



Marine and Tropical Sciences  
Research Facility

# THEME 3

## Halting and Reversing the Decline of Water Quality



# FACT SHEET

Prepared by Toursim Tropical North Queensland

**TOURISM<sup>®</sup>**  
TROPICAL NORTH  
QUEENSLAND™

 **Reef &  
Rainforest**  
RESEARCH CENTRE

  
**Australian Government**  
Department of the Environment,  
Water, Heritage and the Arts

## THEME 3:

# HALTING & REVERSING THE DECLINE IN WATER QUALITY

## INTRODUCTION

In 2006 the Australian Government established the Marine and Tropical Sciences Research Facility (MTRSF) to develop “world-class public good research” projects that utilize the collaborative efforts of the best Australian tropical environmental researchers. A budget of \$40 million dollars over 4 years, was allocated to MTRSF.

All approved projects have to be directly relevant to the conservation and sustainable use of North Queensland's environmental assets, including the Wet Tropics rainforests, the Great Barrier Reef and the connecting coastal regions.

5 major issues, or Themes, of immediate and significant issues were identified

The MTRSF projects are divided into 5 Research Themes:

THEME	DESCRIPTION
<b>Theme 1 Status of the Ecosystems</b>	Understanding the condition, trend and interdependencies of environmental assets of the North Queensland region; developing methods to support ongoing regular assessment and reporting; and developing methods to identify priorities for action.  Program 1 – Great Barrier Reef Program 2 – Rainforests & Catchments Program 3 – Torres Strait Program 4 – Species of Conservation Concern
<b>Theme 2 Risks &amp; Threats to the Ecosystem</b>	Understanding the threats to, and their impacts on the environment and hence the North Queensland region, and developing options to mitigate them  Program 5i – Marine Program 5ii – Rainforests & Catchments Program 6 – Invasive Pests
<b>Theme 3 Halting &amp; Reversing the Decline of Water Quality</b>	Understanding the causes and effects of changing water quality and water resource use in North Queensland's coastal catchments; developing options for improving practices, reducing risks and mitigating adverse impacts; and developing ways to measure the effectiveness of regulation, management and other actions to halt and reverse declines. This goal supports the objectives of the Australian and Queensland Government's Reef Water Quality Protection Plan (Reef Plan).  Program 7 – Water Quality
<b>Theme 4 Sustainable Use &amp; Management of Natural Resources</b>	Understanding the current and potential industry and community uses of biodiversity and natural resources with respect to ecological, social and economic sustainability; and providing information and options to assist North Queensland managers, industries and communities to optimise the use of biodiversity resources and minimise adverse impacts of use where they occur.  Program 8 – Great Barrier Reef Program 9 – Rainforests & Catchments
<b>Theme 5 Enhancing Delivery</b>	Increasing the relevance and adoption of research in policy development, management applications and use practices; supporting effective data exchange and adoption of data standards; funding the delivery of relevant reports in the public interest; providing system wide overviews through the integration of biophysical studies of the environmental assets of North Queensland and the integration of social and economic research into these; and providing access to data and knowledge for organisations and the public.  Program 10 – Enhancing Delivery

Modified from the MTRSF website: [www.rrc.org.au/mtrsf](http://www.rrc.org.au/mtrsf)

As part of Theme 5 (Enhancing Delivery), TTNQ was contracted to facilitate the flow of information from MTSRF to the tourism industry in tropical Queensland (Project 5.10.2) through a series of easy-to-understand Fact Sheets, each one specific to one of the themes. These Fact Sheets set the framework for understanding why this research is important and what the potential impacts are to the environment, our communities and the local tourism industries.

Theme 3: Halting & Reversing the Decline of Water Quality, includes 3 main focus areas:

1. Marine & Estuaries
2. Catchments
3. Ecosystems and Social Frameworks.

## BRIEF OVERVIEW OF THEME 3

'**Water quality**' is a term used to describe the chemical, physical, and biological characteristics of water. Acceptable limits of water quality depend on the particular purpose (e.g. environmental health, drinking water).

**For tourism operators** in the Tropical North Queensland region, water quality is an important concern as it directly affects the health of the natural environment that the industry relies on for its business.

**Water quality is a complex issue** involving several variables and the interaction of many different natural environments. Elements affecting water quality include nutrients (particularly phosphates and nitrates), sediments (from erosion) and agricultural chemicals (pesticides & herbicides).

**Water runoff originates** from the mainland. In basic terms, excess rainwater that is not taken up by plants will carry nutrients from the land as it seeps into streams and rivers. These waterways eventually flow out to the ocean. During this journey, the water passes through a range of environments, including rainforest and mangrove habitats.

**Rainforests and mangroves** act like a series of 'natural filters' that help remove sediment and nutrients from run-off water before it reaches the sea. This process plays an absolutely crucial role in maintaining good water quality. If, however, the effectiveness of these 'filtering' ecosystems is reduced, by habitat loss or degradation, then more of the 'bad stuff' will get washed out to sea. In situations where increased nutrient and sediment loading has resulted from human activities, this filtering process becomes even more vital to the overall health of all the natural environments!

**So...managing water quality** is not a simple matter of just figuring out what and how much of something is being put into the system. It is a highly complex interaction between the amount of 'bad elements' going **into** the system, the amount of 'bad elements' that are being **filtered out** of the system, the **volume** of runoff water in the system and the **condition** of the environments to handle the 'bad elements' (resilience).



### Queensland Catchments

Queensland has 26 major river catchment areas, covering millions of hectares that drain directly into the Great Barrier Reef.



### Herbicides

Herbicide concentrations large enough to cause ecological impacts have been detected at sites more than 30km from the coast.

*Dr Stephen Lewis, JCU*




### Contributors to Water Quality

**Nutrients** are substances used by an organism, which must be taken in from the environment. The main ones, nitrogen (N), phosphorus (P) and potassium (K), are essential for animal and plant growth. Fertilizers containing N, P and K are applied to fields, crops and golf courses to promote the growth of plants and increase yield.

**Sediments** are mineral or organic particles that are transported by water and eventually deposited by the action of wind, water, or glacial ice. Sediments are a natural result of erosion. However, in areas of vast land clearing, erosion can be greatly increased.

**Agricultural chemicals** refer to pesticides and herbicides, commonly used in agricultural practices to control pests and encourage production.



Even if only one variable is changed, the balance can be thrown off, resulting in environmental harm and degradation.

**Fixing the water quality problem** is not just a simple act of getting farmers to stop using pesticides – it requires the need to care for all the environments that the water flows through on the way down to the ocean.

**This is exactly what has happened in Queensland.** Unfortunately, all variables have been altered – (1) levels of nutrients and chemicals have increased through urban development, (2) agricultural practices and aquaculture, clearing of coastal vegetation for development has reduced the area of environmental filtration, (3) heavy seasonal rainfalls have resulted in large flood plumes (massive quantities of freshwater flood waters that flow into the ocean) and (4) reefs are increasingly stressed as a result of warming water temperatures, recent bleaching events and Crown-of-thorn starfish outbreaks. As a result, more 'bad' elements are washing out to sea. Australian Institute of Marine Science researchers estimate that average yearly inputs of nitrogen from the land have nearly doubled over the past 150 years, while phosphorus inputs have tripled.

## MAIN IMPACTS

For the local tourism industry, main concerns with water quality focus on how the impacts on the natural environment of the streams, rivers, catchment areas, coastal communities (e.g. mangroves) and the reef. Poor water quality can have devastating impacts on local environments (see Table below).

### PREDICTIONS FOR CLIMATE CHANGE


Predictions of increased intensity of tropical cyclones (causing local physical destruction) and increased rainfall would result in increased flooding and larger flood plumes. This, in turn, would result in increased amounts of freshwater carrying more nutrients and sediment to reef areas further out from the coast.

All impacts to the natural environment caused by nutrient and sediment loading will worsen.

### IF NOTHING IS DONE...

If appropriate mitigation steps are not taken, the resulting outcomes for both land and marine based tourism industries could be severe.

Visitor reactions to habitat degradation and loss of key tourism destinations, including scenic lookouts, swimming holes, and coral reefs, could lead to **reduced local visitation, poor media coverage and loss of regional marketing power.**



# IMPACTS OF KEY ELEMENTS ON FRESHWATER AND REEF ENVIRONMENTS

ELEMENT	POTENTIAL IMPACTS IN FRESHWATER ENVIRONMENTS	POTENTIAL IMPACTS IN SEAGRASS & REEF ENVIRONMENTS
<p><b>Nutrients</b> phosphates &amp; nitrates</p> <p><b>Sources:</b></p> <ul style="list-style-type: none"> <li>- <i>Leaking septic systems</i></li> <li>- <i>Fertilisers on agricultural lands</i></li> <li>- <i>Sewage discharges from waste water treatment plants</i></li> <li>- <i>Urban stormwater runoff</i></li> <li>- <i>Some industrial plants (particularly paper production)</i></li> <li>- <i>Erosion &amp; sedimentation</i></li> <li>- <i>Detergents with phosphates</i></li> </ul>	<ul style="list-style-type: none"> <li>▪ Blue-green algae blooms               <ul style="list-style-type: none"> <li>↳ reduces water visibility</li> <li>↳ blocks sunlight from penetrating to underwater plants</li> <li>↳ oxygen depletion</li> </ul> </li> <li>▪ Increased stress levels in some aquatic species</li> <li>▪ Wildlife and stock animal poisoning               <ul style="list-style-type: none"> <li>↳ Impaired wildlife immune systems</li> </ul> </li> <li>▪ Drinking water contamination</li> <li>▪ Decline in aesthetic values               <ul style="list-style-type: none"> <li>↳ smelly</li> <li>↳ unsightly</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>▪ Phytoplankton blooms               <ul style="list-style-type: none"> <li>↳ reduces water visibility</li> <li>↳ blocks sunlight from penetrating to underwater plants</li> </ul> </li> <li>▪ Macroalgae (seaweed) blooms               <ul style="list-style-type: none"> <li>↳ overgrows coral colonies,</li> <li>↳ out-competes coral for space (reducing coral recruitment &amp; settlement)</li> <li>↳ shades-out coral colonies (hindering photosynthesis &amp; causing stress)</li> </ul> </li> <li>▪ Weakened coral colony structure               <ul style="list-style-type: none"> <li>↳ Decreases skeletal density</li> <li>↳ Increases susceptibility to storm damage</li> </ul> </li> <li>▪ Inhibited coral reproduction               <ul style="list-style-type: none"> <li>↳ Malformed coral embryos</li> <li>↳ Reduces embryo viability.</li> </ul> </li> <li>▪ Increases coral diseases</li> </ul>
<p><b>Pesticides &amp; Herbicides</b></p> <p><b>Sources:</b></p> <ul style="list-style-type: none"> <li>- <i>Sugar cane cultivation (Diuron &amp; Atrazine)</i></li> <li>- <i>Weed control on beef grazing lands (Tebuthium)</i></li> </ul>	<p><b>Freshwater Environments</b></p> <ul style="list-style-type: none"> <li>▪ Inhibited photosynthesis in aquatic plants               <ul style="list-style-type: none"> <li>↳ Suppressed production</li> <li>↳ Stress &amp; death</li> </ul> </li> <li>▪ Excessive plant growth,               <ul style="list-style-type: none"> <li>↳ premature death</li> <li>↳ Change in biodiversity &amp; relative abundances of aquatic animals</li> </ul> </li> <li>▪ Plant and animal mortalities</li> </ul>	<p><b>Seagrass &amp; Reef Environments</b></p> <ul style="list-style-type: none"> <li>▪ Inhibited photosynthesis               <ul style="list-style-type: none"> <li>↳ In seagrass</li> <li>↳ In zooxanthellae (the symbiotic algae in coral tissue)</li> </ul> </li> <li>▪ Zooxanthellae death</li> <li>▪ Inhibited coral reproduction               <ul style="list-style-type: none"> <li>↳ Malformed coral embryos</li> <li>↳ Reduced embryo viability.</li> </ul> </li> <li>▪ Inhibited successful settlement of coral larvae</li> <li>▪ Localised bleaching</li> <li>▪ Increased coral diseases</li> <li>▪ Increased crown-of-thorns starfish numbers</li> <li>▪ Plant and animal mortalities</li> </ul>
<p><b>Sediments</b></p> <p><b>Sources:</b></p> <ul style="list-style-type: none"> <li>- <i>Land-based erosion</i></li> </ul>	<p><b>Freshwater Environments</b></p> <ul style="list-style-type: none"> <li>▪ Increased turbidity               <ul style="list-style-type: none"> <li>↳ Reduces amount of light penetrating to underwater organisms</li> <li>↳ Reduces water visibility</li> </ul> </li> <li>▪ Sediment accumulation on substrate               <ul style="list-style-type: none"> <li>↳ Smothers existing sessile (bottom-dwelling) organisms</li> <li>↳ Increases organism death</li> <li>↳ Blocks waterways and reduces flow</li> </ul> </li> </ul>	<p><b>Seagrass &amp; Reef Environments</b></p> <ul style="list-style-type: none"> <li>▪ Increased turbidity               <ul style="list-style-type: none"> <li>↳ Reduces amount of light penetrating to underwater organisms</li> <li>↳ Reduces water visibility</li> </ul> </li> <li>▪ Increased sediment accumulation on substrate               <ul style="list-style-type: none"> <li>↳ Smothers existing sessile (bottom-dwelling) organisms</li> <li>↳ Increased marine organism death</li> <li>↳ Reduces area available for organism settlement &amp; recruitment (e.g. sponges, corals)</li> </ul> </li> </ul>

## RELEVANT MTSRF RESEARCH

The Marine and Tropical Sciences Research Facility (MTSRF) is part of an Australian Government initiative to “develop collaborative, public benefit research between Australia's best tropical environmental researchers to support the conservation and sustainable use of North Queensland's environmental assets - the Wet Tropics rainforests, the Great Barrier Reef and the connecting coastal regions”.

The Reef and Rainforest Research Centre (RTRC) is contracted to administer the MTSRF Research Programme in North Queensland.

There are 5 main themes of study:

- Theme 1 Status of ecosystems
- Theme 2 Risks and Threats to the Ecosystems
- Theme 3 Halting & Reversing decline in water quality
- Theme 4 Sustainable use and management of natural resources
- Theme 5 Enhancing Delivery

Water quality studies lie mainly within Theme 3, and include the following seven main projects:

Project Number	Project Name	Main Objectives	Research Providers
Project 3.7.1	<a href="#">Marine and estuarine indicators and thresholds of concern</a>	To identify indicators that are suitable as monitoring tools and to determine threshold levels for key pollutants	AIMS GU DPI&F JCU
Project 3.7.2	<a href="#">Connectivity and risk: tracing sediments from the upper catchment to the reef</a>	To track and link fine sediment and dissolved materials back to their terrestrial sources throughout the catchment area, and look at historical changes to use and distribution.	JCU UNSW@ADFA AIMS CSIRO ANU
Project 3.7.3	<a href="#">Freshwater indicators and thresholds of concern</a>	To develop physical, chemical and ecological indicators of environmental health and determine thresholds.	GU CSIRO JCU
Project 3.7.4	<a href="#">Wetlands and floodplains: connectivity and hydro-ecological function</a>	To develop the capability to predict impacts and changes in land use, management and climate in and water quality	CSIRO GU JCU
Project 3.7.5	<a href="#">Socio-economic constraints to and incentives for the adoption of land use and management options for water quality</a>	to evaluate socio-economic constraints to adopting land use and management options aimed to improve water quality in a region	CSIRO
Project 3.7.6	<a href="#">Delivery of social and economic indicators of water quality</a>	To map land use across all areas (agricultural, urban and industrial sectors) to identify concerns for water quality impacts and to identify priority areas for effective remediation.	GU CSIRO FNQ NRM Ltd JCU UQ
Project 3.7.7	<a href="#">Conceptual and statistical framework for the water quality component of the Integrated Report Card</a>	To develop appropriate statistical methods to estimate annual pollutant loads based on data collected with monitoring methods.	CSIRO

Acronyms: AIMS (Australian Institute of Marine Science), ANU (Australian National University), CSIRO (Commonwealth Scientific & Industrial Research Organisation), DPI&F (Department of Primary Industries & Fisheries), GU (Griffith University), JCU (James Cook University), UNSW @ ADFA (University of New South Wales Australian Defence Force Academy), UQ (University of Queensland)