.

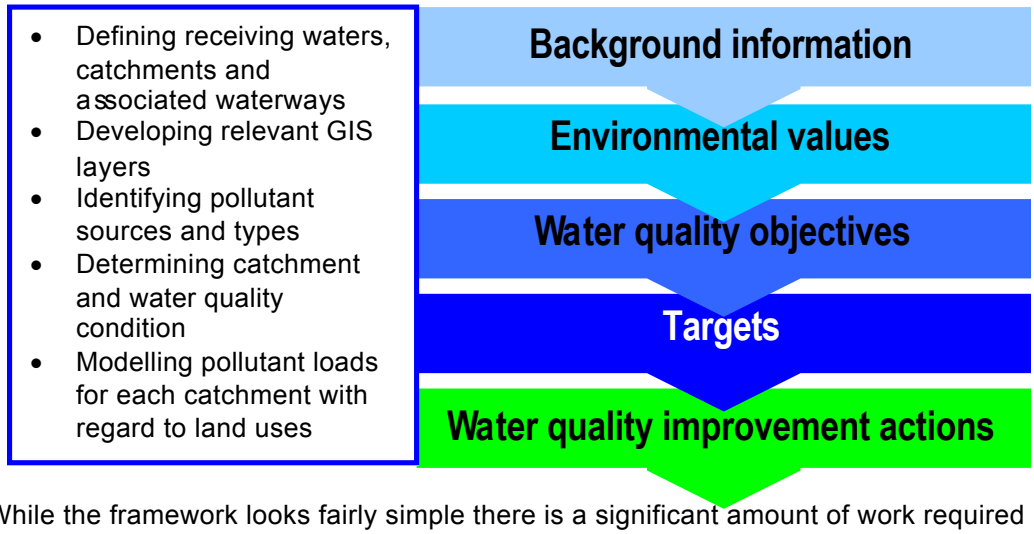
It was originally intended that the whole BDT region be the subject of a single WQIP incorporating rural and urban areas, however the original combined BDT NRM and Creek to Coral application was not supported by the CCI program managers. BDT NRM was then invited to resubmit a proposal to prepare a WQIP for the rural areas only, and subsequently received CCI funding.

Some time later Creek to Coral was invited to submit a proposal to the CCI program to prepare a WQIP for the Townsville coastal catchments. Funding was approved and in late 2006 Creek to Coral started the WQIP development process.

Methods

Water Quality Improvement Plans (WQIP) are essentially catchment management plans with a focus on water quality rather than all aspects of natural resource management. WQIPs are based on the principles and frameworks enunciated in the National Water Quality Management Strategy (NWQMS) and the National Principles for the Provision of Water for Ecosystems.

The preparation of WQIPs follows general planning processes incorporating the State of Environment pressure-state-response model. The main difference between a WQIP and a catchment management plan is the particular attention paid to the NWQMS framework including the determination of environmental values, water quality objectives and water quality targets. Actions are then devised based on altering land based management practices to achieve the water quality targets i.e. improvement in water quality.



While the framework looks fairly simple there is a significant amount of work required to determine environmental values, meaningful water quality objectives and targets

prior to determining appropriate management actions. The main precursor and parallel actions involved are listed beside the NWQMS framework components (see diagram above).

The agreement with the Australian Government regarding the contents of the WQIP required the determination of end of catchment pollutant loads, and reduction targets in relation to those loads. The pollutants of interest for the GBR are sediments, nutrients and pesticides. Event water quality monitoring data was needed to calculate end of catchment pollutant loads in the monitored waterways and to help validate the water quality models used to generate pollutant load estimates in other waterways. Therefore one of the first actions was to arrange for event monitoring for the 2006/07 wet season as no event data was available for the Black and Ross Basins. This was followed up again in the 2007/08 wet season, albeit on a reduced scale.

The next step was to identify potential sources of the pollutants in order to determine priority actions and areas to be addressed to meet the reduction targets. In general terms this is done by matching the proportion of pollutants in run-off to particular land uses. Again this requires data and the event monitoring was designed, as far as possible, to enable comparison of different urban land uses.

The Black Ross WQIP area includes rural catchments as well as the Townsville urban area and as such required an approach, which addressed both rural and urban land uses and their specific pollutant sources and management issues.

This all needs to be done in the context of the Townsville coastal plains and a dry tropical climate noted for its extremes of dry and wet, and could not be extrapolated from data or results from Cairns, Brisbane, Sydney or Melbourne.

Results

As mentioned the main focus of the Black/Ross WQIP is the urban environment. The rural catchments are dominated by either nature conservation/minimal use or grazing land use (see Table1). Intensive agriculture (sugar cane and horticulture) accounts for only 1.5% of the total WQIP area, and that is concentrated in the northern catchments of the Crystal Creek sub basin. By contrast the other intensive land use (not considering mining/quarrying with only 0.2% of the total area) i.e. urban, occupies 7.7% of the total WQIP area, and occupies more than 5% of the area in six of the ten sub basins. While this is well above the average residential land use in rural catchments (normally around 1%), it also means that there is a significant proportion of the sub basins that are non-urban.

Table 1 Land Use in the Black Ross WQIP Area

Land use	Hectares	%
Nature conservation/minimal use	99,786	37.1
Forestry	74	0.0
Grazing	133,908	49.7
Intensive agriculture	4,112	1.5
Water and wetlands	10,020	3.7
Mining/quarrying	462	0.2
Residential	15,186	5.6
Manufacturing and industrial	1,599	0.6
Services and utilities	4,026	1.5
Total (hectares)	269,173	

Note: Land use shaded is considered to be urban and is equivalent to 7.7% of the total WQIP area

The variable nature of landuse types at the sub basin level meant that in terms of establishing the pollutant loads from different urban landuses we needed to operate at a sub catchment, or urban 'paddock' scale, to gain an understanding of the pollutants moving off a particular urban paddock i.e. uniform land use.

As with many planning processes the preliminary work required to gather the requisite data to inform the planning process may be thin on the ground. This preliminary work then becomes an integral part of the planning framework, and can significantly alter the timeframe for delivery of the plan. Also the budget to collect more intensive data generally isn't available and compromises have to be made to gain as much broad water quality information as possible often at the expense of achieving the more specific data acquisition objectives.

Without an adequate amount of higher resolution data assumptions have to be made and less accurate data is then fed into the catchment models, which are the end point for determining end of catchment loads, setting targets and exploring management practice and land use change scenarios.

In an effort to add another layer of evidence to the catchment modelling, and define the uncertainties associated with the relationship between management practices and water quality improvements, a Bayesian Belief Network model isbeing developed for the Bohle River catchment. The Bohle catchment includes the 'coal face' of urban expansion in the Black/Ross WQIP area, and is being used as the pilot catchment to inform the implementation phase, and the adaptive management component of the post-plan planning.

Discussion

Why post-plan planning and adaptive management? There are some management interventions we know will work, some we think could work and some we don't have much idea about. In some cases we are also unsure about the magnitude of the issue and whether we need to do anything at all. Then there are the situations where we know something is an issue and we may find with a bit more investigation that no matter what we do it isn't going to make a difference to the environmental bottom line.

Testing assumptions and learning as we go can only be done in an adaptive management framework incorporating a continuous planning process. It doesn't mean that we aren't implementing water quality improvement measures but it does mean that we aren't trying to implement everything at once.

The two main management interventions that we know will work in urban areas are relevant at two different stages of the urban development cycle, and need to be planned for before the first sod is turned if they are going to be effective.

The first management intervention is the incorporation of water sensitive urban design (WSUD) into new (including infill) developments. The planning to incorporate WSUD needs to occur in the pre development concept planning stage and be carried all the way through to the post construction clean up. WSUD builds water quality improvement into the fabric of the proposed development and becomes operationally effective once the development area has been established i.e. becomes a 'mature' urban area. WSUD is a pre-development intervention that becomes fully operative post-development. In rural areas this could be equated to components of property management planning where the benefits are felt only after all the planning and the soil erosion measures or keyline contours are put in place. The application of WSUD

principles needs to be tested in the Dry Tropics as part of an implementation process and measures adapted as required to suit local conditions.

The second management intervention relates to the stage of development when the urban 'paddock' is bare. As with intensive agriculture the most vulnerable part of the production cycle is when the crop has been removed and the ground is bare just prior to planting. In the urban development cycle this occurs just prior to the construction of infrastructure, such as roads and storm water systems, and buildings. The principles of erosion and sediment control and storm water management are the same for both urban and rural land uses.

The big difference is that there is more incentive to retain the soil on the rural paddock as that is the foundation of production. Lose the soil and the nutrients and you won't be able to grow the same crop without additional inputs e.g. fertiliser, and expense. If the soil disappears from the urban paddock it doesn't really matter that much to the developer or construction contractor, as they will build their 'crop' anyway. They might just have to charge the client a bit more to bring in some extra fill.

Implementing appropriate erosion and sediment control measures and managing the quality of storm water leaving a construction site will lead to significant water quality improvement in urban areas during development and construction. The extent of improvement in the Dry Tropics is something we need to explore and incorporate the learnings into the WQIP through the adaptive management framework. So that would seem to cover developing urban areas where land use becomes more intensive, and reduces the area of less intensive rural uses. The table below shows the relationship between developing and established urban areas and rural areas.

Table 2 Land use relationships

Broad land use	Functional state	Principal land use
Urban	Established	Formal parks
		Natural areas – includes waterways and conservation reserves
		Peri-urban/rural residential
		Residential - traditional housing
		Residential - high density
		Commercial
		Light industrial
		Heavy industrial
	Developing	Eventual land use is dependent on the type of development and principally: • Residential (traditional and high density) • Commercial and light industrial • Heavy industry (rare)
Rural	Operational	Conservation/Natural Areas
		Minimal Use
		Forestry
		Rural residential
		Dam catchment
		Grazing
		Intensive agriculture
		Mining/Quarrying

So what do we do to improve water quality in established urban areas, especially those areas with traditional stormwater drainage systems and no WSUD components? Now we come to the bit where we aren't real sure if the things we think might work will work and whether the issues warrant treating, or can be treated. We have entered the realm of uncertainty. If we were in the rural setting this would be the realm where the agricultural extension officer tells the farmer they think this should work because it worked in the test plot but they want to try it out in a real farm paddock. The innovators will have a go and if it works they reap the benefits and others will follow.

We intend to apply the same approach to the urban environment in both the established urban paddocks and the developing urban paddocks. We'll grow the crops that we know will be productive and pilot and test the ones we are unsure of. Whatever doesn't work will be ploughed under and what does work will be incorporated into the next production cycle. While this happening we will be seeking out the urban extension officers to see what else is on the horizon that might be worth trying. Of particular interest is exploring the potential for behaviour change amongst landowners for water quality improvement in the 'mature' urban environments.

Conclusions

Urban and rural land uses for most part are like apples and oranges. They are different and they are both fruit (yes a Big Fat Greek Wedding line). Many of the management interventions are similar for reducing the amount of sediment and nutrients that are transported by water from both rural and urban land uses.

To implement measures and maximise water quality improvement outcomes in urban areas requires an understanding of the pathways, quantities and management practices that are associated with the movement of sediment and nutrients from the different urban land uses to receiving waters. This can't easily be achieved without the use of an adaptive management framework to ensure that we learn as we do, and do what we learn. It also requires an urban Reef Rescue funding component to enable the ideas to be tested, accelerate the learning and ensure the best possible results are achieved.

Take Home Messages

Adaptive management isn't a fad it is a way of incorporating lessons from the small mistakes in a planned way that can lead to the bigger outcomes being achieved in the longer term at a reduced cost. It is part of a continuous learning cycle that starts with an attitude and doesn't end.

Acknowledgments

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References

Gunn, J. and Manning, C. 2009, *Draft Water Quality Improvement Plan for the Black and Ross River Basins - Queensland*, Townsville City Council/Creek to Coral Program, Townsville.

Gunn, J., Manning, C., and Connolly, N. 2009, *Basins, Catchments and Receiving Waters of the Black and Ross River Basins Water Quality Improvement Plan Area*, Townsville City Council/Creek to Coral Program, Townsville.

Gunn, J. and Barker, G. 2008, *Water Quality Pollutant Types and Sources for the Black and Ross River Basins Water Quality Improvement Plan*, Townsville City Council/Creek to Coral Program, Townsville.

Gunn, J., Manning, C., Connolly, N., Moulton, D., and Bennett, J. 2009, *Draft Environmental Values, Water Quality Objectives and Targets for the Black and Ross River Basins Water Quality Improvement Plan*, Townsville City Council/Creek to Coral Program, Townsville.