# Community perceptions of water quality and current institutional arrangements in the Great Barrier Reef region of Australia

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## Abstract

A mail survey on wellbeing in two catchments of the Great Barrier Reef region found that water quality was perceived by local residents as one of the top five contributors to their wellbeing. A more detailed analysis of local residents' perceptions reveals "water quality" as a complex, multifaceted concept, captured in a composite web of institutional arrangements for water management in Australia.

This paper traces the perceived linkages between sources of water quality deterioration, impacts on human wellbeing, and the institutions responsible for dealing with the sources and impacts. DPSIR (Driving forces-Pressure-State-Impact-Response) framework is used as a guide for data collection and to structure responses and the emerging themes. The web of linkages, as perceived by residents, is then compared with current institutional arrangements across different relevant sectors.

The importance of understanding community concerns regarding water quality, to inform cross-sectoral integration of institutional arrangements for improved water management, is discussed. The implications of the differences between perceived and "actual" linkages between water quality deterioration, impacts, and institutional responsibilities and responses, and the role of improved communication of these in enhancing institutional arrangements and sectoral integration for water management, are also discussed.

**Keywords:**
DPSIR: Great Barrier Reef; institutional analysis; integrated catchment management; perceptions of water;

## 1. Introduction

Over the past two decades, the importance of multi-stakeholder governance processes and structures in the water sector (water policy, planning, and management) for solving water problems has been increasingly highlighted in both the academic scholarship and applied arenas. One of the more notable examples is the European Union's Water Framework Directive which requires member states to increase public participation in decision making at both policy and planning levels (Directive 2000/60/EC). Participation in water planning activities in Australia also has considerable history, steaming from the Water Reform Agreement between States and Commonwealth signed in 1994. The key initiatives stemming from this agreement are the improvement of water quality and refinement of water rights and water allocation procedures, as well as the promotion of community participation (Larson, 2006). However, evaluations of recent water planning processes in Australia conclude that the rules and regulations are still viewed by local stakeholders as being "imposed from above", with varying and often insufficient consultation with the people they will affect (Larson,

2006; McKay, 2005). The Water Reform Agreement, and resulting National Water Initiative, promote two key principles for water planning: microeconomic reform, in particular the use of markets and trading; and community planning. Stoeckl et al (2006: 91) suggests that this combination of privatisation of water and community input in water use through planning mechanisms is likely to lead to conflict. This includes disagreements over aspects of water use to be determined by the market versus communities; and the resolution of differences between market and community views with respect to water use outcomes.

In the last 15-20 years, Australia has also seen a growth in the numbers of planning requirements related to the natural resources, including water, which have resulted in the fragmentation of policy and legislation within and across jurisdictions (Stoeckl et al, 2006). For example, coastal catchments in the state of Queensland are regulated by a dozen statutory plans, based on various acts, as well as an equal number of relevant non-statutory plans (EPA, 2006). A review of Commonwealth, States and Territories legislative requirements for tropical rivers in northern parts of Australia found that there are over 20 policies and programs impacting on water use and 26 pieces of legislation relating to the use of tropical rivers (Hegarty et al, 2005). Some researches are concerned that increased planning requirements are not necessarily resulting in increased concern for ecological values, nor in improved participation of communities affected (Marsden 2002). In addition, Gentle and Olszak (2007:62) highlight that the delivery of water plans is often delayed as a result of a "lack of practical and realistic operational policies in relation to economic, social, and cultural issues", "inexperience of technical planners in dealing with complex economic and social issues and processes", and "inexperience of stakeholders and community groups in dealing with conflicts with government and water planners over science, economic and social impacts, values, information and institutions."

This paper aims to investigate perceptions of community residents of a shire located in Queensland regarding water quality and institutional arrangements. Taking a case study and exploratory research approach, this paper traces the perceived linkages between sources of water quality deterioration, impacts on human wellbeing, and the institutions seen as responsible for dealing with the sources and impacts. This is accomplished through the use of the "Driving forces-Pressure-State-Impact-Response" (DPSIR) approach, a common framework for evaluating the relationships between human activities and environmental changes. This web of linkages, as perceived by residents, is then compared with current institutional arrangements. In doing so, we gain insight into the level of convergence and gaps in perceptions versus actual institutional responsibilities and responses.

The research was carried out in the Whitsunday Shire, in Queensland, Australia. Located 1,100 km north of Brisbane, the Whitsunday Shire is a coastal shire in the tropical region of Australia, with a population of some 17,500 residents (OESR, 2005). The main economic activity in the Shire is tourism, due to the natural beauty of the landscapes and the proximity of the Great Barrier Reef. The main land use in the Shire is agriculture, in particular cattle grazing and sugar cane plantations (OESR, 2005). In a previous research project lead by one of the co-authors (Larson 2007a; 2007b; forthcoming), a mail survey on wellbeing in two catchments of the Great Barrier Reef region, one including the Whitsunday Shire, found that water quality was perceived by local residents as one of the top five contributors to their wellbeing.

The paper is organised as follows. We begin with an introduction to the case study, in section 2 below. In Section 3, we outline the conceptual framework (DPSIR); we provide an overview of its origins and use to date, define the key components of the framework, and discuss our use of the framework for the case study. Section 4 discusses the methodologies. The analysis of the case study is presented in Section 5 and 6. In the former, we present the results of our interviews. This is followed by the results of the review of institutional

arrangements. In that section, we provide an overview of some of the institutional arrangements in place for water quality management. We identify the organisations responsible and their key roles and responsibilities at the time of writing. We conclude with a discussion of the implications of the misconceptions between current institutional arrangements and the local residents' perceptions.

## 2. Case study: The Whitsunday Shire

The Whitsunday Shire (Figure 1) is adjacent to the Great Barrier Reef (GBR) World Heritage Area, a region of natural and cultural significance for both Australia and internationally. The Shire's Whitsunday Islands group, comprised of 74 tropical islands, draw more then 700,000 tourists to the region annually (WDC, 2008). In addition to the GBR Word Heritage Area, the region hosts four national parks and series of state forests; wetlands of national significance; protected habitats of endangered and endemic species; as well as 75 recorded Aboriginal archaeological sites (EPA, 2006).

The topography of case study area is characterised by combination of low mountains and hills that slope into fertile floodplains and coastal beaches. The landscape is dominated by dry tropical forest at higher elevation, cleared cultivated land and remnant patches of forest on the alluvial plains, and wetlands and estuaries near the sandy coast. The climate in the Whitsunday Shire is tropical, characterised by an intensive wet season from December to March, and a dry season from April to November. The average annual rainfall is 1,300 mm, with an average daily maximum and minimum temperature of 28.8°C and 17.6°C (OESR, 2005).


Figure 1. Whitsunday Shire and the catchment areas (relevant rivers and creeks) overlay

The total estimated resident population of the Whitsunday Shire was 17,500 persons in 2005, with an average density of 6.5 people per $km^2$ over the Shire area of some 2,700 $km^2$. The major townships of the shire include Airlie Beach (with estimated population of 2,370 residents in 2003), Cannonvale (3,430) and Proserpine (3,350). The total population of the Shire is expected to increase to some 27,300 residents by 2025, mainly due to the interstate immigration (OESR, 2005). Based on the Australian Bureau of Statistics' Socio-economic Indices for Areas, socio-economic conditions in the Whitsunday Shire are above the

Australian average. Some 65% of Shire population fall within the two highest (most advantaged) population quintiles (Hug and Larson, 2006).

At the 2001 Census, tourism related services including accommodation, cafes and restaurants were the largest employer in the Whitsunday Shire, employing 19.5% of the region's labour force (OESR, 2005). Although 70-80% of land in the catchments of the Whitsunday Shire is under grazing, and 8-21% of land is under sugar cane, the agricultural sectors combined employed only 6.5% of Shire's workforce (OESR, 2005). The annual gross value of agricultural production in the Whitsunday Shire was $52.6 million, compared to $104.5 million from tourism (OESR, 2005).

A survey investigating perceptions of wellbeing of the Shire residents, conducted in 2006, found that 88% of respondents selected water quality as contributing to their wellbeing, with 51% of them selecting water quality as one of the key factors contributing to their wellbeing. Overall, water quality ranked fifth in importance, following family relations, health, income and safety. Water quality also received lowest satisfaction scores out of five most important factors, with a score of 5.8 on a 10 scale (Larson, 2007c).

These perceptions are reflective of the fact that the quality of water flowing into the GBR lagoon has progressively deteriorated as catchment landscapes have been transformed. Over the last 150 years, the catchments adjacent to the Reef have undergone extensive modification and now support flourishing agricultural, mining, timber and tourism industries (Larson 2007b). Diffuse pollution from broad-scale agricultural land use and in particular by pesticide and nutrient applications have had a significant impact on water quality.

**3. Conceptual framework: DPSIR Framework**

This research applied the "Driving forces-Pressure-State-Impact-Response" (DPSIR) approach, a framework commonly used for evaluating relationships between human activity and environment degradation. DPSIR has been used as an analytical framework in a wide range of human-ecological systems, from watershed management (Fassio et al, 2005; Karageorgis et al, 2005); coastal management (Bowen and Riley, 2003); and fisheries management (Mangi et al, 2007); to water pollution (Pirrone et al, 2005); and environmental degradation assessment(Agyemang et al, 2007). The framework is most commonly used for the development of indicators (Bowen and Railey, 2003; EEA, 1999), however, it has also been used for organising the information contained in management plans (Giupponi et al, 2004) and for stakeholder communication (Karageorgis et al, 2005).

The DPSIR framework was deemed appropriate for the framing of the analysis presented in this paper for two reasons. Firstly, it previously has been used and worked well in the context of water quality (Fassio et al, 2005; Karageorgis et al, 2005; Nixon et al, 2003). Secondly, it has been used in furthering the understandings of the causes created by human activities, and their effects on both biophysical and socioeconomic environments. Furthermore, as Bowen and Raily (2003) argue, the DPSIR allows researchers to understand the nature and scale of social-biophysical interaction dynamics.

The DPSIR framework is based on a concept of causality: human activities exert pressures on the environment and change its quality and the quantity of natural resources. These changes in the condition of the environment incite the society to develop responses to the new conditions (EEA 1999; Pirrone et al, 2005). The DPSIR framework originates from the STRESS framework developed by Statistics Canada in late 70-ties that was modified into the OECD Pressure State Response (PSR) model in late 80-ties and early 90-ties (Gabrielsen and Bosch, 2003). The framework in its current DPSIR form came into use in early 90-ties, and was popularised through its use by the European Environmental Agency (EEA, 1999).

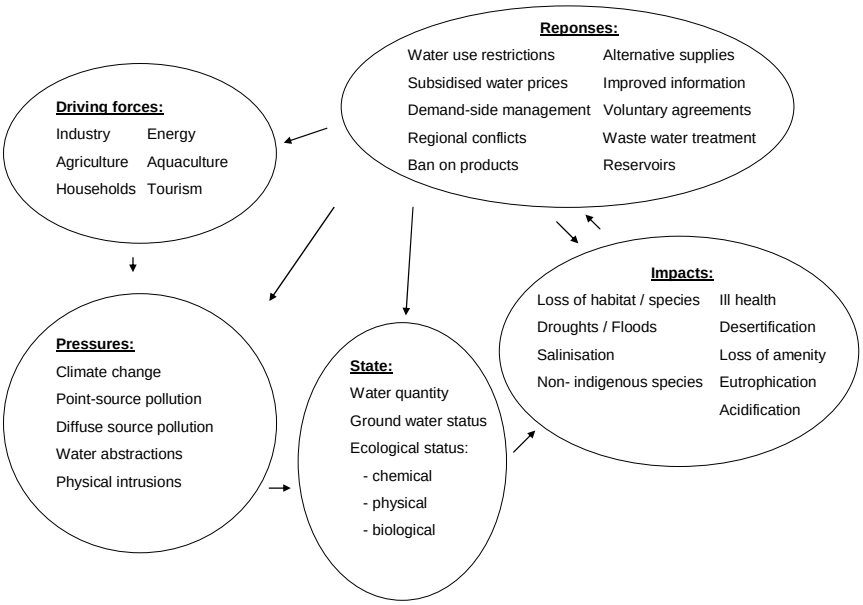


Figure 2. European Environmental Agency (EEA) generic framework for water

A generic DPSIR framework developed by EEA for water resources is presented in Figure 2 (based on Nixon, 2003 and Larson and Smajgl, 2006). Gabrielsen and Bosch (2003) describe the DPSIR from the systems-analysis point of view: Social and economic *driving forces* exert *pressure* on the environment and, as a consequence, the *state* of the environment changes. This leads to *impacts* on e.g. human health, ecosystems and materials that may elicit a societal *response*. The *response* feeds back on the *driving forces, pressures, state* and/or *impacts*, through adaptation or curative action. The model thus describes a dynamic situation, providing for various feedbacks in the system.

Potential describers of *driving forces* include for example economic sectors; structural features of the economic system; demography and social characteristics; patterns of resources use; and cultural and religious factors (Maxim and Spangenberg, 2006). The *pressures* are described by Maxim and Spangenberg (2006) as anthropogenic factors inducing "unwanted" environmental change. Pressure can be exerted through emissions (pollution) and/or use of resources, including land use. The EEA defines the *state* as the quantity and quality of certain phenomena in a certain area (Gabrielsen and Bosch, 2003), and it can represent either the state of a natural system or a social system (Bowen and Riley, 2003). The 'state of the environment' is therefore a combination of the physical, chemical and biological, as well as socioeconomic conditions. The changes in the state of the environment might have impacts on the functions that these environments provide. *Impacts* may manifest themselves as changes, such as changes in resources quality and availability or human health. Impact might also manifest themselves as losses, for example of manufactured capital or biodiversity (Gabrielsen and Bosch, 2003; Maxim and Spangenberg, 2006). *Responses* refer to responses by groups and individuals in society, including government, attempting to prevent, compensate, ameliorate or adapt to changes in the state of the environment (Gabrielsen and Bosch, 2003). *Responses* typically include legislation, market-based instruments, awareness campaigns, voluntary actions etc.

## 4. Methodology

This study was exploratory with the principal goal of highlighting, through a case study approach, some of the mismatches between local residents' perceptions of a range of water quality issues and key water management institutions' framing and understanding of the same issues and their responsibilities and actions. Thus two major target groups for analysis were identified and selected: (a) community residents; and (b) commonwealth, state and local water management institutions. Consequently, the study relied on two sources of data: interviews with local residents and secondary data on water management institutions. These are discussed in sequence.

One-on-one, semi-structured interviews were carried out in February 2008 with 11 Whitsundays residents, 7 women and 4 men, ranging from early twenties to mid-fifties, who had lived locally from 6 months to over 35 years. Previous work conducted in the region, with 194 respondents, indicated that importance assigned to water quality did not appear to be a function of socio-demographic or other personal characteristics (Larson, 2007c). Interviewees were therefore selected on the basis of their place of residence within the Shire, and an attempt was made to have respondents with varied age, gender, sector of employment and length of residence within the Shire, aiming to gain insight into the diversity of community perceptions of issues related to water quality in the region.

The interview schedule was designed using the DPSIR framework as a guide for the themes and sequence of questions. Collectively, the interview schedule aimed to address the following three broad questions:

1. What are the perceptions of the local residents about the (i) **D**riving forces; (ii) **P**ressures; and (iii) **S**tate of the water in their region?
2. For each change (past or anticipated change) in the **S**tate of the water mentioned, what are the perceived **I**mpacts (physical, biological or social)?
3. What are the perceived linkages between the specific **I**mpact and the societal (individuals, community, local government, state and national agencies) **R**esponses?

The DPSIR framework was also used to guide the collection of data on and analysis of existing institutional arrangements governing the water (quality) sector in the Whitsundays Shire. We selected the key formal organisations at different scales (commonwealth, state, regional, and local) that had, at the time of the study, a role in either developing or implementing water quality policies, laws, and plans affecting the Shire. We collated and reviewed published documents that described and analysed these organisations and associated institutions (policies, laws, plans).

## 5. Results: From the perspective of Whitsundays residents

All 11 residents interviewed described the *state* of the water in the Whitsunday Shire as not being very good (see Figure 3). Seven interviewees focused on one water quality issue, while four mentioned two or more issues. By far, the quality of drinking water was discussed most frequently, with nine interviewees bringing it up. Drinking water was described as "terrible" in terms of its taste and the fact that it is brown and stains; "it's safe to drink but has a funny taste and smells"; and "the worst I ever had…it is funny tasting…very chemically tasting…and is brownish and stains". No-one perceived a health risk. A couple of people who lived in a remote section of the shire viewed the main issue with drinking water as being the lack of piped water. They depend on rain water tanks and the purchasing of truckloads of water. People whose main source of drinking water came from filtered rain tanks did not perceive any problems with that water. Aside from drinking water, people discussed the state of other bodies of water: water in the Dam (Peter Faust dam and reservoir were constructed in

1990-ies for irrigation, flood mitigation and town water supply purposes, however, it is also a major recreational and in particular fishing spot in the region); water in the Lagoon (a large, free access, open-air, man-made swimming complex built and operated by the Council), in the creeks and rivers, and in the marine environment. "Muddy" and accompanying low visibility were used to describe the state of the water in the Lagoon, creeks, rivers, marine, and the Dam. Some of the creeks also suffered periodic episodes of low oxygen concentrations. In the marine waters, the high sedimentation events also resulted in a nutrient rich environment for fish. An additional issue encountered in these waters was the presence of rubbish.

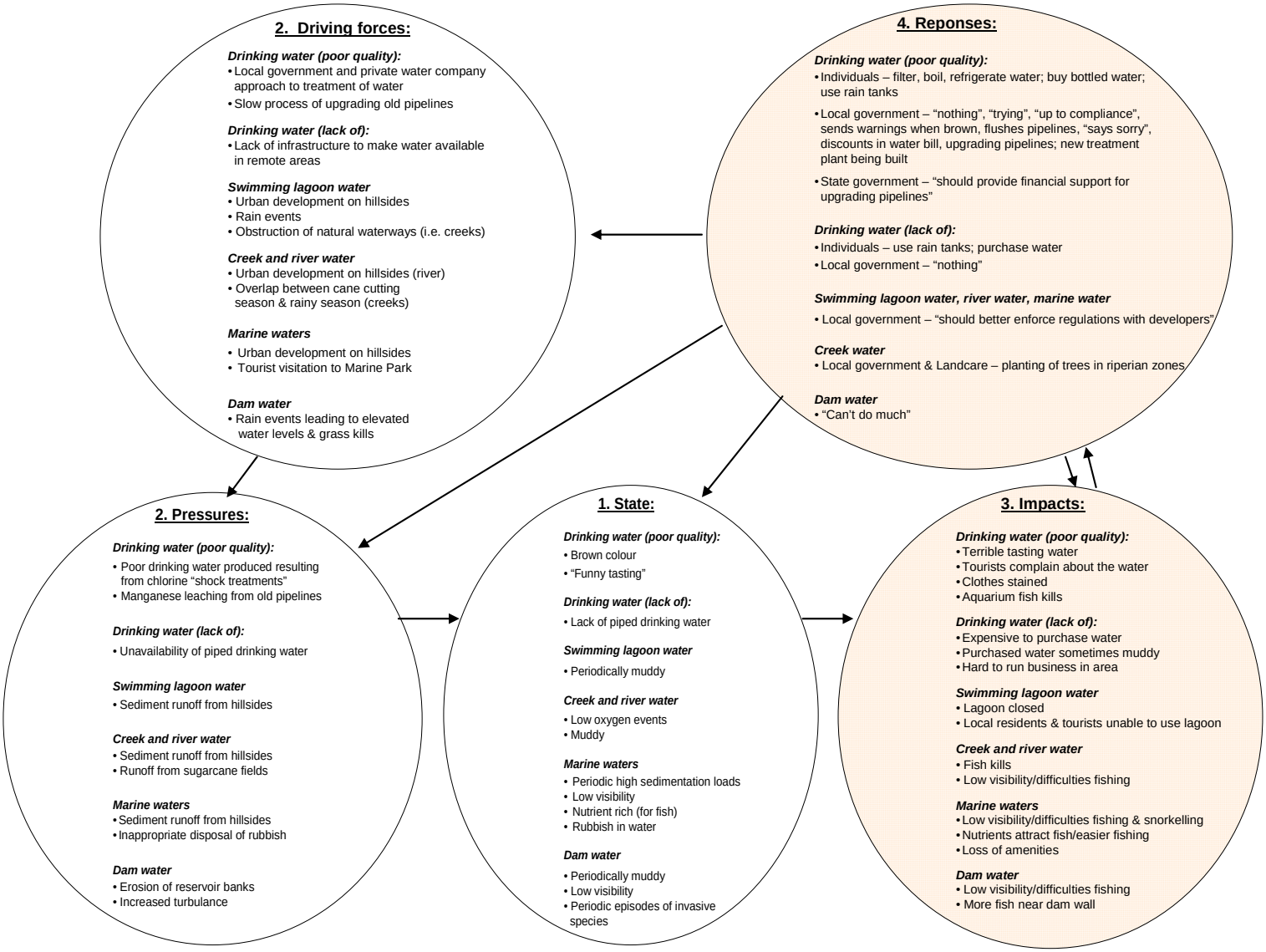


Figure 3. DPSIR model for water developed based on resident perceptions

The *driving forces* and *pressures* behind the poor drinking water quality were attributed to the drinking water infrastructure (treatment plant and pipelines) and the entities responsible for running and maintaining this infrastructure (see Figure 3). The brown colour and bad taste of the water was perceived as being the result of the quality of water produced in the water treatment plant and subsequently transported through old pipelines. The "shock

treatment" of water with chlorine, particularly after rain events, was seen as one of the major driving forces behind the bad tasting water produced. The brown colour of the water was attributed to manganese leaching in the old pipelines which were viewed as "inadequate" and the responsibility of the council to upgrade and maintain. The unavailability of piped drinking water to the remote regions was seen as the result of deficiencies in infrastructure, particularly the council's perceived failure or lack of capacity to install water pipelines. The driving force behind the swimming lagoon's muddy waters was attributed to the extensive urban development on nearby hillsides, combined with the obstruction of natural waterways such as creeks. In combination, these were seen as leading to significant sediment runoff during rain events, some of which drained into the lagoon. Urban development was also perceived as one of the major driving forces, and the resulting pressure of sediment runoff was seen as also responsible for the muddy state of the water in creeks, rivers, and coastal waters. In addition, the overlap between the sugarcane cutting season and the rainy season was seen as causing water runoff from the sugarcane fields into the creeks, resulting in poor oxygen conditions. In the marine waters, tourists visiting the Great Barrier Reef Marine Park were perceived as the major driving force behind the inappropriate disposal of rubbish into the sea. At the Dam, major rain events during the wet season were mentioned as contributing to elevated water levels and the killing of grass on the reservoir banks. This resulted in erosion of the banks and increased turbidity in the dam waters.

The *impacts* from the various states of water mentioned by the residents of the shire were numerous (Figure 3). In the case of the poor quality of drinking water, the impacts were: terrible tasting water, complaints by tourists, staining of washed clothes, and the killing of fish in aquariums that used tap water. The lack of piped water meant an additional expense for residents who had to purchase their drinking water. Often times, the water purchased and transported by trucks was itself a bit muddy. Others mentioned that due to these expenses, it made it difficult to run a business in the area. In the case of the swimming lagoon, muddy conditions resulted in the closing of the facility which meant that both residents and tourists could not go swimming. Runoff of sediments and accompanying muddy conditions in creeks, rivers, marine waters, and in the Dam resulted in two paradoxical impacts. On the one hand, low visibility made it difficult for fishers to see and catch fish; on the other hand, high nutrient levels that came with sediments attracted fish to the area (e.g. more fish appearing near the dam wall) and increased the number of fish available for fishing. Periodic episodes of invasive species were also observed in the reservoir. In marine waters, low visibility also negatively impacted on snorkelers and snorkelling companies. In addition, the rubbish found in the sea was seen as eroding the Marine Park's recreational amenity. In creeks, episodes of low oxygen were stated to result in extensive fish kills which also negatively impacted on recreational fishers.

These impacts were met with different *responses,* both at individual as well as a communal level (Figure 3). In the case of the impacts resulting from poor drinking water quality, individuals either filtered, boiled, or refrigerated (purported to reduce the bad taste) the water coming from the tap. Some bought bottled water, while others used rain tanks as their main source of drinking water. The majority of people we talked with viewed the local government (Shire Council) as responsible for the quality of water produced; only one person saw the responsibility fall with the private company running the water treatment plant. The local government's (Shire Council's) response to these impacts were perceived as ranging from "do nothing" to "trying" and "up to compliance". People mentioned that the Council sent warnings to residents in the events of significant manganese leaching. The council also included discounts in water bills. In some areas of the shire, the old pipelines were also being upgraded and a new treatment plant was being built. One resident felt that the State

government should play a more significant role by providing financial support to the Council to upgrade the infrastructure. Responses to the impacts from a lack of piped water included individuals purchasing rain tanks and/or truckloads of water. The Council was seen as doing "nothing". In the case of impacts from the state of water in the swimming lagoon, rivers, and marine environment, people felt that the Council was not adequately enforcing environmental regulations with developers. In response to fish kills in the creeks, people mentioned that the Council and the local Landcare group (volunteer-based environmental protection group) were planting trees in riparian zones in effort to reduce soil erosion and excessive water runoff during the rainy season. In the case of the impacts at the Dam, that is low visibility and increase in invasive species, people felt that the council and the company operating the Dam "couldn't do much". In summary, the responses were largely viewed as the responsibility of the local government, the Shire Council.

## 6. Results: Institutional arrangements for dealing with water quality impacts in the Whitsunday Shire, Queensland

Australia has a highly complex and multi-scale set of institutional frameworks and arrangements governing water planning, management, and monitoring (see ACIL Tasman 2005, Gentle and Olszak 2007). In the Whitsunday Shire, many of the policies, regulations, and statutory authorities that influence water quality issues locally are defined and are localised outside the shire, at the national and state levels (in general terms, the State of Queensland is responsible for all surface and marine water to 3 nautical miles from the shore, while Commonwealth is responsible for national marine waters between 3 and 200 miles and areas of national interest). Some of the most important institutional arrangements are highlighted below.

*Commonwealth and State level*

At the Commonwealth level, the National Water Quality Management Strategy (NWQMS) is the policy framework that oversees water quality regulations and planning. It is intended to complement the National Water Initiative, which largely regulates water quantity issues (Stoeckl et al, 2006). The NWQMS was jointly developed in 1992 by the Australian Government in cooperation with state and territory governments, with the main objective to "achieve sustainable use of the nation's water resources by protecting and enhancing their quality while maintaining economic and social development" (DEWHA 2008). As a part of NWQMS, several sets of water quality guidelines were prepared, on both national and state levels, covering the issues of primary recreation, human drinking water, agriculture, stock watering etc.

The Queensland Water Quality Guidelines were issues by the Environmental Protection Agency (EPA) in 2006 "primarily for the protection of Queensland aquatic ecosystems. The guidelines include locally and regionally relevant water quality data for fresh, estuarine and marine waters." (EPA, 2006, p2). In accordance with the *Environmental Protection Act 1994*, EPA is also responsible for the development approvals including point source discharges.

In 2003, the Australian Federal government and Queensland State government adopted the Reef Water Quality Protection Plan. The Plan builds on other water policies, including the NWQMS, and deals specifically with the diffuse sources of pollution and provides strategies for actions to minimise the entry of those pollutants to the reef. The Plan embraces a cooperative approach that seeks to involve government, scientific, local and other

stakeholders at all levels (Larson 2007b). The objectives of the Plan are to be achieved through improvement in sustainability of land use practices: '*The focus of actions [in the Plan] is relatively low cost measures to encourage good planning and to assist landholders in adopting best management practices that are both profitable and environmentally sustainable*' (Australian Government and Queensland Government 2003, p. 2).

The Great Barrier Reef Marine Protection Agency (GBRMPA) is a national-level agency in charge of the management and the protection of the Great Barrier Reef marine areas. Several legislative and support measures were introduced to slow and halt the deterioration of the quality of waters entering the Great Barrier Reef. However, the current legislative and support measures deal largely with diffuse source pollution from agriculture (see for example Australian Government and Queensland Government 2003), while impacts of urban changes and mining and associated activities are either not addressed or are not covered in much detail.

*Regional and catchment level*

Inter-linkages between management of land, water and other natural resources are captured in the establishment of catchment scale management authorities, plans and strategies. The institutional arrangements for catchment management vary across states and territories. In Queensland, natural resource management (NRM) bodies are non-statutory organisations responsible for developing and implementing regional NRM strategies and plans in each of the 14 natural resource management regions. These catchment or multi-catchment level institutions do not focus specifically on the water sector, but on natural resources in general (ACIL Tasman 2005).

One of the activities of the regional natural resources management bodies is development of the regional Water Quality Improvement Plans. The Mackay Whitsunday Water Quality Improvement Plan is currently in a draft stage. The basis of the plan, being developed with the aim to improve long-term water quality in the region, are "Report Cards". Report cards provide an overview of the current conditions of the catchments within the management area in terms of ambient and event freshwater quality. Plans also define targets for water quality for year 2050 and the required adoption rates of best land management practices that would need to be achieved in order to meet the water quality targets. The objectives of the plans are not clear as the best land management practices adoptions are entirely voluntary.

*Local level*

The urban water management of potable water supply, wastewater and stormwater has been compartmentalised as a result of the current structures of water authorities, government departments, local authorities and private industry (ACIL Tasman 2005). Planning for water infrastructure involves relevant state government departments, local government, and major water suppliers in the region, who are responsible for constructing, managing and operating water-related infrastructure (ACIL Tasman 2005). However, in most of the rural regions of Australia, local councils maintain their roles as primary water services providers.

Under the Queensland Health regulations, councils are "*expected to supply their communities with a clean, safe supply of water that meets the Australian Drinking Water Guidelines*" (Queensland Health, 2008). As water service providers, councils also need to comply with the *Water Act 2000*, and this particular legislation is administered by the Department of Natural Resources and Water.

Sewerage and stormwater disposal is also handled by the Council. The Whitsunday Shire Council acknowledges that sewerage effluent as currently released is not expected to

comply with upcoming Environmental Protection Agency (EPA) and Great Barrier Reef Marine Protection Agency (GBRMPA) requirements for 2008 (WDC, 2008).

A special issue facing the council in this case study is a problem of discoloured water. Council acknowledges that discoloured water has been an ongoing concern with residents for a number of years (WDC, 2008). According to the shire web site, the Whitsunday Shire did not have a manganese problem before the Dam was built. The source of manganese appears to be the geology beneath the dam's reservoir, where the water at depth is dissolving manganese from the rocks. In order to address the issue, council is constructing the new Water Treatment facility to remove excessive iron and manganese that is present in the council water supply to an acceptable standard.

## 7. Conclusions and practical implications

Current legislative environment related to the water in Australia appears rather complex and interrelated. This paper addresses only some of the institutional arrangements present that shed light on the issues identified as of concern to the local residents interviewed.

In larger urban centres, water authorities at various stages of privatisation are typically responsible for delivering drinking water and wastewater services. However, some or all of water-related services might remain responsibility of the shire councils in the rural areas. State-level EPA and Health departments have responsibility for regulating water quality, in terms of environmental and human health standards, respectively. However, the providers of the water services are registered with neither of them but rather with the Department of Natural Resources and Water. This State-level department also has overall legislative responsibility for water in Queensland. Apart from the State EPA, quality of environmental waters is also managed by regional non-statutory natural resources management bodies at the catchment side, and by the national-level Great Barrier Reef Marine Protection Agency at the marine side. Both State and local agencies have responsibilities for urban planning and approvals.

In the eyes of the local residents, however, the responsibility for all aspects of the water, identified as important by them, appears to sit with the local council. This mismatch of perceptions and realties is presented in Figure 4, as a summary of the perceived and institutional responsibilities for the water management in our case study region. This paper presents results of an exploratory research only, and therefore Figure 4 by no means captures entire set of perceived nor real players in water management (hence, room is left for "other" players in the system). Rather, Figure 4 is meant as a conceptualisation for the future research and analysis.

The findings of this study potentiate a need for better communication between the policy makers and the communities. In particular, in this case, the local council is held responsible for several discontents for which it does not appear to have any real responsibility, or the ability to take actions. Therefore, local council in particular could benefit greatly from improving its communication with the residents. Improved communication could clarify the extent of Council's responsibilities versus the responsibilities of the State and national governments. As a result, local council - supported by its residents – could potentially have greater influence in lobbing the State and national governments for improved funding and other actions that would benefit both ecological and human water uses in the region. Good example of an area that might benefit from communication is the issue of manganese in the water. The relationship between the council and residents could benefit from further clarifications that manganese is present in the water as a result of the geological process under the Dam, rather than aged or mismanaged pipeline infrastructure.

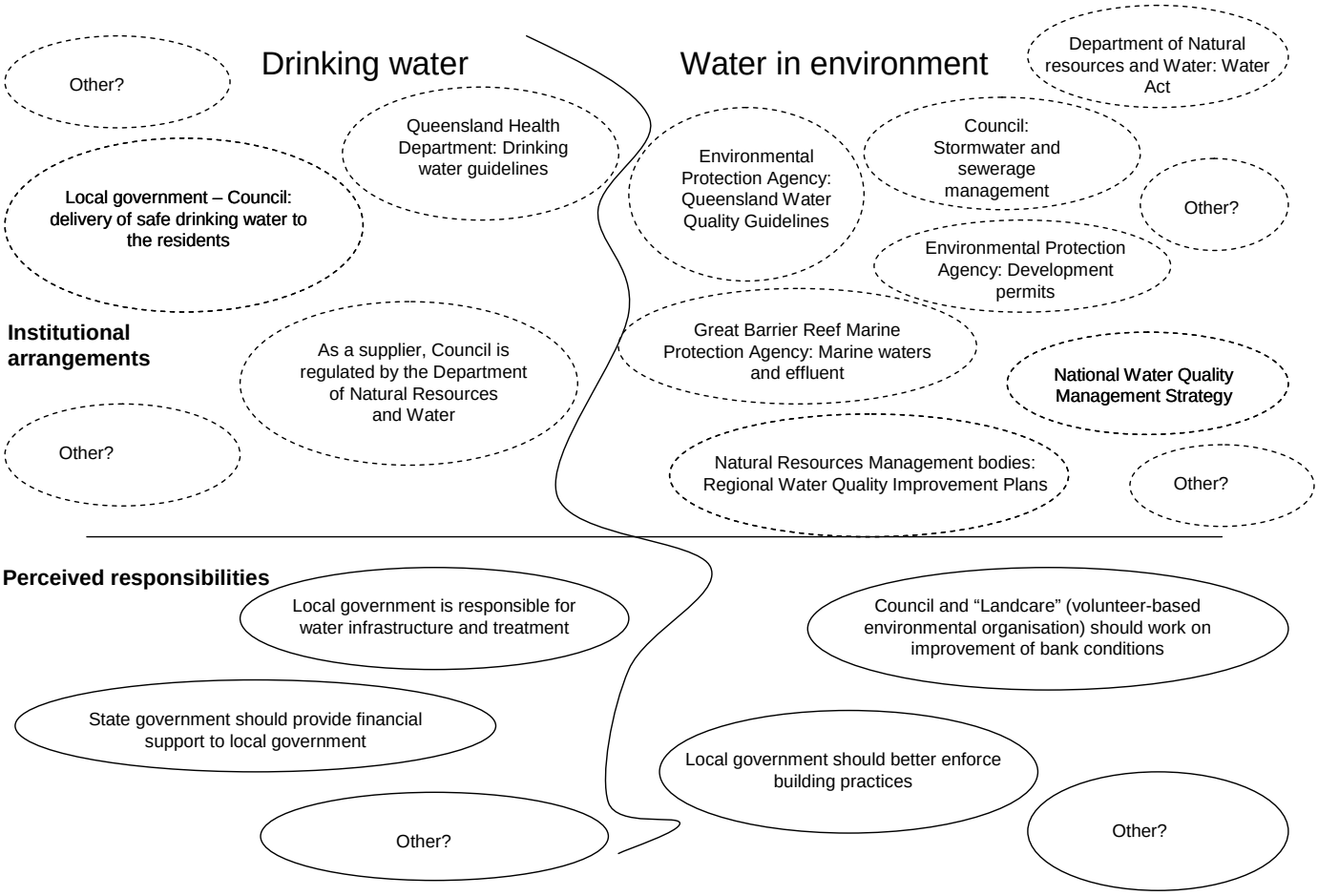


Figure 4. Who should be responding to water-related problems? Perceived and institutional responsibilities for the water management

The complexity of the institutional arrangements for management of both drinking and environmental waters appears to be well beyond what is perceived in the community. This might have significant consequences for the management of the environmental quality in the future: agencies and bodies at national, state and regional level have formulated various management Plans, some of which depend on voluntary uptake by the landholders and other members of the community. Community awareness of the existence of these arrangements would, however, need to be improved if any of those Plans are to have significant uptake in the future.

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