ECONOMIC AND SOCIAL IMPACT ASSESSMENT OF WATER QUALITY IMPROVEMENT

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ABSTRACT: Water quality in Queensland's rivers, coasts and estuaries varies considerably, ranging from some in pristine condition to others in very poor condition. Despite a range of government programs and initiatives, levels in many areas have continued to decline. Declining water quality levels impact on communities and stakeholders in a number of ways including direct impacts, impacts on human support systems, and impacts on biodiversity and other ecological systems. This paper demonstrates how setting of more stringent water quality objectives can enhance and protect environmental assets of water resources. There are very large and damaging economic and social impacts associated with further declines in water quality in some specific Queensland water systems. Therefore, the case for averting these impacts by at least maintaining current water quality levels is very strong, justifying a range of current government initiatives to minimise further damages. There is also a strong case for undertaking improved water quality objectives above the current standards through best practice management intervention strategies.

1. INTRODUCTION

A key issue in addressing water quality objectives is the assessment of both positive and negative impacts on regional communities. In recent years, water quality issues have become a major environmental concern in Australia including Queensland. In particular, concern has been expressed over the progressive decline in water quality in the catchments and waterways entering the Great Barrier Reef (Haynes *et al.*, 2001; Brodie *et al.*, 2003; PC, 2003; SQCA, 2003; Science Panel, 2003). The Science Panel[1] indicated major land use practices in the catchment were responsible for increased delivery of sediment and nutrients over pre-1850 levels in Queensland waters including the Great Barrier Reef lagoon (Science Panel, 2003). It also found a compelling reason to intervene in order to halt or reverse the declining trend of water quality.

The chemical, sediment and nutrient pollutants affecting water quality come from a diverse source. The majority of them are from diffuse sources relating to

[1] The Queensland Government commissioned independent panel of experts.

the land use practices. Although mostly controlled under the regulatory framework, the risks from the point sources of pollution still exist (SQCA, 2003).

The *Environmental Protection (Water) Policy 1997* (EPWP 1997) developed under the *Environmental Protection Act 1994* provides a framework to protect, maintain and attain Queensland's water environment. The *EPWP 1997* sets water quality objectives for different uses, and makes it an offence if a discharge results in the receiving water quality standards being exceeded. One of the key objectives of the EPWP 1997 is to provide a framework for identifying environmental values (EVs) and associated water quality objectives (WQOs).

However, under current policy settings of the EPWP 1997, water quality levels are expected to decline further over time as a consequence of increased population and economic growth factors. This may have a number of adverse consequences for regional populations, leading to overall social and economic losses.

Against this backdrop, the Queensland Environmental Protection Agency (EPA) released the draft *Water Quality Guidelines (WQGs) 2004*. Simultaneously, Queensland EPA also released draft *Environmental Values and Water Quality Objectives* for community consultation. Once finalized, these EVs and their supporting WQOs will be incorporated into the Schedule 1 of the EPWP 1997, and both statutory and non-statutory natural resource management planning will need to consider these when deciding development applications for environmentally relevant activities (EPA, 2004a).

Key features of the WQGs 2004 and EVs and WQOs include the protection or attainment of environmental values through setting appropriate water quality objectives. Environmental values[2] can be thought of as some measure of the differing impacts on society. These impacts are related to the qualities of waters that need to be protected from the effects of pollution and waste discharges to ensure healthy aquatic ecosystems and waters that are safe for recreational and productive use. Water quality objectives are measures of water quality needed to protect or improve environmental values. The draft WQGs 2004 includes locally specific stringent water quality levels to protected designated environmental values. It provides numerical concentration limits as well as narrative statements for indicators aimed to protect major Queensland water uses including estuarine waters, marine waters and freshwaters.

However, if policies to enhance or protect water quality under the new WQOs are introduced, a number of negative impacts may be avoided alongside with positive impacts that may be gained. It is important to determine these impacts from the perspective of society. Policy makers and communities can

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[2] The EPA uses the term 'environmental value' to mean the categories and aspects of water use that communities think are important (EPA, 2004a). However, the economic concept of value is different in that it reflects the net change in the welfare of society. Such values can be revealed by an individual's willingness to pay to obtain a specific good or service or willingness to accept compensation for a loss of that good or service . The terms 'environmental value' and 'environmental asset' are used interchangeably throughout this paper to indicate environmental resources such as water.

then use this information in developing their preferred policy options. It is therefore important to assess the economic and social impacts of changing water quality standards.

The main objective of this paper is to assess, at a regional level, what the economic and social impacts would be of firstly not protecting water quality standards further, and secondly of targeting improved water quality. This paper is based on a desktop exercise using available materials including catchment modeling of load reduction strategies using the SedNet model.

Section 2 of this paper briefly describes the study area, key issues relating to water quality, intervention strategies, potential scenarios for reductions in pollution loads and methodological issues of measuring benefits of water quality improvement. Section 3 contains a discussion on both economic and social impacts followed by some concluding thoughts in section 4.

2. DATA SOURCES AND METHOD

2.1 Description of the Study Area and Specific Water Quality Issues

The Douglas Shire covers 2,456 km^2 or 0.1 percent of Queensland's area. The estimated resident population in 2004 was 11,654 persons representing 0.3 percent of the State's population. Population projections indicate that the Shire's population will increase from 10,466 in 2001 to 17,059 in 2026 (OESR, 2005a). It is further predicted that the average annual growth rate for the region between 2001 and 2026 will be 2 percent as compared to 1.5 percent for Queensland (OESR, 2005a). Douglas Shire is one of the fastest growing regions in Queensland.

Douglas Shire waters include fresh and estuarine waters of the Daintree, Mossman, Mowbray and Saltwater catchments with a total catchment area of ~1,850 km^2 (Bartley *et al*. 2004a) and coastal waters[3]. Beyond the impact of population growth, water demand has been rising in response to economic expansion including tourism growth, increased reliance on irrigated agriculture, urbanization, and rising living standards. The development pressures facing the Shire are particularly challenging given the region's high ecological values. In particular, 78 percent of the Shire's area comprises two World Heritage listed areas – the Great Barrier Reef (GBR) and the Wet Tropics of Tropical North Queensland. The Shire's water systems directly drain into the GBR.

Major land uses include rainforest and sclerophyll forest (~87 percent), mixed agriculture such as sugar cane, grazing, horticulture and aquaculture (~9 percent) and urban and rural residential uses. The region itself is a high tourism growth area, attracting huge numbers of tourists every year. Land use activities in the catchments are generally contributing to a decline in water quality. High concentrations of total suspended sediment (TSS), total nitrogen (TN) and total phosphorus (TP) affect not only Shire water resources, but also the GBR. The control and reduction of sediment and nutrient movement is considered an

[3] However, the total area of these four catchments sums to ~4,190 km^2 which include many small coastal streams not draining into these catchments (Bartley *et al.*, 2003).

essential mechanism to reduce pollutant loads within the GBR.

Understanding the sources of sediment and nutrient within a catchment is important when designing management strategies to address these pollutants. The Douglas Shire Water Quality Improvement Program (WQIP) with the Natural Heritage Trust (NHT) funding identified major sources of pollutants in the Shire's waters. The most important findings include (Bartley *et al.*, 2004a):

- Hill-slope erosion being the dominant source of sediment contributing 65 percent of the total sediment load in the catchment, and drain (particularly from sugar cane farms) and stream bank erosion contributing 23 and 12 percent respectively.
- The main land use contributing to the hill-slope erosion budget are the rainforest and sclerophyll forest areas, as these areas make up 87 percent of the catchment land use.
- Both the nitrogen (N) and phosphorous (P) budgets are dominated by losses from forested areas that contribute large amounts of organic matter to the system, followed by cultivated cane lands and tree crop areas on the floodplain.

On the basis of this understanding, an intervention strategy can be defined aimed at reducing or halting loadings of pollutant contaminants into the water.

2.2 Defining the Intervention Scenarios

The recently developed Sediment River Network Model (SedNet) at the CSIRO provides a new approach to the estimation of sources and transport of sediment and nutrients at catchment scales. Bartley *et al*. (2004b) used the SedNet model to measure the sediment and nutrient loads for each of the four main catchments within the Douglas Shire. The main purpose of the use of this model was to generate information about the sources of sediment and nutrients supplied, determine the total pollutant loads and importantly, to determine how management practices and land use changes can alter sediment and nutrient loads to the estuary.

Based on the research undertaken by Bartley *et al*. (2004b), three broad scenarios were considered for this study. The scenarios involved an assessment of expected annual pollutant loads for:

- the current situation (the Base Case 2004);
- no further management actions are implemented up to 2026 (the No Intervention Case)[4]; and
- a range of Best Practice (BP) management actions and interventions are implemented up to 2026 (the Intervention Case). These BP interventions are considered in several different ways, namely (i) agricultural diffuse, (ii) riparian rehabilitation, (iii) urban diffuse retrofit, (iv) urban diffuse greenfield sites, and (v) point sources.

Water quality objectives are considered at the catchment level for the varying

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[4] Although originally the *No Intervention 2026* scenario for Douglas Shire was not modelled due to lack of future land use projections, in this study, based on the South-east Queensland data, it is assumed that the base case will continue without an intervention.

water types. Using SedNet modelling, estimates are made of total point and diffuse source loads for each of the four catchments in the Douglas Shire. Suspended sediment, nitrogen and phosphorous loads are used as surrogate indicators of the characteristics needed to protect environmental values in the Shire waterways.

2.3 Modelling Pollutant Load Reductions in the Douglas Shire Waters

In order to assess the benefit of introducing load reducing best management strategies to the Douglas Shire, yearly benefits are compared for the *No Intervention* and *Intervention* scenarios for 2004-2026. The basis for this comparison is the annual difference between TSS, TN and TP loads for the two scenarios starting in 2004 and running through to 2026.

The first key step in the estimation of benefits is to identify the level of changes involved. These are summarised in Table 1.

Table 1. Summary of Predicted Load Reduction (tonnes/year)

Scenario	TSS	TN	TP
Base Case (2004)	262,383	1,712	300
No Intervention (2026)	274,283	1,717	307
Intervention (2026)	207,383	1,549	264

Source: EPA (2004b)

By 2026, the staged introduction of best practice management strategies was predicted to have reduced TSS, TN and TP loads from the *No Intervention* levels by the following amounts (EPA, 2004b):

- Reduction in total sediment of 66,900 tonnes/year;
- Reduction in total nitrogen of 168 tonnes/year; and
- Reduction in total phosphorous of 43 tonnes/year.

As per estimates, under the *Base Case* scenario TSS, TN and TP discharges are 262,383 tonnes, 1,712 tonnes and 300 tonnes respectively. Under the proposed *Intervention* scenario, these pollutant loads would be reduced to 207,383 tonnes, 1,549 tonnes and 264 tonnes respectively by 2026, which represent 21, 10 and 12 percent reductions respectively (Table 1).

The total benefit of water quality improvement in the Douglas Shire region is directly related to the difference in annual loads in the *No intervention* and *Intervention* scenarios. The next step is to identify the physical linkage between the projected changes and the benefits received by society. For example, a relationship needs to be established between the projected load reductions under different scenarios and human use activities such as fishing and recreation. However, this information is difficult to assess for a number of reasons:

- impacts often depend on a number of factors;
- there are a number of time lags involved;
- scientific data and modelling is limited; and
- there is little data available about how human use varies with ecosystem

health.

It is likely that a further deterioration in ecosystem health will have a larger impact on human interactions than will further improvements. This is because further deteriorations might mean that critical thresholds are reached, so that fish catches plummet, or swimming is not allowed in some waterways because of health reasons. In contrast, improvements in water quality are unlikely to directly correspond with increased levels of usage. For example, if water quality parameters improve by 50 percent, it is very unlikely that the number of people swimming (or the number of swimming events) increases by 50 percent as well.

A review of the literature was unable to identify a plausible scientific approach to estimate marginal changes in the value of water use (i.e. for all direct, indirect and non-use water activities) resulting from the intervention measures assessed for this study. Unfortunately there is a lack of modelling data to indicate how human use of water resources varies with ecosystem health. The difficulty of estimating marginal impacts resulting from changes in water quality indicates further research is required to quantify net benefits. Owing to the difficulties of establishing the linkages between changes in water quality and the impacts on human populations, the emphasis is given on qualitative description of the potential changes with some indicative value estimates.

2.4 Methods of Economic and Social Impact Assessment

The economic consequences of differing water quality standards in a catchment scale can be evaluated using three approaches, namely (i) economic and social impact assessment (identifies the impacts on different groups within the community of particular policy options); (ii) cost-effectiveness analysis (identifies the most cost-effective means of achieving set objectives); and (iii) cost-benefit analysis (evaluates whether particular policy options provide net benefits to society).

This study employed the broadly descriptive approach of economic and social impact assessment (ESIA) considering the difficulties to perform more evaluative techniques such as cost-benefit analysis. The intricacy arises mainly for two reasons. First, there are difficulties within the constraints of a desktop study to reliably place dollar values on many of the important direct, indirect and non-use values associated with improved water quality. Secondly, there is a significant lack of scientific data available for the study region that links reductions in TSS, TN and TP exports to more complicated biological improvements in water quality.

An ESIA is used to identify where policy options may impact on different groups in society[5], without making any judgement about whether the policy

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[5] Although commonly termed as 'social impact assessment', this study used the term 'economic and social impact assessment' on the basis of the understanding that economic and social impacts are closely interrelated, quite often one leads to the other. Many social impacts arise as a result of economic impacts. Consequently, social and economic impact assessments are often conducted together (Stanley *et al.,* 2004). Economic impact assessment has many common elements with social impact assessment, where a key focus

options create net benefits. For example, the use of economic assessment in the study area could be used to identify the financial impacts of mitigation strategies on households and industry.

Impact assessment is often conducted with the aid of input-output (I-O) analysis, where the 'ripple' effects of changes in income, expenditure and employment on a community can be modelled. However, unsophisticated application of I-O analysis has the limitation of only capturing economic effects directly associated with the mitigation strategy being considered. Due to its varying nature, enhancing or protecting water quality in the relevant study catchments can generate a wide range of goods and services for the society, most of which are external to the actual water market. For example, water bodies provide recreation and aesthetic benefits to communities, as well as being a basis for a number of ecosystem services that communities rely on.

Therefore, the focus of the ESIA is to include all relevant categories of impacts, whether or not they can be easily assessed and measured. There are three broad categories of values that are relevant to an ESIA, being:

- Direct use values, relating to direct impacts on people;
- Indirect use values, relating to impacts on life support systems for people; and
- Non-use values, relating to impacts that people find important without actually using them.

A summary of the impacts that might be expected from improvements in water quality are shown in Table 2.

Table 2. Expected Benefits of Water Quality Improvements

Direct Use	**Indirect Use**	**Non-use**
Direct recreation - Residents - Tourism Recreation fishing - Residents - Tourism Commercial fishing Water treatment for household Water treatment for industry Human health Agriculture	Impact on property value - Aesthetics - Waterfront vs regions Gain of reputation for tourism Impact on infrastructure Prevention of adverse health impacts	Cultural heritage Waterway protection Estuary protection Great Barrier Reef protection

Although many of the impacts reported in Table 2 are comparatively easy to identify, it is rather difficult to monetize these impacts. For example, major impacts of reduced water quality may reduce recreation activities (i.e. beaches

is to identify groups that may be disadvantaged so that remedial or compensatory strategies can be developed.

closed to swimming and boating) and put more biodiversity at risk. Many of the most significant impacts of reduced water quality are for items that are not directly priced in markets. If these impacts are ignored in the analysis, it may lead to a very misleading evaluation. Where impacts are not directly priced in markets, specialised valuation techniques may be employed. There are two main groups of these techniques: revealed preference methods and stated preference methods. An overview of economic valuation techniques is provided by Queensland EPA (EPA, 2003). Where values are not directly available for a case study analysis, it is sometimes possible to use benefit transfer techniques to estimate values on the basis of other similar studies.

Caution has to be used in comparing the values assessed with different valuation techniques with the results of an economic and social impact assessment process. The former are 'net' economic values, also referred to as economic surplus values. These represent the difference between what people had to pay for an item and what they were actually prepared to pay. Economic surplus values are the appropriate measures to use when conducting a cost-benefit analysis or other evaluations of social welfare. In contrast, an economic impact assessment identifies the total changes in income, expenditure and employment that might be associated with a change, while a social impact assessment might identify broader concerns at a community level. Economic surplus values are effectively measures of community concerns about potential changes that should be included in a broad impact assessment process.

An ESIA often only focuses on demographic, financial and employment changes associated with some impact, with the size of an industry or activity giving some guide to the size of the potential impact. In many cases non-market impacts, including impacts on environmental and social factors, are ignored. In this case study, such an omission would be very misleading and would lead to underestimation of potential impacts. To address this, the ESIA framework outlined in this paper is being extended in two main ways:

- all major impacts (Table 2) are being identified where possible; and
- non-market values are being reported for those impacts where possible to give some sense of their importance.

This study, therefore, extends previous work by widening the benefit categories (i.e. including non-use benefits). This will help policy decision makers to include the expected broader effects of potential improvements in water quality.

3. RESULTS AND DISCUSSION

3.1 Economic Impacts of Improved Water Quality with Indicative Value Estimates

Potential impacts of the water quality improvement identified within the methodological framework discussed above are summarised in this section. Only key impacts have been identified and summarised. First, there are the impacts of allowing water quality to continue to deteriorate. A number of major impacts have been identified, showing that there are a number of industries and social groups that would be disadvantaged if water quality continues to deteriorate. The predicted impacts include:

- Substantial losses in recreational activities;
- Expenditure reduction on recreational fishing;
- Expenditure reduction from commercial fishing;
- Increased water treatment costs;
- Average annual reduction in property prices;
- Reduction in tourism expenditure;
- Associated significant employment impacts, and
- Potential losses in biodiversity and environmental systems.

The impacts of the *No Intervention* scenario may be substantial, particularly if there are major impacts on tourism, the key industry in the Shire. Potential negative impacts would flow through to reduced incomes, expenditure and employment in the Shire.

In the second stage, the impacts of moving to the *Intervention* scenario have been assessed. The key benefits are avoiding the potential losses and problems identified with the *No Intervention* approach. Key benefits identified under this scenario include:

- Increased expenditure on recreational fishing;
- Increased revenue from commercial fishing;
- Reduced water treatment costs;
- Average increase in property prices,
- Tourism growth (with associated revenue and employment opportunities); and
- Benefits of improved environmental and biodiversity protection.

Under these two scenarios, major impacts are described below with the indicative value estimates. Other benefits considered minor in the study area are not described, but are summarized in Table 3.

Direct Recreation Impact: If water quality decreases substantially, it would become unsafe for activities such as swimming, particularly in freshwater sites. This would be a major impact in the region because of the expected high levels of outdoor recreation activities. There may be higher levels of private and public expenditure on recreational facilities (such as swimming pools) to compensate for the reduction in recreation choices. If water quality improves under the *Intervention* strategy, then recreational use may increase. In areas where water quality is good, there may be very limited additional use. In areas of poor water quality where major improvements are made, then increased recreation use can be expected.

Recreational Fishing Impact: Using an average population estimate for the Douglas Shire to 2026 of 17,059 people, and an average fishing participation rate of 28 percent (Henry and Lyle, 2003), the total expenditure of the resident Shire population on recreational fishing can be estimated at $1.5 million[6], with the

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[6] Dollar ($) value indicates Australia dollar in this paper.

bulk of this expenditure occurring in the region. This expenditure will be at risk if water quality deteriorates further.

It is more difficult to identify changes in recreational fishing activities when water quality improves. This is because there is unlikely to be a direct relationship between improvements in water quality and both fish catch rates and participation in recreational fishing. Little data exists to estimate these proportions. Rolfe *et al*. (2004) reported willingness to pay by Queensland anglers for a 20 percent improvement in catch rates at inland waterways, ranging from $19 per angler at the Fairbairn Dam to $43 per angler at the Boondooma Dam. Using an average value $32.83/angler for a 20 percent improvement in catch, the value of improved catch across all angers in the Shire can be estimated at $127,000. These results indicate that there may be substantial value associated with improving fishing experience in the region. Good water quality in estuary areas may be important to many fish stocks in Queensland because of breeding cycles, hence declines in water may impact on both commercial and recreational species.

Commercial Fishing Impact: Fenton and Marshall (2000) estimate that 34 commercial fishing businesses operate out of Port Douglas employing 62 full time equivalents. The total catch price paid on wharf to commercial operators in the Douglas Shire can be estimated as $3 M per annum[7]. According to the QSIA (2004) around 75 percent of fisheries production is directly dependant on the estuarine environment for at least one stage of their life cycle. Should the life cycle stages be interrupted, population impacts can be significant. However, it is not clear how a decline in water quality standards in the Shire will affect commercial fishing, although it is certain that fish stocks may drop sharply once some threshold levels in water quality are breached. As well, fishing areas targeted by operators from Port Douglas may be some distance away from the water inflows from the Douglas Shire catchments.

Urban Water Treatment Costs: Total water charge by Local Government Authorities in the Douglas Shire was $2.7 M (DLGP, 2003). As water quality declines, it is expected that water treatment costs by local government will increase. Some of these increases will be ‘lumpy’ investments as new treatment plants are built, so that water quality can have a major impact on urban water charges.

Industry Water Treatment Costs: Industry tends to use bulk supplies of water in a limited number of locations for a variety of uses. These include operations such as abattoirs, timber mills, cement mixing, power generation and sand mining operations. In some cases, industry sources water from urban supplies. Where industry does use bulk supplies, such as for cooling towers, the standard of water quality is not always important. This makes estimation of impacts difficult. It is expected that there will be some costs to industry if water quality standards decline, but there will be few savings if water quality standards improve (because treatment infrastructure is already fixed). A hidden cost of

[7] The Queensland Seafood Industry Association (QSIA, 2004) reported a slightly higher GVP of $4.7 M for the Douglas region.

declines in water quality standards is that it may make the region less competitive in attracting new businesses. There are 24 potential point source sites in the Shire (Bartley *et al.,* 2004a).

Agriculture Water Treatment Costs: Agriculture is a major industry sector in the Douglas Shire, with a total gross value of production for the year ended June 2001 of $18.6 M and 1,895 people employed in the agriculture, forestry and fisheries sector. Sugar cane is the dominant agricultural industry in the area. Agriculture is typically a bulk user of raw water supplies that is rarely involved in any treatment of water used as inputs. Typical uses include supplies for irrigation and stock watering purposes, although these uses are limited in the Douglas Shire. Where higher levels of nutrients lead to algal blooms and other water quality problems, then deterioration in water quality may generate high costs to industry, particularly relating to livestock watering purposes.

Aquaculture is one sector of agriculture that may be very sensitive to varying levels of water quality. In the far northern region (including the Douglas Shire), the gross value of aquaculture production in the 2002-3 year was $16.22 M (Lobegeiger and Wingfield, 2004). For this sector there may be some treatment costs involved if water quality standards decline, although it is more likely that aquaculture enterprises might relocate to areas where water quality standards are maintained. There is also a limited amount of harvest fishing (including aquarium fish, bloodworms, coral, sandworms, yabbies, and shells) with an estimated annual production of $164,000 in the Douglas Shire (Fenton and Marshall, 2001).

Property Values: There is evidence that properties with waterfront access command market premiums. Recent data on real estate values in the Douglas Shire indicates that prices in waterfront areas command substantial premiums (REIQ, 2004). Sales data in the region for differences in unimproved value according to whether blocks having waterfrontage or not indicate that the Douglas Shire region has a 47-210 percent premium on unimproved land value of water frontage compared with non-waterfront properties (QVAS, 2004).

It is expected that housing prices would be affected by lower water quality standards, particularly if these impact on health or recreation activities. However, lower property prices may not be the only impacts if water quality standards continue to decline. If the Douglas Shire region has lower water quality standards relative to other areas of Australia, this may affect migration patterns to the area and property pricing more generally. As well, if there are health effects associated with poor water quality levels, impacts on property prices may be very substantial. If water quality standards improve, particularly in areas where quality is currently poor, then this could be expected to have a positive effect on housing prices.

Aesthetics: Aesthetics are likely to be important, particularly if there are reductions in the appeal of the region. There will be some overlap with residential house prices and recreational uses, so these issues have mostly been covered above.

Tourism Impact: Total tourist income in the Douglas Shire accounts for about 10 percent of total tourist income in the Tropical North Queensland region which is about $202 M per year. Huybers and Bennett (2000, 2003) report that visitor numbers from the United Kingdom to Far North Queensland are likely to fall by 27 percent if environmental conditions fall from 'unspoilt' to 'somewhat spoilt'. Visitor expenditure will fall by 30 percent under the same conditions. If conditions fell from 'unspoilt' to 'very spoilt', the respective falls in visitor numbers and expenditure was predicted to be 58 and 61 percent respectively. This implies that if environmental conditions in the Douglas Shire fell from 'unspoilt' to 'very spoilt', the annual shire income from tourism might fall by up to $120 M (this is more than six times the total value of agricultural production in the Shire). If water quality deteriorated to the point where recreation/tourism activities such as swimming and fishing were affected, major economic impacts might be expected. For example, even a 1% reduction in expenditure equates to $24 M, a 1 percent change in gross regional product equates to $10 M, and a 1 percent loss of full time equivalents (FTEs) is 171 jobs.

Potential Health Impact: Declining water quality has potential impacts on human health, together with the public and private costs of dealing with the health problems. Pathogenic (disease-causing) micro-organism such as *Cryptosporidium* and *Giardia* are now common in Australia, and toxic substances such as blue-green algae (Cyanobacteria) are also considered health hazards for many waters. They release toxins which have a variety of impacts from skin rash to liver and nerve damage.

While the potential increases in the sediments and nutrient loads in Douglas Shire waterways are modest under a *No Intervention* strategy, there may be some health impacts, particularly where the deterioration in water quality is larger.

Biodiversity Protection: Biodiversity protection is a major issue for society, and reduced water quality that leads to environmental losses is likely to arouse community passions and protest. One implication of declining water quality levels is that biodiversity systems will become more stressed, and pockets of remaining biodiversity and natural systems will become more valuable. This may restrict development opportunities because community concerns about biodiversity protection are heightened and there is increased opposition to environmental losses.

Studies show that Queensland residents value biodiversity protection highly (Rolfe *et al.,* 2001; Windle and Rolfe, 2004). Spanning two World Heritage Areas, the protection of biodiversity in the region will be significant not only to local residents, but also to other Australians and the international community. No useful dollar estimates of these specific values were available in the literature.

The economic benefits considered here are those potentially accruing to both users and non-users, which include direct use, indirect use and non-use values. There are many and diverse potential benefits associated with improved water quality, ranging from the easily identifiable and quantifiable (i.e. direct use) to the intangible and difficult to measure (i.e. indirect and non-use). Benefits include both (a) reductions in costs (cost saving), and (b) additional benefits resulting from the interventions, over and above those that occur under current conditions.

Table 3. Summary of Potential Economic Impacts

Type of Benefit	Benefit	Expected Impacts Under the *No Intervention* Scenario	Expected Impacts Under the *Intervention* Scenario
Use	Direct recreation	Expect a major change in population use as it becomes unsafe for activities such as swimming	Expect some increase in population use as swimming and other activities becomes more attractive
	Recreational fishing	Expect reduction in spending from current estimates of $1.5 M/year	Expect increase in expenditure as fish catch rates improve
	Commercial fishing	Expect reduction in value of catch from current levels of $3 M/year in Shire, and $53 M/year	Expect increase in expenditure and value of catch, assuming that fish catch rates improve.
	Urban water treatment costs	Expect water treatment costs to increase. Current water charges are $19.1 M/year	Expect water treatment costs to maintain
	Industry water treatment costs	Some impact likely, but will vary according to type of use	Little impact predicted
	Agricultural water treatment costs	Little impact predicted unless major reduction in water quality. Gross value of agricultural production in the Shire is $18.6 M. Value of aquaculture in the region is $16.2 M.	Little impact predicted
Indirect	Property values	Expect reduction in property prices – impact may potentially be much larger	Expect some increase in property prices
	Aesthetics	Likely to be some impacts on top of recreation use and property value impacts	May be some small impacts on top of recreational use and property value impacts
	Tourism reputation	Some impact predicted if recreation and amenity values affected. Current level of expenditure in the region of $2 064 M/year	Small impact predicted
Non-use	Biodiversity in waterways	Expect potential losses in biodiversity to be a key issue for people	Expect people to have some value for improving biodiversity
	Biodiversity in estuary and coastal areas	Expect potential losses in biodiversity to be a key issue for people	Expect people to have some value for improving biodiversity
	Protection of cultural heritage	Only expect impact if poor water quality impacts on heritage sites	Little impact predicted
	Indigenous cultural	Increased protection afforded to traditionally important resources such as protection of indigenous values (viz. fish traps and totemic species), maintenance or improvement of protected areas	Little impact predicted

Only key impacts are identified and summarized here. It is possible that there may be other impacts not included here. For example, reduced water quality levels may increase the cost of avoidance and prevention incurred by state and local governments. Furthermore, there may also be impacts on health and public safety which have not been assessed here, as well a number of impacts on water quality for industrial and agricultural use.

3.2 Social Impacts

The demographic profile suggests that the Shire is a relatively prosperous region with few low income families. Douglas Shire enjoys more social and economic advantages than disadvantages and has a relatively high proportion of residents with high incomes working in skilled occupations (OESR, 2005b). The likelihood of residents in the Shire being disadvantaged by the introduction of the environmental values and water quality objectives considered in this paper appear low.

The social impacts of protecting and enhancing water quality are not expected to be large because:

- the costs of most actions will be very broadly spread across the community, with most costs to be met by (i) existing general taxpayer funds, and (ii) existing rate reallocations (to cover additional costs of wastewater treatment plants);
- any community interests will gain from the proposed actions (e.g. recreational users will benefit); and
- impacts on the rural sector will be muted because participation in protection measures will be voluntary and subject to the National Action Plan for Salinity and Water Quality (NAPSWQ) and the Natural Heritage Trust (NHT) initiatives.

The areas where social impacts could be higher are:

- any loss of productive land in the rural sector as a consequence of retiring land in riparian zones (need to be tested by estimating overall impacts on production); and
- potential cost impacts on local governments.

The loss of productive land in agriculture can be estimated in the following way. If a 15 metre strip along relevant waterways (300 kms) is assumed to be taken out of production as a measure to reduce rural diffuse impacts, the total expected amount of land to be taken out of production is 300 hectares. The total area of land used for cattle grazing in the region is estimated at 84,650 hectares, suggesting that 0.3 percent of grazing land in the region might be retired. This will be some of the most productive land available, so the impacts on production may be higher. Even if the impacts on production were double the land proportion, there would still only be a 0.6 percent reduction, suggesting that any impacts on rural communities would be extremely small.

Rolfe *et al*. (2005) estimated the amount of annual rates payments needed to service the expenditure of the *Intervention* scenario at approximately $8.71 per household within the Shire. On the other hand, the average utility charge is $1,384 per household in a year, indicating that about 0.6 percent of rates will be needed to service the expenditure. Given that households will also be enjoying the benefits of improved water quality, the social impact of allocating rates for this purpose is not expected to be high.

4. CONCLUSION

The aim of this paper was to evaluate the economic and social impacts on regional communities of protecting the environmental assets for the waters in the Douglas Shire. For this purpose, the implications of two main scenarios for the region were considered. The first is a *No intervention* approach, where the state and local governments continue with existing water quality improvement programs. Under this scenario, water quality is predicted to decline substantially by 2026. The second is an *Intervention* scenario, where water quality is expected to improve by 2026. The *Intervention* scenario can be achieved through a range of management actions targeting rural diffuse sources, urban diffuse sources and urban point sources. A number of major impacts have been identified, showing that there are a number of industries and community groups that would be benefited from the water quality improvements. Benefits of water quality improvement include direct use, indirect use and non-use benefits. Environmental values need to be protected on the basis of the total value of a resource, not on the basis of its direct use. For some resources, indirect and/or non-use values are very significant.

The estimates of economic impacts that are presented are rather conservative and need further care in terms of application. These are only assessed through a desktop exercise, and caution should be taken in using this framework. However, the results generally show that there are very large and damaging economic and social impacts on regional communities associated with further declines in existing water quality. Because conservative estimates are used for most impacts, these results are probably understated. The case for averting these impacts by at least maintaining current water quality levels is very strong. There is also a case for protecting or enhancing water quality to protect environmental assets through an *Intervention* strategy. A more detailed economic analysis such as cost-benefit analysis would be needed to assess the net benefits of various *Intervention* strategies that might be considered.

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