# Managing what matters:

## The cost of environmental decline in South East Queensland

*A report prepared*
*for South East Queensland Catchments*

*April 2010*

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This report may be cited as: Managing what matters: the cost of environmental decline in SEQ, Marsden Jacob Associates, 2010



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# Key messages

- Despite the significant efforts of government, business and the community to improve environmental management in SEQ, the condition of critical natural assets is still declining. This includes declining water, air and coastal condition and losses of critical biodiversity, habitat for key species (such as koalas), and losses of open space.
- Key drivers of this decline are population growth and the associated economic activity (e.g. urban development) and climate change.
- Declines in the condition of our natural resource asset base are not just an environmental issue. They are an economic issue as:
  - many sectors are reliant on the natural resource base to underpin their productivity and value (e.g. primary industries and nature based tourism), and:
  - there are significant social values associated with the natural resource base (e.g. we value a healthy environment for our enjoyment and purely for its existence values).
- This report has found that there are significant risks to several sectors in SEQ attributable to further declines in the condition of our natural resources, particularly for agriculture, nature-based tourism, the recreation industry, and for government service provision (such as health costs, costs of environmental rehabilitation and water treatment).
- The social costs of a decline in natural resource condition are very substantial. It is estimated that the social costs could be as high as $5.2 billion between now and 2031.
- Ultimately SEQ households will bear these costs and a major survey of SEQ households indicates that the community is prepared to pay to avoid further damage, particularly where actions to reduce the decline in natural resource condition are done effectively and efficiently.
- The SEQ Natural Resource Management Plan provides a blueprint for natural resource management in SEQ. The social values of achieving the targets in that plan could be worth as much as $7 billion between now and 2031, while meeting the targets would also reduce risks and costs to many sectors and the government.

# Executive Summary

Despite the significant efforts of government, business and the community to improve environmental management in South East Queensland (SEQ), the condition of critical natural assets is still declining. This includes declining water, air and coastal condition and losses of critical biodiversity, habitat for key species (such as koalas) and losses in open space.

The SEQ Natural Resource Management (NRM) Plan is the first major attempt to establish a comprehensive NRM planning framework for SEQ. Marsden Jacob Associates was engaged by SEQ Catchments to investigate the economic costs of environmental decline in SEQ and the potential benefits of meeting the targets established in the SEQ NRM Plan (i.e. the costs of degradation avoided and the value of enhancing environmental condition). The purpose of this report is to:

- analyse the targets established in the SEQ NRM Plan;
- identify, scope and assess the potential economic cost of environmental degradation if the targets are not achieved; and
- document the findings into a report that will inform future decision makers.

Without this information, there is a very real risk that NRM policies and programs may be insufficient and/or poorly targeted.

## THE COSTS OF DECLINE IN RESOURCE CONDITION: KEY FINDINGS

While there are significant gaps in biophysical information, particularly condition and trend forecasts for key resources, there is sufficient information to broadly understand the potential risks to underpin a 'do nothing more scenario' (i.e. what happens if actions are not taken to meet the targets in the SEQ NRM Plan).

There are two broad sets of economic costs attributable to any decline in the condition of natural resources in SEQ:

- Economic impacts on business, governments and households. These are assessed as changes to key economic indicators for each sector such as changes in production (e.g. nature based tourism), changes in activity (e.g. recreational expenditure), or changes in cost (e.g. water treatment costs). These impacts have been assessed using a desktop approach based on currently available data.
- Economic estimates of the social values (biodiversity, recreation, coastal condition, etc) lost by the community. These values are not observable in the market place and a specific internet-based choice modelling survey of over 920 SEQ households (implemented by DBM Consulting) was conducted to estimate these costs. It is these values that are more important from a public policy perspective.

Key findings relating to impacts on business, government and households include the following.

- The majority of impacts on business (e.g. higher input costs) and government (e.g. water treatment costs) will ultimately be passed on to customers and households. Businesses will only absorb the costs (and reduce profits) where they are essentially a 'price taker' (e.g. agriculture and to a certain extent international tourism).

- While primary industries are relatively less important to the SEQ economy than in other areas of Queensland, the value of production in 2007-08 was still in excess of $1.2 billion. Declines in resource condition will have negative impacts on productivity and profitability. However, the multitude of environmental and market risks faced by the primary industry sector make it difficult to isolate and estimate the costs solely attributable to declining resource condition (as many factors may be changing at the same time). Despite that, even a modest decline of 2% in primary production attributable to further decline in resource condition would cost the sector almost half a billion dollars over the next 20 years.
- Tourism is a major contributor to SEQ's gross regional product (around 5%), and is highly reliant on the natural asset base. It is estimated that approximately 28% of tourism expenditure in Queensland is attributable to visitation to natural areas. Analysis of tourism behaviour undertaken elsewhere often shows significant declines in nature-based tourism where the natural resource base is eroded or environmental risks occur (e.g. algal blooms). These risks are particularly significant for the Gold and Sunshine Coasts. While the tourism sector will adjust to changes in demand, it is likely that the growth of the tourism sector will be slower if the NRM targets in the SEQ NRM Plan are not met. A 5% reduction in nature based tourism by 2031 would equate to a fall in approximately $2 billion in turnover for the sector between 2009 and 2031.
- Open space and nature-based recreational opportunities (e.g. recreational fishing) are key drivers of quality of life and migration into SEQ. While the relationship between resource condition and benefits is not well understood in a quantitative sense, qualitative research indicates that recreational values could be significantly compromised by further declines in resource condition. Even a modest decline of 2% in recreational activity (excluding fishing) by 2031 would result in a decline in expenditure of approximately $200 million over the 2009 to 2031 period. For recreational fishing, a 5% reduction in participation rates from business as usual levels by 2031 would result in a reduction in expenditure of approximately $160 million over the 2009 to 2031 period.
- Costs to governments at all levels are likely to rise as the condition of the natural resource base declines. Direct costs will include higher water treatment costs, while indirect costs will include increased health costs (e.g. due to a lack of outdoor recreational exercise opportunities).

Key findings regarding the social costs to the one million plus households in SEQ attributable to losses in resource condition are as follows.

- The social costs are generally greater than other costs assessed.
- The social costs to the community of a do nothing more scenario and the loss of resource condition are very significant (in excess of $5.2 billion between 2009 and 2031). The greatest costs relate to losses in river and stream and coastal condition.
- The survey results indicate that by 2031 households would, on average, be prepared to pay almost $300 per annum to avoid the expected decline in resource condition from current levels.
- The marginal costs tend to increase as resource condition declines. In other words, while small declines have relatively low values. The values associated with the larger declines expected in the latter part of the NRM Planning period are much higher.

- The community is also prepared to pay for enhancements in resource condition from current levels. The value of those enhancements could be as high as $1.9 billion over the life of the SEQ NRM plan.
- The total social benefits of the SEQ NRM Plan (avoiding declines and enhancing condition of some assets) could be worth as much as $7 billion over the life of the plan ($3 billion in present value terms). This is likely to be lower than the costs of meeting the key targets in the SEQ NRM Plan.
- The survey indicated that the community is willing to pay more to avoid marginal declines in condition from current levels than for marginal enhancements of the same magnitude.

Ultimately, households will bear the majority of the costs of declines in resource condition, both directly and indirectly. House values are likely to be negatively impacted as amenity levels decrease (representing capitalised losses in recreation and other natural resource attributes), while the operating costs for households will rise (e.g. greater use of air conditioners due to a lack of local climate moderation and increased flood risks attributable to changes in land use intensity).

### POLICY AND MANAGEMENT FINDINGS

The principal manageable threats to resource condition in SEQ are driven by population growth (both directly and indirectly).

The natural resource management gains of the past need to be acknowledged. However, it also needs to be acknowledged that existing interventions (i.e. a do nothing more scenario) will still result in a decline in resource condition. This is largely because, even with the existing interventions in place, there is still residual damage to the natural resource base occurring. For example, the design objectives being established for water sensitive urban design in greenfield developments only partially mitigate ongoing increases in pollutant loads, and loads attributable to the construction phase will continue to be high as feasible on-site management options are limited.

Multiple policy responses are possible, including public provision, regulation, suasion and economic/market-based approaches, etc. No one policy option is uniformly superior in all circumstances and a portfolio of complementary policy responses will need to be established to address the different risks faced by different assets.

The survey of households also revealed strong community preferences for particular policy principles, specifically the following.

- Taking a regional approach to achieving NRM where it is more efficient, even if local rates were spent elsewhere in the region (60% endorsed).
- Paying farmers to provide ecosystem services where it is the most efficient means to achieve targets (68% endorsed).
- Taking preventative action now to reduce the decline in resource condition, rather than rehabilitate later (60% endorsed).
- All future housing and other development should be required to compensate for negative environmental impacts, through actions such as offsets (80% endorsement).

Often the community preferences were inconsistent with the current approach to natural resource management in SEQ. It should be noted that there are probably economic efficiencies to be gained from further application of these policy principals in certain

circumstances. For example, taking a regional approach to the protection of biodiversity and delivering some outdoor recreational opportunities; or paying farmers in the Lockyer Valley to reduce erosion to deliver better water quality outcomes in Moreton Bay.

This report fills a major information gap and assists policy makers at all levels to understand the costs of further degradation of the natural resource base in SEQ. As a next step, it would be prudent to undertake a comprehensive review of the adequacy, effectiveness, efficiencies and synergies of current and potential NRM interventions to determine the most efficient means to achieve the targets established in the SEQ NRM Plan.

# 1. Introduction

The community in South East Queensland (SEQ) values its environment highly as it provides significant ecosystem services and functions (e.g. habitat for endangered species such as koalas, quality locations to underpin tourism and recreational activities). The condition of our environment is a major reason why people choose to live in SEQ and why in excess of 60,000 move to the region each year.

> *"the next two decades will be our most challenging as we work to manage our inevitable population growth and channel it towards opportunity and prosperity without compromising the things we love about Queensland"*
>
> Premier Anna Bligh. 18 November 2009

Recognising the pressure the additional population and economic activity will place on SEQ, the State Government has identified around $124 billion in infrastructure investments between 2009 and 2026.[1] While a significant investment is going into hard infrastructure to underpin population and economic growth, at this stage, only limited additional resources and policies have been earmarked to address the losses of 'green infrastructure' – the natural resource base that underpins much of our lifestyle and industry in SEQ.

The extent and condition of SEQ's natural resources and environmental assets have been in decline for a significant period. Part of the response to this trend has been the development of the South East Queensland Natural Resource Management Plan 2009 – 2031 (the SEQ NRM Plan). The Plan has a number of core elements, specifically:

- a common set of regional NRM targets to 2031 for SEQ;
- a coordinated NRM planning system;
- coordinated reporting against targets;
- coordinated monitoring, evaluation and improvement of actions; and
- a move towards coordinated institutional arrangements to enhance the effectiveness and efficiency of NRM planning, policy and on-ground NRM implementation within SEQ.

The SEQ NRM Plan established a series of (primarily) physical targets across a number of classes of natural assets.[2] These assets are air and atmosphere, coastal and marine, community, land, nature conservation, regional landscape areas, Traditional Owners, and water. However, the economic benefits and costs of the targets are largely unknown. In addition, our understanding of the distribution of the benefits and costs of achieving the targets is only broadly understood. Generally the benefits of achieving the targets will be diffuse across the community (e.g. we all benefit directly and indirectly from enhanced water quality), while the costs of management actions to meet the targets may fall disproportionally on a subset of the population (e.g. it is often farmers who are required to change land management and use practices).

Unless these benefits and costs are better understood:

- it is less likely that Government interventions in NRM will be socially optimal;

[1] Queensland Government, 2009, South East Queensland Infrastructure Plan and Program 2009–2026

[2] These targets are outlined in more detail in Section 2. For a full coverage of the targets, see the SEQ NRM Plan.

- investment in NRM may be inadequate and potentially poorly targeted; and
- the design of effective and efficient policies will be hindered.

In short, unless the benefits and costs of achieving the NRM targets are better understood, the risks of insufficient and poorly directed investment are great. This will ultimately result in a continuation in the decline in the extent and condition of our natural asset base.

## 1.1. Purpose of study

The SEQ NRM Plan has established a series of resource condition targets and there is a cost associated with not meeting those targets. The overall purpose of this study is to examine and quantify, wherever possible, the economic costs of the decline in the extent and condition of the natural environment in SEQ.

The key purposes of this report are to:

- analyse the targets established in the SEQ NRM Plan;
- identify, scope and assess the potential economic cost of environmental degradation if the targets are not achieved; and
- document the findings into a report that will inform decision makers.

## 1.2. General approach

This current 6-month study has involved a major review of relevant data and information from multiple sources to scope, understand and estimate the economic costs of resource decline up to 2031. It builds on a scoping study completed by Marsden Jacob Associates in June 2009. Based on information available, a number of economic approaches were adopted to establish scenarios of potential economic impacts. Specific approaches are outlined in this report.

A key finding from the scoping study was that there was virtually no information on the social values attached to natural resource assets in SEQ because values are not revealed through market transactions (i.e. they are non-market values). For example, what is the value of protecting water quality? Therefore the centrepiece of the quantitative analysis was a choice modelling study to estimate households' willingness to pay to achieve different levels of natural resource condition in SEQ (including the current levels, the targets established in the SEQ NRM Plan, and the potential condition in 2031 under a 'do nothing more' policy scenario). To do this, a survey of 921 households in SEQ was performed and then results were weighted using SEQ demographic data to ensure the results obtained are a statistically significant representation of the views of households in SEQ. Complex econometric analysis was then used to elicit economic values from the survey results.

### 1.2.1. Report structure

The report is structured as follows.

- **Section 2. Context, background and risks**. This section provides a brief overview of the SEQ region, the community's aspirations for natural resource management, an outline of the assets in the SEQ NRM Plan, and an overview of key threats to those assets.

- **Section 3. Linking resource condition and economic values.** This section provides an overview of the framework and methodology used to develop the estimates of the economic values in this report.
- **Section 4. Costs to businesses, governments and households.** This section outlines the direct financial impacts on key business sectors that would be impacted by declining resource condition (e.g. potential reductions in tourism turnover), potential impacts on government budgets (e.g. impacts on health costs), and impacts on households (e.g. housing values).
- **Section 5. Community and social values.** This section summarises the economic estimates of the values to the community of maintaining resource condition (e.g. water quality).
- **Section 6. Policy responses.** This section briefly outlines the potential policy responses that may be needed to achieve the targets established in the SEQ NRM Plan.
- **Appendix.** The appendix outlines the targets in the SEQ NRM Plan in more detail and includes background information that has assisted with the development of this report. The information is largely contextual and is not essential reading for most stakeholders.

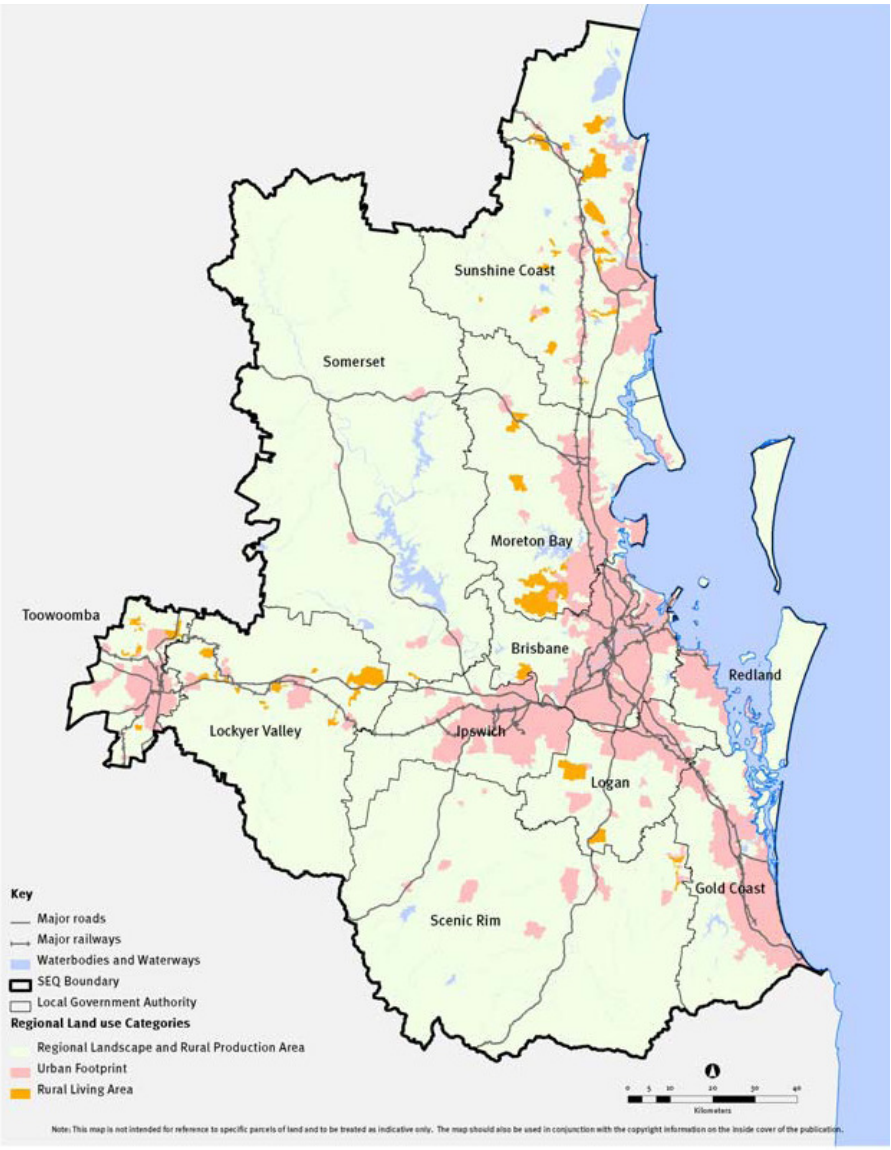
# 2. Context, background and risks

This Section provides an overview of the context and background within which this economic analysis has been undertaken.

## 2.1. South East Queensland

The SEQ region is shown in Figure 1. The SEQ population was estimated at 2.8 million in 2006, with the majority living predominantly in the coastal zone with easy access to the Sunshine Coast, Moreton Bay and Gold Coast.

**Figure 1: SEQ region**




*Source: SEQ NRM Plan 2009-31*

### 2.1.1. Land use in SEQ

Unlike much of Queensland, the region is characterised by a large urban area which accounts for in excess of 16% of the total land area (shown in pink in Figure 1). The approximate break-up of land use is shown in Table 1.

Due to population growth, land use will become increasingly urbanised over the next quarter of a century. While the SEQ Regional Plan aims to encourage infilling (i.e. development within existing suburbs) wherever possible, significant areas of land are expected to be converted to urban and related industrial use over the next 25 years, particularly west of Caboolture, east of Laidley and south east of Ipswich (e.g. Greenbank).

**Table 1: Land Use in SEQ**

| *Land use* | *Proportion of SEQ (%)* |
|---|---|
| Intensive uses (e.g. urban, industrial) | 16% |
| Conservation | 20% |
| All agricultural production | 61% |
| Water bodies | 3% |
| Total | 100% |

*Source: SEQ Catchments*

### 2.1.2. Economic structure

The SEQ economy differs from the broader Queensland economy, with a significantly lower reliance on primary industries and mining and a higher reliance on the services sectors. Table 2 shows the relative structure of the SEQ and Queensland economies based on estimates of gross value added for the 2005-06 financial year.[3]

Key points to note regarding SEQ's economy include the following.

- The relatively lower contribution of primary industries in SEQ compared to the whole of Queensland. However, it should be noted that primary industries in SEQ have a significantly higher concentration of horticulture crops than the State average and that these industries are highly reliant on a quality natural resource base (water, soil condition etc) to maintain production.
- As expected, the contribution of mining is minimal, although the SEQ region provides significant support services for the sector (e.g. corporate head offices located in Brisbane).
- While the relative concentration of manufacturing in SEQ is only marginally higher than for the State, much of the manufacturing outside SEQ is food manufacturing (particularly sugar), whereas manufacturing in SEQ is significantly more diverse.
- Service sectors (property and business, finance and insurance, etc.) are more prominent in SEQ reflecting the concentration of population and major firms in the SEQ region.

[3] Gross value added is used to analyse industry contributions to regional production (as opposed to more sophisticated measures like gross regional product) as there is no adequate method to allocate taxes less subsidies on products across industries. While these estimates are dated, they are the best available at the regional scale that allow a comparison of SEQ with the whole of Queensland

**Table 2: Economic structure of SEQ and Queensland**

| | *Sector contribution (%)* | |
|---|---|---|
| *Sector* | *SEQ* | *Queensland* |
| Agriculture, forestry and fishing | 0.7 | 3.4 |
| Mining | 0.6 | 10.6 |
| Manufacturing | 11.1 | 9.8 |
| Electricity, gas and water | 1.6 | 2.1 |
| Construction | 8.5 | 7.9 |
| Wholesale trade | 5.8 | 4.9 |
| Retail trade | 8.4 | 7.5 |
| Accommodation, cafes and restaurants | 3.1 | 2.9 |
| Transport and storage | 6.5 | 6.0 |
| Communication services | 2.8 | 2.3 |
| Finance and insurance | 6.7 | 5.2 |
| Property and business services | 12.9 | 10.0 |
| Government administration and defence | 5.0 | 4.7 |
| Education | 5.1 | 4.7 |
| Health and community services | 7.2 | 6.3 |
| Cultural and recreational services | 1.6 | 1.3 |
| Personal and other services | 2.6 | 2.3 |
| Ownership of dwellings | 9.7 | 8.3 |
| Total | 100.0 | 100.0 |

*Source: OESR Experimental estimate of Gross regional Product 2005-06*

## 2.2. Community aspirations and NRM priorities

Formal socio-economic studies into the relative importance of the extent and condition of the environment to the SEQ population are relatively limited. However, one major survey[4] and subsequent study found that 30.3% of the variance in responses regarding quality of life was accounted for by aesthetic factors, including:

- openness or spaciousness;
- closeness to natural areas (bush, creeks, beaches etc);
- attractive appearance of neighbourhood;
- recreational opportunities; and
- community size.[5]

In other words, these factors play a major role in maintaining the quality of life in SEQ. Maintaining these factors is highly reliant on maintaining the extent and condition of SEQ's

[4] 2003 Quality of Life Survey conducted in the Brisbane-SEQ region.

[5] Chhetri, P., Corcoran, J., Stimson, R., Bell, M., Cooper, J., Pullar, D, 2007, Subjectively Weighted Development Scenarios for Urban Allocation: A Case Study of South East Queensland, Transactions in GIS, 2007, 11(4): 597-619.

natural resource base. The analysis of the survey indicated these were the most important factors and were even more important than other factors normally considered central to good planning (i.e. closeness to work, convenience to shopping centres and schools and the proximity of public transport).

As part of this project, in the fourth quarter of 2009, a major survey of 921 SEQ households was undertaken by DBM Consultants.[6] This purpose of this survey was to elicit quantitative data across a number of issues including community aspirations regarding resource condition and priority environmental issues. The extent and condition of the natural environment were an important reason why many respondents liked to live in SEQ, with 68% of respondents stating the natural environmental (bushland, national parks, air quality, etc) was one of the four most important reasons why they liked to live in SEQ, while good beaches, the Bay and the coastline was important for 58% of respondents. However, it should be noted that these NRM issues were not as important to respondents as issues like employment and education opportunities.

Importantly these findings are consistent with the State's own social research undertaken as background to the Growth Summit in March 2010 which found the relaxed outdoor lifestyle, quality of and access to beaches, open spaces etc all featured highly in what was valued strongly in SEQ.[7]

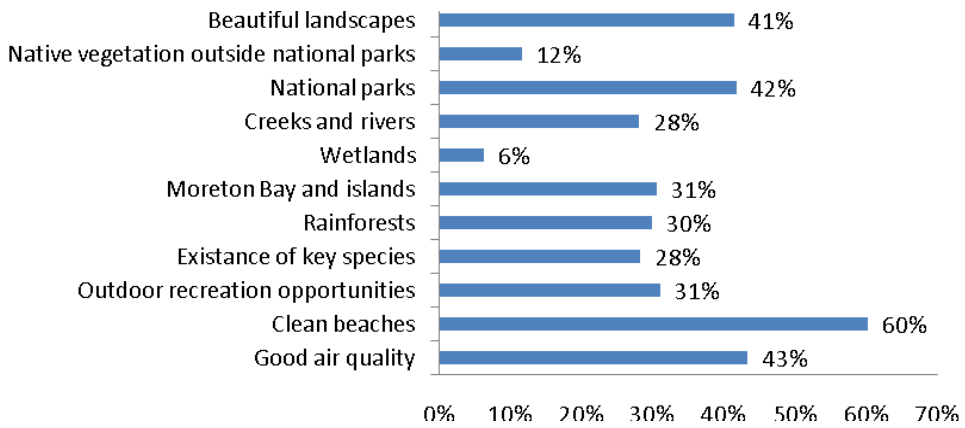
### 2.2.1. Most liked environmental attributes in SEQ

The household survey also elicited data in the most liked natural environment attributes in SEQ (Figure 2). The results show that clean beaches, good air quality, national parks and beautiful landscapes are the most liked attributes, while outdoor recreation opportunities that flow from the extent of outdoor recreation opportunities (including recreational fishing) was also recognised. Interestingly, further analysis of the survey results indicates no statistically significant differences between respondents in the coastal zone of SEQ (i.e. postcodes within 20km of the coast) compared with respondents further inland.

[6] 921 households were surveyed and then results were weighted to match the demographic profile of the SEQ NRM region.

[7] TNS Social Research, 2010, Queensland Growth Management Summit 2010 Social Research on Population Growth and Liveability in South East Queensland.

**Figure 2: Most liked natural environmental attributes**

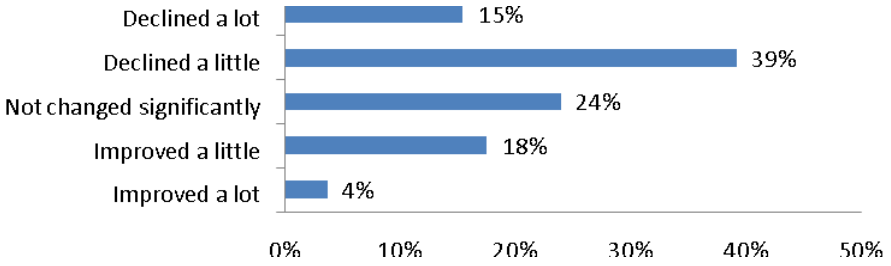



*Source: DBM and MJA*

### 2.2.2. Community perceptions on resource condition and trend

The same survey also elicited data regarding the community's perception on trends in the quality of the natural environment over the past decade (Figure 3). 54% of the respondents thought the quality of the environment had declined, with 15% of the view that the quality had declined significantly. Only 22% of respondents believed that condition had improved, and only 4% believed it has improved a lot. The data shows that approximately a quarter of respondents thought there had been no significant change in the quality of the natural environment. In other words, a significantly higher proportion of households think environmental quality is getting worse than those who think it is getting better. While further analysis of the data based on a split of respondents in the coastal and inland zones did not generate statistically significant differences, results in the inland zone were slightly more skewed towards a decline than results from the coastal zone.

**Figure 3: Change in quality of natural environment over past 10 years**



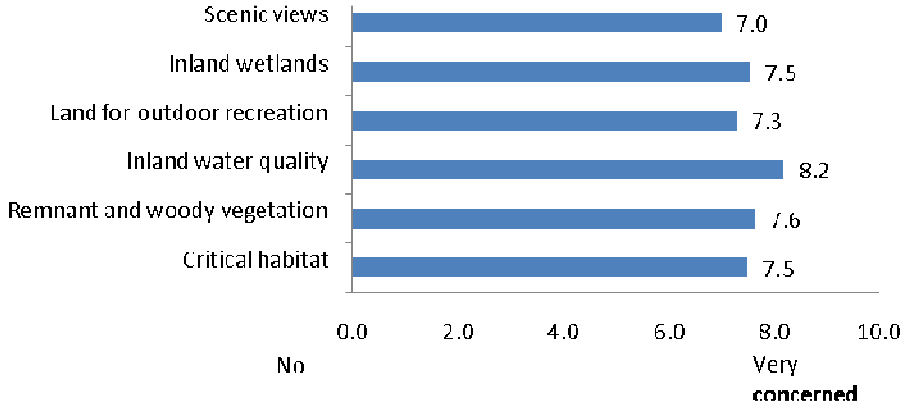

*Source: DBM and MJA*

### 2.2.3. Community's major concerns

There was a general high level of concern regarding natural resource condition. Water quality featured particularly highly in community concerns, as did critical habitat such as remnant and woody vegetation and inland wetlands. Concerns for amenity issues such as

scenic views and the availability of land for outdoor recreation were slightly lower (Figure 4).

**Figure 4: Greatest environmental concerns and levels**




*Source: DBM and MJA*

### 2.2.4. Environmental management and economic growth in context

Survey respondents were asked their preferences regarding economic growth and protection of the environment. Survey results indicate a strong community preference that economic growth and the protection of the environment should at least be given equal priority. **Overall, the survey results are slightly skewed towards a preference for protecting the environment as a higher priority, even if economic growth were constrained.**

**Table 3: Preferences for balance between environmental management and economic growth**

| *Statement* | *% of households that agree* |
|---|---|
| Protection of the environment should be given priority, even at the risk of holding back economic growth | 29.2 |
| Economic growth should be given priority, even if the environment suffers to some extent | 4.1 |
| Economic growth and protection of the environment should be given equal priority, with sacrifices being equally made when trade-offs are inevitable | 61.3 |
| Don't know | 5.4 |

*Source: DBM and MJA*

## 2.3. The SEQ Natural Resource Management Plan

NRM in SEQ is achieved through an array of approaches including regulations (e.g. the *Environmental Protection Act*), direct investments such as the formal reserves system, economic approaches to encourage more sustainable behaviours (e.g. volumetric water pricing) and suasive programs designed to provide the community with the information and ability to implement positive change.

SEQ Catchments[8] has recently lead the development of the SEQ Natural Resource Management Plan (SEQ NRM Plan) that establishes a strategy for the long term sustainability, continued lifestyle and economic prosperity of the region. The plan includes consideration of the extent and condition of key (primarily) natural assets and establishes a number of targets for those assets. In effect, SEQ Catchments has been a true integrator across NRM issues and the SEQ NRM Plan is the first genuinely integrated NRM plan in SEQ.

### 2.3.1. Key NRM assets - condition and trend

For the purposes of the SEQ NRM Plan and this report, key natural resources are considered as different natural resource assets. Broad assessments have also been made of their current condition and trend. **Generally the region is tracking well in terms of air quality, fisheries, scenic and protected areas and water use. However, the loss of natural habitat and critical regional ecosystems and increasing pollutant loads are threatening the region's biodiversity and the loss of open space is impacting on the community's ability to enjoy an outdoor lifestyle.** Key assets and their current condition are broadly set out below and in more detail in the Appendix.

**Air and atmosphere**

Factors such as population growth and increases in households and car use can cause increases in greenhouse gas emissions and air, thermal, noise and light pollution which have negative impacts on air and atmosphere quality.

Generally, the SEQ State of the Region Report indicates that while air quality is currently good, increases in greenhouse gas emissions caused by population growth and higher motor vehicle use pose a threat to future air quality.

**Coastal and marine**

The SEQ coastline supports diverse coastal and marine ecosystems and is the basis for significant community, recreational (including tourism) and commercial activities. Key assets and issues include the extent and condition of seagrass and mangroves, coral, beaches, fish stocks, key species and coastal wetlands, and the extent and frequency of coastal algal blooms.

The State of the region reporting indicates the marine environment is under threat and that marine protected areas need to be expanded.

**Community**

A key asset of the region is the ability and capacity of the community to engage in planning, implementation and monitoring of activities to achieve regional targets, including natural resource managers, government and non-government organisations.

The State of the Region report indicates that social capital within the region is stable, and many other indicators for strong communities are improving, in good condition or sustainable, although indicators for healthy lifestyles and housing affordability are in poor condition.

[8] SEQ Catchments is a non-government organisation that works with corporate, community and government partners with the aim of maintaining and restoring the environment for future generations.

**Land and nature conservation**

Rich and diverse native animal and plant species exist across the region, with key habitat assets including remnant and woody vegetation, corridors, wetlands, vulnerable ecosystems, threatened species and habitats for priority species. In addition, the supply of food, fibre and other materials to sustain the community is dependent on the extent, condition and area of land in the region, which can be impacted by salinity, acidity, soil erosion and contamination.

The majority of natural environment indicators show the region's biodiversity is under threat. The populations of selected species are declining.

**Regional landscape areas**

Access to and connection with regional landscapes such as heritage areas, recreational spaces and waterways, including those which provide high or important scenic amenity, is vital to the quality of life of people residing in the region.

The total amount of land available per person for recreational activity has decreased due to population growth, despite an overall increase in public open space, and the region's landscape heritage and outdoor recreation participation are assessed as of concern, or less sustainable. The scenic amenity of the region is assessed as improving or in good condition.

**Traditional Owners**

Indigenous peoples from the region provide valuable input to community planning and decision making, alongside natural resource managers, government and non-government organisations.

State of the region indicators for Indigenous equity, health and housing show these are in poor condition and not sustainable, and that Indigenous education is of concern.

**Water**

Waterway and groundwater flows and health are vital for human water consumption and the provision of ecosystem services, including the control of pollution and water quality. In addition, the region provides water for various recreational, agricultural and industrial uses and for plant and animal habitats.

Residential potable water use and water usage indicators show that, despite the recent severe drought in the region, water use has reduced due to a range of policies and programs introduced by government. Nonetheless, groundwater availability is getting worse and rural water use efficiency is of concern.

Water quality is declining under pressures from climate change and population growth. This will have a negative impact on the ecological health of catchments in the future if action is not taken.

### 2.3.2. Resource condition targets in the SEQ NRM Plan

Table 4 provides a summary of the targets established under the Plan and the degree to which the current information enables a quantification of the changes required over the planning period to meet each target.

**Table 4: Summary of targets in SEQ NRM Plan**

| *Asset* | *Targets, measures and estimates (number)* | | |
|---|---|---|---|
| | *Quantitative measures (current condition)* | *Quantitative estimate (condition in 2031 w/o policy / investment change)* | *Quantitative estimate of management actions required* |
| Air & atmosphere | 4 | 0 | 0 |
| Coastal & marine | 5 | 0 | 0 |
| Community | 3 | 0 | 0 |
| Land | 4 | 0 | 0 |
| Nature conservation | 5 | 0 | 0 |
| Regional landscape | 0 | 0 | 0 |
| Traditional owners | 0 | 0 | 0 |
| Water | 0 | 0 | 0 |

*Source: SEQ NRM Plan, SEQ NRM Plan Atlas, SEQ State of the Region Technical Report*

Key points to note from the assessment of targets in the SEQ NRM Plan include the following.

- There is a distinct lack of quantitative measures of current condition for many of the indicators for many of the asset classes. This makes monitoring and evaluation of progress towards the targets established under the plan problematic.
- Estimates of the likely condition and trend indicators for future periods without interventions are only available for a small number of indicators (e.g. water pollutant loads). In effect, this undermines our understanding of the risks of doing nothing more. It also creates problems in understanding the extent of change or investment required to meet the targets established in the SEQ NRM Plan.
- Many indicators will have threshold levels, beyond which the risks to the natural asset base, human health and ecosystem function may be significantly greater (e.g. critical sediment loads beyond which irreversible loss of ecosystem function in Moreton Bay may occur). An understanding of these threshold levels would enhance the ability to prioritise and design interventions aimed at improving the conditions of key assets.
- Some indicators are essentially intermediate outcomes (e.g. number of engaged community groups) and do not necessarily relate directly to any change in asset condition.
- Some indicators do not lend themselves to quantification.

**The targets established in the SEQ NRM Plan are a significant step forward in our understanding of the condition and trend of SEQ's key natural resource assets.** In addition, there is a significant degree of ownership of the targets at all levels of government.

**However, there are still significant gaps in the availability of quantitative information on the likely future condition of key assets without further interventions. This information gap limits the ability to understand the risks associated with current policy and planning settings and the costs to society of not intervening.**

**These limitations in biophysical information constrain the degree to which accurate estimates of economic impacts of current policy settings can be established.** This is

particularly the case where the relationships between resource condition and the economic benefits derived from that natural resource are not known with any certainty.

## 2.4. Key drivers of threats

There are a number of direct and indirect anthropogenic threats to the natural resource asset base. Two key threats are climate change and population growth (coupled with the development that result from population growth).

The threats relating to climate change are important but are of a broader contextual nature in this analysis. However, it should be noted that significant actions will be required in SEQ to adapt to climate change at the local and regional scales. **This report largely focuses on threats related to population growth. The rationale for this is simple – these are the threats that can be materially reduced through actions at a regional and/or local scale.**

### 2.4.1. Climate change

Climate change forms a key driver of threats to the extent and condition of SEQ's natural asset base as it will fundamentally change climate patterns and subsequently impact on the resilience of ecosystems. In addition, it will create a number of new risks to SEQ attributable to increased severity of drought, flood and bushfire risks.

Table 5 summarises some of the key potential impacts attributable to climate change in SEQ.

**Table 5: Potential impacts of climate change – whole SEQ NRM region**

| *Timeframe* | *Annual rainfall (average % reduction)* | *Sea level rise (m)* | *Coastal encroachment (m)* | *Increase in average temp (deg C)* | *Increase in hot days p.a. (>35 deg C)* |
|---|---|---|---|---|---|
| 2030 | 13% | 0.15 | Up to 35 | 2 | 5 |
| 2070 | 40% | 0.60 | Up to 45 | 6 | 43 |

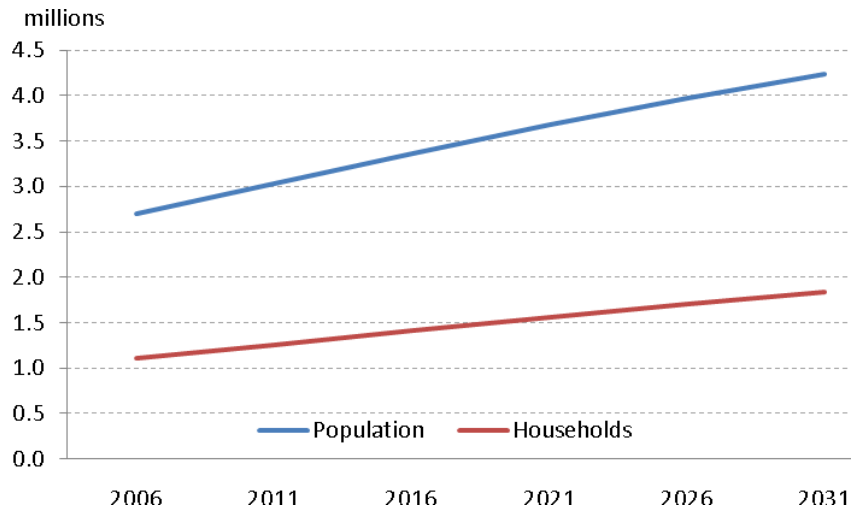
*Source: SimCLIM modelling undertaken for SEQ Catchments*

**It should be noted that many of the risks associated with climate change come from changes in extreme events, not from changes in the means (averages) of key variables like temperature.** For example, while average temperatures are only expected to increase by around $2^{O}$C, the number of extremely hot days in summer will increase significantly, resulting in much higher fire risks, stress on a number of ecosystems, significant spikes in energy use, and negative health impacts.

### 2.4.2. Population growth, distribution and high level impacts

The SEQ region is experiencing an extended period of population growth and this growth is expected to continue for the life of the SEQ NRM Plan. By 2031, the State Government's medium projections for population are 4.2 million people living in 1.8 million households (Figure 5).

**Figure 5: SEQ population and household estimates and forecasts**




*Source: Queensland Government PIFU*

While the overall population is expected to increase by approximately 57% by 2031 (or 1.8% per annum) it is worth noting the following

- The distribution of population growth is not uniform across SEQ. Much of the population growth will occur in areas already highlighted in the SEQ Regional Plan, i.e. in areas away from the coastal zone such as Ipswich (up 295,000 persons or 205% increase). In addition many of the smaller regional centres are also expected to experience significant growth (e.g. Beaudesert, up 115,000, or 178%). However, the more established regions in the coastal zone are still expected to cater for the bulk of population growth (e.g. Brisbane (up 230,000 or 23%) and the Gold Coast (up 350,000 or 70%)).
- The population growth, its distribution and the changes in land use will all trigger major direct and indirect impacts on the natural resource base in SEQ.

### Inward migration the key driver of population growth

Much of the population growth is expected to be driven by inward migration. Various factors have been identified that have driven the high rates of domestic and international migration into SEQ such as:

- overseas migration, often for economic reasons (e.g. income differentials with other economies) attributable to Queensland's high recent economic growth rates;
- increased numbers of overseas students;
- policies to attract skilled migrants;
- quality of life factors, such as climate; and
- events in interstate economies (such as high unemployment in Melbourne in the 1990s and the spike in housing prices in Sydney in the 2000s).

Lifestyle attractions (including outdoor recreation opportunities) and accessibility are also key drivers of migration into SEQ. This is recognised at all levels of government and

industry. For example, in promoting investment and migration to SEQ; the Council of Mayors in SEQ state:

> *SEQ offers a unique and beautiful natural environment and quality social and cultural infrastructure. The environmental attributes continue to attract residents and influence the decision to locate a business in the region.*[9]

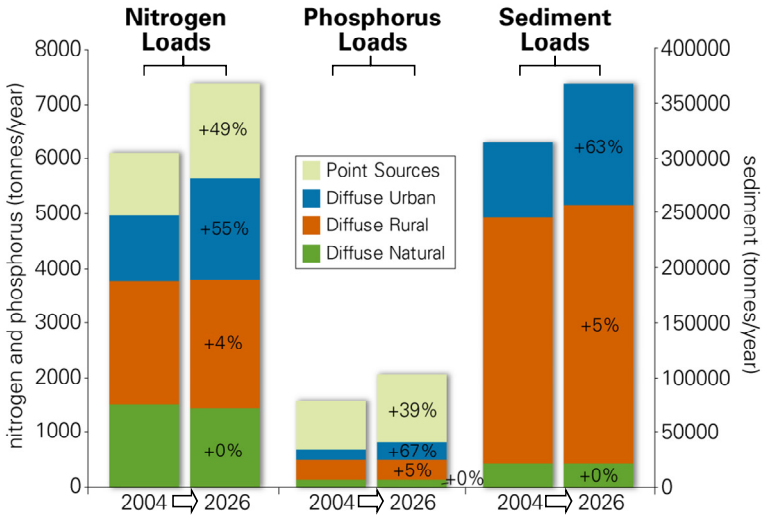
Demographic change creates a significant set of challenges for regional planning in SEQ, including maintaining/enhancing the region's key natural resource attributes that act as draw cards to migration and investment.

### Environmental consequences of population growth

Population growth and associated development are a major threat to the condition of SEQ's natural resource asset base. Population growth will result in a number of impacts including:

- changes in land use into more intensive uses (e.g. residential) and losses of green space, agricultural land and biodiversity;
- increased GHGs and poorer air quality due to urban spread resulting in additional transport tasks;
- additional pressures on the resilience of key ecosystems, particularly Moreton Bay, to cope with shocks (e.g. temperature changes, availability of biomass in the food chain); and
- poorer water quality and waterway health due to increased key pollution loads from changes in land use if no additional measures are undertaken (see Figure 6).

**Figure 6: Example of environmental threats - impact on water pollution loads if no additional measures undertaken in SEQ**




*Source: South East Queensland Healthy Waterways Strategy 2007-2012*

[9] SEQ Council of Mayors, South East Queensland – Australia www.councilofmayorsseq.qld.gov.au

### Community perceptions of relationship between population growth and environmental condition

This report highlights that much of the risk to the condition of the region's natural resource base is ultimately driven by population growth. It is apparent that the broader SEQ community are very aware of this risk. For example, in the recent surveys for the Growth Summit, respondents did not identify the environment as something that would benefit from population growth, yet 20% of respondents identified that there would likely be negative impacts on the environment attributable to population growth.[10]

**Figure 7: Community perception of long-term impacts of population growth**


*Source: TNS Social Research*

Figure 7 shows some of the major sustainability concerns of the community attributable to population growth. There is a clear trend towards a belief that things will get worse (often significantly) due to population growth. The major concerns relate to marine and waterway health. This is entirely consistent with the findings of the survey conducted specifically for this report.

[10] TNS Social Research, 2010, Queensland Growth Management Summit 2010 Social Research on Population Growth and Liveability in South East Queensland.

# 3. Linking resource condition and economic indicators and values

This Section briefly outlines the framework and process used for linking resource condition and economic values throughout the report.

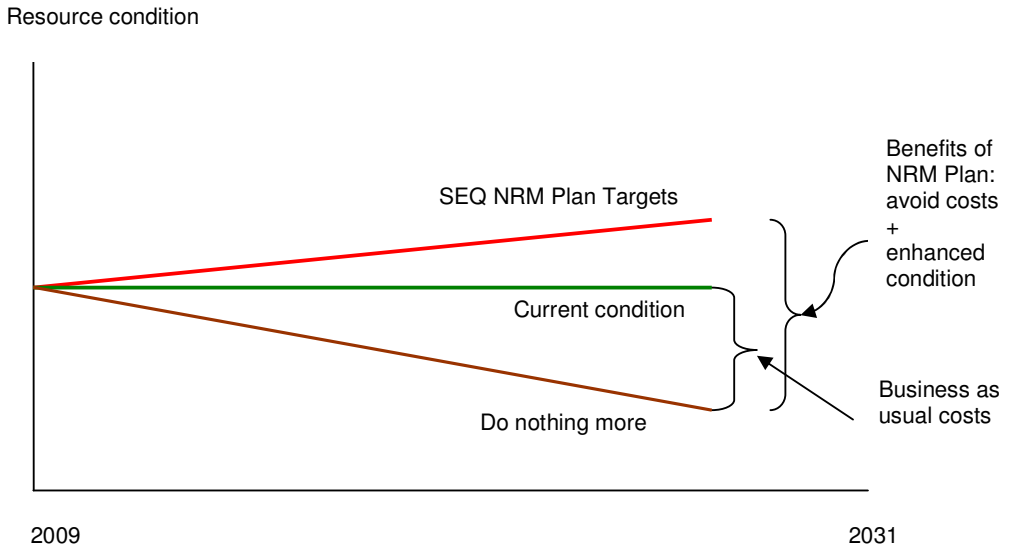
## 3.1. Resource condition – business as usual trends

In undertaking the economic assessment, it is vital to assess the potential impacts against a base case that represents what might reasonably be expected to happen in the absence of any material changes in interventions (policy or investment). This concept is shown in Figure 8.

- The difference between the 'current condition' and the 'do nothing more' lines represents the loss in natural resource condition expected by 2031 without further interventions. This would be considered the economic costs of a business as usual scenario.
- The difference between the current condition and the 'SEQ NRM Plan targets' indicates the potential enhancement of resource condition that have been outlined in the Plan.

**Ultimately the economic benefit of meeting the targets is the difference between the 'do nothing more' and the 'SEQ NRM Targets'. These benefits include the avoided cost of further degradation and the enhancement of the current condition for some assets.** From a public policy perspective, if the market has failed to deliver socially optimal natural resource management outcomes and the benefits of meeting the targets exceed the costs, there is an economic case for intervention.

**Figure 8: Consideration of business as usual base line for assessments**

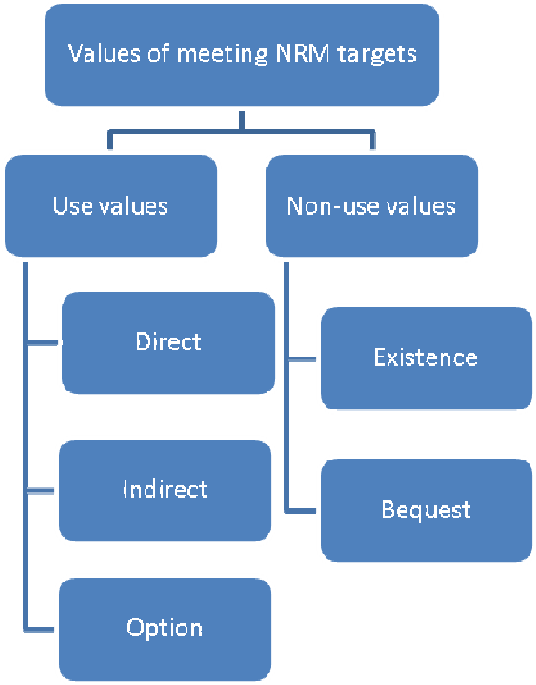



*Source: MJA*

## 3.2. Types of economic values

There are a number of types of economic values relevant to the study and there are a number of ways to categorise and estimate these values. Often the values are categorised as use values and non use values, with use values being further categorised into direct, indirect and option values. These are shown in Figure 9 below.

**Figure 9: Values of meeting NRM Targets**




*Source: MJA*

Use values generally relate to the value of directly or indirectly using a natural resource. These include:

- **Direct values.** These relate to the values directly attributable to the use of natural resources for production or consumption such as water, fish, timber, etc. Typically these values are reflected within market prices paid for goods and services.
- **Indirect values.** These values relate to values indirectly attributable to the natural resource base that also often have market values. Examples include the value of reducing sediment loads in rivers that reduce the need to use chemicals in the water treatment process.
- **Option values** represent the premium placed on maintaining a natural resource asset for future possible uses. For example, a river is valued because, although people may not use it now, they may want to retain its condition for the possibility of using it in the future.

Often natural resource assets also have non-use values – for example, people value something regardless of whether they can actually use it. Non-use values include:

- **Existence values** where people value something simply because it exists – e.g. a species such as the platypus, or habitat for endangered fauna species, regardless of whether they plan to visit to see the species, they value knowing that it exists.
- **Bequest values** which relate to the value of being able to pass something on to the next generation - e.g. knowing that future generations can visit a beautiful river.

**The maintenance of the natural resource base in SEQ generally involves both use and non-use values, often simultaneously from the same natural resource asset.** The estimation of these values is highly dependent on the natural resource and its use. Many values are revealed through market transactions and are called **market values**. For example, the value of timber is revealed through the price paid for it in the market. However, many values associated with meeting the NRM targets do not relate to goods and services traded in a market situation. These are called **non-market values**.

## 3.3. Linking resource condition and economic indicators and values

Table 6 maps out the linkages between changes in resource condition and economic values assessed for each resource asset in the SEQ NRM Plan. It includes information on the following.

- **Assets (sub-assets).** The key resource assets (and sub-classes of assets) outlined in the SEQ NRM Plan.
- **Key drivers of declining resource condition.** A description of the key environmental, demographic and socio-economic drivers of declines in resource condition for each asset.
- **Manageability of resource condition.** The manageability of the risks posed to resource assets and the primary interventions (regulation, planning, policies, and investments) that are used to currently manage the environmental risks. These interventions are assumed to underpin the 'do nothing more' case for the assessments.
- **Relative economic risk.** A qualitative assessment of the relative economic risks posed by the decline in resource condition. This reflects the fact that there is not necessarily a one-to-one relationship between physical risks and economic risks. It also reflects that the linkages between physical asset condition and economic values are greater for some assets.
- **Relationship between resource condition and economic values.** A brief summary of the information known to underpin quantitative relationships between resource condition and economic values and the broad approach used to make these linkages in this report. As noted in Section 2.3.2, this information is relatively poor.
- **Economic values assessed.** A brief description of the relevant economic values assessed in this report. Note: To avoid double counting, where the same costs could be categorised under multiple asset classes, they are only assessed once. For example, nature based tourism will be affected by declining waterway, coastal, biodiversity and regional landscape assets. Therefore the impacts on nature–based tourism reflect a decline across all of the relevant asset classes.

**Table 6: Linkages between resource condition and economic indicators and values**

| *Assets (sub-assets)* | *Key drivers of declining resource condition* | *Manageability of resource condition* | *Relative economic risk* | *Relationship between resource condition and economic values* | *Economic values assessed* |
|---|---|---|---|---|---|
| ***Air and atmosphere***<br><br>(GHGs, air quality, thermal, noise and light pollution) | ▪ Population growth driving GHG emissions.<br>▪ Climate change increasing bushfire risks. | ▪ Can make contribution to GHG emission reductions, but key strategy is adaptation.<br>▪ Mange bushfire risk to mitigate air quality problems. | Low (except GHGs) | With the exception of climate risks (known at broader scale), information is very limited. | No assessments for this project due to relatively low risk, but climate change incorporated into context for assessment. |
| ***Coastal and marine***<br><br>(seagrass and mangroves, coral, beaches, fish stocks, key species, algal blooms, wetlands) | ▪ Development in the coastal zone – loss of habitat.<br>▪ Declining water quality impacting on habitat and triggering algal blooms.<br>▪ Climate change can increase extreme rainfall and storm events, leading to flooding affecting coastal and marine environments. | ▪ Avoiding loss of key habitat through planning mechanisms.<br>▪ Manage declining water quality (and subsequently risks to coastal assets) via EPP water and direct investment in pollutant mitigation. | High | ▪ Quantitative relationships between asset condition and economic risks poorly understood. Accessed via use of scenarios.<br>▪ Proxy indicators of resource condition used in survey to make direct link between resource condition and non-market economic values. | ▪ Potential direct financial impact on nature-based tourism expenditure.<br>▪ Potential direct financial impact on recreational expenditure.<br>▪ Potential non-market economic values of loss of recreational, amenity and environmental benefits. |
| ***Community*** | Change in gov't priorities. | N/A | Low | N/A | Outside scope of this report. |
| ***Land***<br><br>(salinity, agricultural land, soil erosion & condition, grazing land condition, land contamination, extractive resources) | ▪ Population growth and land use change.<br>▪ Climate change. | ▪ Mitigate risks via planning instruments.<br>▪ Rehabilitation and land use management to avoid soil erosion. | Medium | Quantitative relationships between asset condition and economic risks poorly understood at scale necessary to develop definitive values. Assessed via use of scenarios. | Potential direct impact on the gross value of primary production. |

| *Assets (sub-assets)* | *Key drivers of declining resource condition* | *Manageability of resource condition* | *Relative economic risk* | *Relationship between resource condition and economic values* | *Economic values assessed* |
|---|---|---|---|---|---|
| ***Nature conservation***<br><br>(remnant woody vegetation, vegetation fragmentation and connectivity, wetlands, vulnerable ecosystems, native species, priority habitat) | ▪ Areas with high biodiversity and native vegetation values being used for urban development – loss of biodiversity conservation.<br>▪ Wetlands threatened by urban development and poor water quality – loss of biodiversity/ habitat protection. | ▪ Manage land use change via planning instruments and policies such as offsets.<br>▪ Direct intervention to reduce threats to assets. | High | ▪ Quantitative relationships between asset condition and economic risks poorly understood. Assessed via use of scenarios.<br>▪ Proxy indicators of resource condition used in survey to make direct link between resource condition and non-market economic values. | ▪ Indirect financial values of nature conservation asset underpin nature-based tourism and recreational expenditure.<br>▪ Potential non-market economic values of loss of recreational, amenity and environmental benefits. |
| ***Regional landscape areas***<br><br>(landscape heritage, outdoor recreation settings, scenic amenity) | ▪ Conversion of agricultural land to urban - loss of production and aesthetic benefits.<br>▪ Conversion of State-owned land and subsequent loss of outdoor recreation opportunities. | ▪ Manage land use change via planning and planning instruments such as offsets.<br>▪ Direct investment by government to mitigate risks. | Medium | Proxy indicators of resource condition used in survey to make direct link between resource condition and non-market economic values. | ▪ Indirect financial values of regional landscape areas underpin nature-based tourism and recreational expenditure.<br>▪ Indirect financial values of State Budget health impacts.<br>▪ Potential non-market economic values of loss of recreational, amenity and environmental benefits.<br>▪ Potential indirect impact on house values attributable to changes in amenity (e.g. view sheds). |

| *Assets (sub-assets)* | *Key drivers of declining resource condition* | *Manageability of resource condition* | *Relative economic risk* | *Relationship between resource condition and economic values* | *Economic values assessed* |
|---|---|---|---|---|---|
| ***Traditional owners*** | Change in gov't priorities | N/A | Low | N/A | Outside scope of this report. |
| ***Water***<br><br>(environmental flows, groundwater levels and quality, groundwater dependent ecosystems, high ecological value waterways, waterway condition) | ▪ Urban development and agricultural intensification – impact on water quality.<br>▪ Urban development impact on waterway health.<br>▪ Climate change impact on water quality and flows. | ▪ Water quantity and flow managed via Water Resource Plans and Water Supply Strategies.<br>▪ Water quality managed via point source treatment, WSUD and rural diffuse management. | Medium / high | ▪ Quantitative relationships between asset condition and economic risks poorly understood. Assessed via use of scenarios.<br>▪ Proxy indicators of resource condition used in survey to make direct link between resource condition and non-market economic values. | ▪ Indirect financial values of increased water treatment costs.<br>▪ Potential non-market economic values of loss of recreational, amenity and environmental benefits. |

*Source: MJA*

## 3.4. Key methodologies and assumptions used in quantitative assessment

Sections 4 and 5 of this report outline the findings from the economic assessments. The assessment has been separated into two broad categories:

- costs to business, governments and households from declines in resource condition represented by changes to key economic indicators (Section 4); and
- community and social values which represent actual losses in economic welfare from reductions in the condition of key natural resource assets (Section 5).

### 3.4.1. Costs to business, government and households (economic indicators)

A number of key direct and indirect financial costs to businesses, governments and households have been identified, scoped and estimated wherever possible. These are assessed and presented as changes to key economic indicators for the relevant sectors. This component of the project was essentially undertaken as a desk top analysis based on information from publicly available, government and corporate sources.[11]

Costs to businesses, governments and households have been presented as impacts on key economic indicators (e.g. industry turnover or increased production costs). Because of information and data limitations, more sophisticated economic approaches were not possible.

For each key sector, scenarios have been developed and economic estimates established of the financial change that could be attributable to a decline in resource condition consistent with the risks to resource condition outlined in Section 2. An overview of the approach is outlined below.

- **Qualitatively identify and isolate likely impacts.** The first step for each sector was to identify and isolate the likely physical and subsequent financial impacts attributable to declines in resource condition (e.g. a reduction in nature-based tourists due to a decline in coastal condition). This is summarised in Table 6 (page 20). It should be noted that this often requires assumptions to be made based on available information.
- **Quantitatively isolate relevant market segment.** Next data was gathered from available sources on the key sectors and, where necessary, analysed to establish a value for the relevant market segment. For example, official tourism statistics were used in conjunction with research findings from academics to estimate the current proportion of tourism activity attributable to nature-based tourism.
- **Quantitatively estimate current sector economic indicators and establish baseline forecasts.** Using available information and data, estimates of the current economic indicators of each sector were established. This required adjusting historically available data to match 2009 prices and/or levels of activity. Forecasts of future levels of activity were then established using relevant available forecasts (e.g. State estimates of future population, Tourism Forecasting Council estimates of tourism demand, etc). Activity forecasts were then converted to financial forecasts using available financial data (e.g. tourism expenditure per guest night for the relevant market segment). Where data on future prices is not available, it has been assumed that current prices will be maintained in real terms.

[11] All sources of information are referenced in relevant sections.

- **Establish a range of feasible scenarios of losses attributable to declining resource condition.** Because there are no formal quantitative estimates of resource condition for 2031, or quantitative estimates of relationships between resource condition and economic indicators, scenarios were then established to represent the potential range of outcomes by 2031. These ranged from a 1% to 20% decline from a business usual level of activity attributable to declines in resource condition. This range is generally in line with the limited number of relevant studies undertaken outside SEQ. This approach has assumed that declines in activity levels by 2031 occur at a constant rate between 2009 and 2031.[12]
- **Estimate changes to economic indicators attributable to each scenario.** Finally, estimates of economic indicators of each of the scenarios were established. These were calculated annually over the life of the SEQ NRM Plan and are presented as total impacts (e.g. total reduction in nature-based tourism turnover between 2009 and 2031) and the present value of the impacts.[13] This was done for declines in activity from business as usual of 1%, 2%, 5%, 10% and 20%. This provides a range of potential impacts.

It should be noted that industries are dynamic and will adapt in response to changes in environmental and market circumstances over time. Therefore the range of economic indicators is necessarily broad.

**While understanding potential impacts on economic indicators for key sectors is instructive, it is most likely that any changes in the condition of resources will result in a redistribution of expenditure and investment into other sectors of the economy. The most relevant impacts relate to the economic estimates of community and social values.**

### 3.4.2. Economic estimates of community and social values

The centrepiece of the quantitative assessments was the estimation of community and social values attributable to declines in resource condition. The majority of the community and social values attributable to declines in resource condition are non-market in nature (i.e. their values are not revealed in typical market transactions). Therefore a choice modelling approach was undertaken to elicit the SEQ community's willingness to pay (WTP) to avoid declines in resource condition and meet the targets established in the SEQ NRM Plan.

Choice modelling is a stated preference economic valuation technique that involves creating a hypothetical market generally via survey formats. The survey asks respondents to state their preference for a status quo option and various 'choice sets', involving alternative profiles or environmental attributes and a cost associated with each choice set. The attribute levels used in the choice sets for this project ranged between the targets from the SEQ NRM Plan (a best case environmental outcome) and the expected condition under a do nothing more policy scenario (a worst case environmental outcome).

The approach is both sophisticated and robust and provides relatively reliable estimates of community and social values attributable to changes in resource condition. The approach has been used widely by the Queensland Government to underpin levels of service for regional water supplies in SEQ and recently by Brisbane City Council to establish economic values to underpin planning, policy and investment relating to Brisbane's water resources.

[12] It is acknowledged that a constant rate of decline may be inconsistent with what will actually occur, particularly where threshold conditions exist.

[13] A real discount rate of 5.5% was used.

### Questionnaire design

A workshop was held at SEQ Catchments in November 2009 in which information gaps relating to the 'Economics of NRM' project were identified, including the natural resource issues needing to be addressed in the choice modelling exercise. A major outcome of the workshop was the identification of a set of potential attributes to be included in the choice modelling study, together with how they should be defined, and what is known about their current state and also their target state for 2031.

Drawing on the workshop findings and follow-up information provided by SEQ Catchments, a draft questionnaire was developed and circulated for feedback.

### Pre-testing

The draft questionnaire was then pilot tested among prospective respondents in four focus groups, two of which were undertaken in Brisbane, one in Ipswich and one in Gatton. The objective of the groups was to identify any issues of comprehension, recall, judgement or response with the questionnaire from the respondents' perspective.

Group participants were asked to complete the questionnaire and then taken back through the survey and asked to comment on what they were thinking about when answering each question, what they understood the question to mean, and whether they found anything confusing or difficult.

The participants were generally very positive about the questionnaire, seeing it as easy to complete and yet thought provoking and comprehensive. However a number of refinements were made to the questionnaire based on the feedback received, including substantial shortening of the background information.

The revised questionnaire was then programmed and a further pilot-test was undertaken prior to full launch in order to test that the program was working as intended and confirm that performance statistics for the choice modelling tasks were within the acceptable region.

### Survey methods

The survey was conducted online with the sample being sourced from MyOpinions, one of the research industry's leading online panel providers. Email invitations were sent out by MyOpinions and respondents agreeing to undertake the survey were diverted to the DBM site where they completed the survey. Households were eligible to participate if they lived within the SEQ region, defined by the Brisbane, Gold Coast, Ipswich, Lockyer, Logan, Moreton Bay, Redland, Scenic Rim, Somerset, Sunshine Coast and Toowoomba Councils. Screening questions at the beginning of the questionnaire were used to confirm they met these recruitment criteria.

Using available records from MyOpinions, invitations to participate were sent to qualifying households within the above SEQ local government areas. To complete the survey, respondents needed to be sole or joint household heads.

### Achieved sample

A final sample of 921 residents of SEQ was obtained in December 2009 for the online survey.

### Weighting

As an additional measure to ensure representativeness, the sample was weighted to reflect the incidence of family versus non-family households in each of the Brisbane, Gold Coast, Sunshine Coast and West Moreton Statistical Divisions, estimated from ABS Census data.

### Analysis

The data analysis involved a number of approaches. Following initial checking of the data, an exploration of the data was undertaken using basic tables. The choice modelling results were then run with a number of different specifications for the attributes being estimated. These included full linear models, part-worth models, log transformations, and quadratic and piecewise and other threshold models. An examination of the part-worth utilities for each of the attributes indicated the presence of diminishing marginal utility for all attributes and the presence of threshold effects for some.

Of the various models estimated, the model involving log transformations was selected as providing the best overall representation of the data.

To examine geographic differences, the sample was divided into respondents living in postcodes located within 20kms of the coast and those living further than 20kms from the coast. This difference was of particular interest given that some natural resource issues such as water quality in creeks and rivers provide many benefits downstream and closer to the coast when the actions required to prevent quality declines and undertake restoration programs are often required higher up in the catchment. Any differences in WTP relating to proximity to the coast were thus of interest.

### Interpretation of WTP results

The parameters of the choice model can be used to estimate marginal willingness to pay (MWTP) for changes in resource condition. Specifically, the MWTP for a one unit increase in an attribute is calculated as the ratio of the derivative of utility with respect to that attribute and the negative of the derivative of utility with respect to the monetary attribute. In the case of log transformed natural resource attributes such as employed here, this means that MWTP varies as a function of the level of the attribute in question. For this reason, estimates of WTP to move from state 1 to state 2 were calculated by dividing the interval between these states into smaller one unit intervals and summing the corresponding MWTP values across the range in question.

The final estimates of WTP for an attribute are interpreted as the average willingness to pay per SEQ household to move from state 1 to state 2, where state 2 represents a higher level of quality in natural resource outcomes than state 1. As such, the estimates can be multiplied by the population of households to arrive at aggregate estimates of WTP. To do this, State estimates and forecasts of the number of households in SEQ were used.

### Currency of WTP estimates

While the WTP estimates reported herein were current as of December 2009 when the survey was undertaken, some evolution of household preferences and hence WTP might be expected to occur in the future. However in comparison to many other choice modelling studies concerning natural resources, we expect the results of this study to be among the most stable over time. This is because the study concerns relatively generic natural resource outcomes for SEQ as a whole and not a specific set of outcomes associated with a currently

topical and controversial issue.[14] Notwithstanding these considerations, some evolution in the values for NRM outcomes estimated in this study might be expected. These changes are perhaps most likely to relate to the following.

- Changes in the NRM targets advocated by scientists, perhaps due to increased understanding of ecosystem vulnerability and resilience, or better measurement programs. Because NRM targets were mentioned in the questionnaire and many respondents appear to have taken these into account when formulating their responses, the WTP results estimated herein are conditional on these targets and any substantial changes in the targets can be expected to have an influence on WTP.
- Significant media coverage of issues relating to certain attributes included in this study. For example, if SEQ were to experience particularly bad coastal algal blooms in 2010, resulting in much greater inconvenience to the community and a dramatic increase in media coverage on the topic, then the relative importance of the water quality attribute might be expected to increase.
- Significant changes in the state of the economy (e.g. recovery from the global financial crisis) could affect households' ability to pay and hence WTP.
- An increase (or decrease) in general levels of environmental concern, or the impacts of development on community wellbeing, could result in an across the board increase (decrease) in WTP for improved NRM outcomes.

However, in the absence of hard information to indicate when, or by how much, these values may change, it has been assumed that the values elicited from the survey will remain relevant for the life of the SEQ NRM Plan.

[14] It should be noted that values elicited in the context of 'hot' environmental issue, such as water supply at the time of the debate concerning the possible building of Traveston Crossing dam, are likely to be driven more by short-term emotional responses and may change significantly when the emotional tone of the issue and media coverage thereof changes. Therefore, the currency of those WTP estimates tends to be lower.

# 4. Costs to businesses, government and households (economic indicators)

This Section summarises the analysis of the potential costs to business, government and households attributable to declines in resource condition under a do nothing more policy scenario. These costs are represented by changes to key economic indicators for each sector. Analysis is presented based on key sectors and/or issues. Because the basis for the economic estimates is not consistent across all sectors/issues (due to data constraints) it is not appropriate to aggregate costs from all sectors/issues to establish an estimate of the total financial costs.

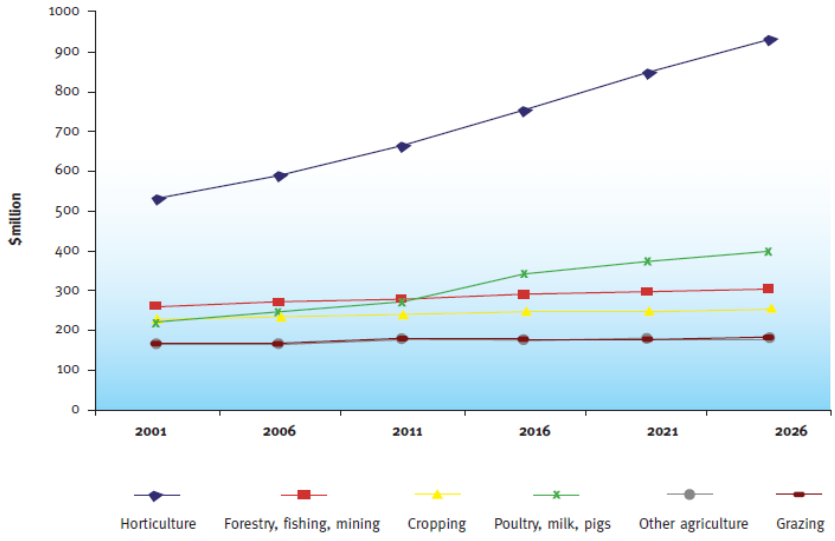
## 4.1. Agriculture

Agriculture is a sector that is directly reliant on the condition of the natural asset base to underpin production levels. While agriculture is a relatively small sector in SEQ compared with the State as a whole, the sector is still of strategic importance to the economy.

### 4.1.1. Agricultural production values

The gross value of agricultural production in South East Queensland in 2007-08 was approximately $1.2 billion, which was 13% of the Queensland total. In addition, there are also significant economic flow-on impacts through demand created in upstream and downstream sectors. It has been estimated that if sufficient water is available at reasonable prices the value of agricultural production in SEQ could reach almost $2 billion by around 2026 (Figure 10).[15]

**Figure 10: Protected value of primary production in SEQ**




*Source: Robinson and Mangan, 2007, South East Queensland Rural Economic Analysis*

[15] Robinson and Mangan, 2007, South East Queensland Rural Economic Analysis

Key elements of current production include the following.

- **Broadacre crops.** The total value of crops for SEQ was $717 million in 2007-08, accounting for 15% of the total for Queensland. Hay is a significant broadacre crop in SEQ, with a gross value of $38.2 million or 19% of the total for Queensland.
- **Horticulture.** The gross value of horticulture (nurseries, cut flowers and cultivated turf) in SEQ was $233.3 million in 2007-08 (68% of the total for Queensland). Vegetable horticulture was worth $278 million in Queensland in 2007-08 or 28% of the total for Queensland. Significant vegetables for SEQ included ginger, lettuce, and mushrooms. Fruit horticulture had a gross value of $147.5 million in 2007-08 or 13% of the total value for Queensland. Strawberries were the most significant fruit grown in SEQ with a gross value of $83.1 million or 95% of the Queensland total. Macadamia nuts were worth $5.2 million in SEQ in 2007 08, or 26% of the total for Queensland.[16]
- **Livestock.** SEQ contributed 10% of the total value of livestock slaughtered in Queensland, with a value of $394 million. The largest contributor to this total was chicken with a gross value of production of $288.7 million (92% of the total for Queensland). The value of SEQ livestock products was $96.3 million (21% of Queensland). Milk is a significant livestock product for SEQ, with a gross value of $88 million in 2007-08 (around 35% of the total for Queensland). Production is expected to be approximately 440 million litres in 2009-10.[17]

SEQ waterways are a major source of commercial fishing activity. Data from the Queensland Department of Primary Industries and Fisheries Coastal Habitat Resources Information System (CHRIS) database[18] shows there were over thirty seven thousand commercial fishing days reported in SEQ waterways during 2005 (latest data available). These resulted in a total catch of approximately 4,400 tonnes with a gross value of production (GVP) in excess of $30 million. Trawling (47% of fishing days) was found to be the primary fishing activity, followed by netting (31%) and crabbing (20%).

The commercial fishing sector is very reliant on the natural resource base for its ongoing livelihood. The Queensland Seafood Industry Association has reported the importance of good quality water to the Queensland commercial (and recreational) fishing industry. This is highlighted by the fact that around 75% of fisheries production depends directly on the estuarine environment for at least one stage of their life cycle. Should the life cycle stages be interrupted, population impacts can be very significant and the volumes and values of catch can diminish significantly. Also, because of the capital intensive nature of commercial fisheries, viability of fishing enterprises can be extremely susceptible to small reductions in catch.[19]

Analysis of historical fishing effort and catch data indicates a potential downward trend in catch rates in recent years (Figure 11). At least some of this decline is likely to be attributable to declining resource condition.

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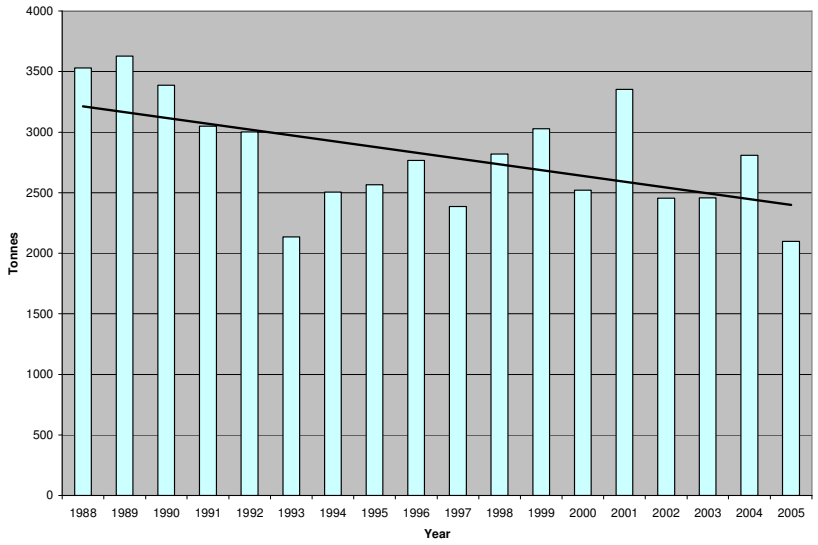
16 ABS, 2009, Valie of Agricultural Commodities Produced, Australia, 2007-08.

17 DEEDI, 2009, Prospects 2009-10.

18 Queensland Department of Primary Industry & Fisheries, 2005, *Coastal Habitat Resources Information System* (CHRIS), [online] available at: http://chrisweb.dpi.qld.gov.au/chris/.

19 Institute for Sustainable Regional Development, 2005, *Considering the Economic and Social Impacts of Protecting Environmental Values in Specific Moreton Bay / SEQ, Mary River Basin / Great Sandy Strait Region and Douglas Shire Waters*, Report prepared for the Queensland Environmental Protection Agency, March.

**Figure 11: Moreton Bay: Fishing effort and catch rates**




*Source: CHRIS Database.*

Aquaculture is another, rapidly growing, industry that relies heavily on the health of SEQ's waterways and water quality to maintain commercial production. The industry is very sensitive to water quality, and while in the short term the main cost of water quality deterioration would be treatment costs, in the long term it is more likely that aquaculture enterprises might relocate to areas where water quality standards are maintained. The industry, therefore, is likely to reap substantial benefits from actions and programs that protect or enhance waterway health.

### 4.1.2. Other values of agricultural areas

In addition to the direct production values outlined in section 4.1.1, agricultural landscapes provide a number of other benefits. These include:

- aesthetic values attributable to open space for both locals and tourists;
- opportunities for outdoor recreation in some circumstances; and
- other ecosystem functions such as the provision of habitat and enhanced water quality (under appropriate land management regimes).

These values are primarily non-market in nature and are discussed in detail in Section 5 of this report. These values are also specifically recognised in the Rural Futures Strategy for South East Queensland 2009.[20]

### 4.1.3. Economic impacts of declining resource condition

The agricultural sector is typified by 'price takers' that have little/no influence on prices received for products sold. The industry is also typified by high levels of risk from multiple sources including:

[20] Department of Infrastructure and Planning, 2009, Rural Futures Strategy for South East Queensland.

- climate variance impacting on productivity and profitability;
- soil quality risks (e.g. salinity, soil acidity, acid sulphate soils and soil erosion);
- loss of and further fragmentation of areas under agricultural production;
- changes to water quality and quanity;
- high variance in prices received by farmers driven by short-run market demand and supply fundamentals; and
- potentially high levels of policy risks impacting commercial viability.

The extent and timing of these risks differs significantly between regions, sectors and commodities.

While it can be generally concluded that a declining resource base will have a detrimental economic impact on the agricultural sector, because of the multiple risks driving production and profitability, it is not possible to establish highly robust estimates of potential impacts. However, using the primary production growth estimates prepared by the Robinson and Mangan from the University of Queensland for the SEQ Rural Futures Strategy and then applying a series of scenarios of feasible reductions due to declining condition, it is then possible to understand the potential range of impacts.

Based on 2007-08 ABS Agricultural Survey estimates and growth rates from Robinson and Mangan[21], broad estimates of the gross value of production for key commodity types are shown in Table 7.

Key points to note are that under the growth assumptions used for the SEQ Rural Futures Strategy:

- the value of production could increase by as much as 65% by 2031, primarily driven by an almost twofold increase in horticulture;
- significant growth is also expected in other livestock and livestock products (e.g. poultry); and
- the real value of broadacre crops, grazing and fisheries is likely to remain around current levels.

The major constraints on growth for these sectors is likely to be access to sufficient water at a reasonable cost and the ability to expand or intensify production while minimising land use conflicts with expanding urban settlements.

**Table 7: Estimated and forecast gross value of primary production in SEQ ($ million per annum)**

| | *Current* | *2016* | *2021* | *2026* | *2031* |
|---|---|---|---|---|---|
| Broadacre crops | 60 | 60 | 60 | 60 | 60 |
| Horticulture | 800 | 1,000 | 1,160 | 1,340 | 1560 |
| Grazing | 400 | 410 | 420 | 430 | 440 |
| Other livestock & livestock products | 100 | 130 | 150 | 180 | 210 |
| Commercial fisheries | 30 | 30 | 30 | 30 | 30 |
| Total | 1,390 | 1,630 | 1,820 | 2,040 | 2,300 |

*Source: MJA based on ABS data and Robinson and Mangan.*

[21] Robinson and Mangan, 2007, South East Queensland Rural Economic Analysis

Despite the land use controls in the SEQ Regional Plan, some agricultural land will be lost to urban development over the next 20 years. While the magnitude of that loss cannot be predicted as future development patterns are only partially known, it would not be unreasonable to expect a loss of around 25,000 ha (assuming household projections from the SEQ Regional Plan and a ratio of 15 dwellings per ha).

This area is approximately the same size as the area currently under irrigated annual horticulture production, or about a quarter of the area currently under dryland agriculture or plantations in SEQ.

Table 8 shows a range of scenarios of potential impacts over the life of the SEQ NRM Plan. As stated previously, the reductions outlined in these scenarios could be triggered by a number of threats to the resource base underpinning production including outright losses of area, soil quality decline (e.g. salinity or acid sulphate soils), or declines in water quality and quality.

**Table 8: Scenarios of potential impacts over the 2009 to 2031 period**

| *Indicator* | *Reductions in activity from business as usual levels by 2031* | | | | |
|---|---|---|---|---|---|
| | *1%* | *2%* | *5%* | *10%* | *20%* |
| *Broadacre* | | | | | |
| Reduction in turnover ($ millions) | 10 | 15 | 40 | 75 | 155 |
| Present value of reduction in turnover ($ millions) | <5 | 5 | 20 | 35 | 70 |
| *Horticulture* | | | | | |
| Reduction in turnover ($ millions) | 160 | 320 | 800 | 1,600 | 3,200 |
| Present value of reduction in turnover ($ millions) | 70 | 140 | 340 | 690 | 1,380 |
| *Grazing* | | | | | |
| Reduction in turnover ($ millions) | 55 | 110 | 270 | 540 | 1,070 |
| Present value of reduction in turnover ($ millions) | 25 | 50 | 120 | 240 | 480 |
| *Other livestock and livestock products* | | | | | |
| Reduction in turnover ($ millions) | 20 | 40 | 105 | 210 | 420 |
| Present value of reduction in turnover ($ millions) | 10 | 20 | 45 | 90 | 180 |
| *Commercial fisheries* | | | | | |
| Reduction in turnover ($ millions) | 5 | 10 | 20 | 40 | 75 |
| Present value of reduction in turnover ($ millions) | <5 | 5 | 10 | 20 | 35 |
| *Total* | | | | | |
| Reduction in turnover ($ millions) | 245 | 490 | 1,230 | 2,460 | 4,900 |
| Present value of reduction in turnover ($ millions) | 105 | 210 | 530 | 1,070 | 2,140 |

*Source: MJA.*

Key points to note from the scenarios include:

- Some losses in broadacre production due to land use change and the condition of the underlying resource base are inevitable in the absence of more actions. Even a modest decrease from business as usual trends of just 5% would cost the sector around $40 million over the life of the plan.
- **The greatest economic risks probably lie with the horticulture sector. Where horticulture land is lost to urban development, the cumulative economic costs are**

**likely to be significant. Even a modest reduction in the area under horticulture (say 5%), would reduce the gross value of production over the life of the SEQ NRM Plan by $800 million dollars.** Losses in horticulture are also likely to be exacerbated by declining soils and water quality. These costs would partially be passed onto consumers via higher prices, while producers would have to absorb a portion of the costs (depending on broader market demand and supply).

- Largely due to a lack of economies of scale in production, grazing is relatively limited in the region and is not anticipated to grow significantly in the future. However, market and land use conflict pressures on existing graziers will be exacerbated by declining resource condition (particularly soil and pasture condition) as productivity falls and input costs rise.
- Growth in other livestock and associated products such as poultry will also be constrained as land use conflicts increase between more intensive agriculture and urban development. These costs could also be relatively significant as, along with horticulture, this sector has some potential for further material growth and intensification.
- There has already been significant efforts to enhance the natural resource base underpinning the commercial fishing sector (e.g. the establishment of green zones), while license buybacks have reduced some pressure on the resource. However, the expected increases in pollutant loads into waterways will continue to adversely impact on habitat and fish breeding. This will place further pressure on the sector in the future.

**While there remains significant uncertainty about the quantitative relationships between resource condition and agricultural productivity, even relative minor reductions in production attributable to declining resource condition could have significant economic consequences. For example, a 2% reduction by 2031 from a business as usual scenario across the sector would reduce the gross value of production by half a billion dollars over the next 20 years.**

## 4.2. Nature-based tourism

Tourism is a major contributor to the SEQ and Queensland economies. It is estimated that in 2006-07, tourism contributed $12.8 billion (approximately 3.9%) to the State's gross value added (GVA). The direct contribution to State employment was estimated at around 119,000 FTE jobs, while flow-on employment was a further 97,000 FTE's.[22]

Regional tourism expenditure estimates[23] indicate that approximately 62% of Queensland's total tourism expenditure occurs in SEQ. This equates to gross value added of around $7.9 billion, 2.4% of the State's GVA, or around 133,000 direct and indirect jobs.

Clearly tourism is a major industry in SEQ. Key tourism statistics for SEQ and Queensland are shown in Table 9. Key points to note include the following.

- 84% of total expenditure in SEQ is undertaken by the international and domestic overnight sectors. These sectors are at greatest risk of a downturn from a decline in natural resource condition, particularly where substitute locations exist.
- Domestic day visitors are probably at less risk from degradation of the natural resource base as there are no realistic alternatives. However, if resource condition declines

[22] Tourism Queensland, 2008, *Direct and indirect contribution of tourism to the Qld and Australian economies*.

[23] Tourism Research Australia, 2009, *Regional Expenditure 2008*.

significantly, SEQ residents may elect not to take certain types of nature-based day trips at all.

- Further analysis of the data indicates that tourism expenditure in SEQ is marginally more reliant on the international and domestic overnight sectors than for all Queensland.

The tourism sector has experienced difficult times in recent years and forecast growth is expected to remain low in the medium term. In the 10 years to 2018, the Tourism Forecasting Council expect domestic tourism visitor nights for Brisbane and the Gold Coast to grow by 0.3% per annum, while international visitor nights for the whole of Queensland are expected to grow by approximately 3.5% per annum.[24,25]

It would be reasonable to assume that domestic day trips will continue to grow at the same rate as the SEQ population (i.e. 1.8% per annum).

**Table 9: SEQ tourism – key statistics (2008)**

| | *SEQ* | | | *Queensland* | | |
|---|---|---|---|---|---|---|
| | *Visitors '000* | *Visitor nights '000* | *Expenditure $M* | *Visitors '000* | *Visitor nights '000* | *Expenditure $M* |
| International | 1,948 | 27,751 | 2618 | 2051 | 40,564 | 4,051 |
| Domestic overnight | 10,577 | 41,033 | 7,588 | 16,711 | 72,187 | 12,427 |
| Domestic day | 18,486 | 0 | 1,879 | 28,558 | 0 | 3,124 |
| Total | 31,011 | 68,784 | 12,085 | 47,320 | 11,2751 | 19,602 |

*Source: Tourism Research Australia, 2009, Regional Expenditure.*

### 4.2.1. Nature-based tourism

Research by Tourism Research Australia indicates that nature-based tourists tend to stay for longer periods and spend more than typical tourists. Average international nature-based visitor expenditure in 2008 was $6,009 per trip, compared to $3,747 per trip for all international visitors. For domestic tourism, nature-based visitor expenditure was $925 per trip, compared to $567 per trip for all domestic visitors.[26]

Tourism in SEQ and more generally in Queensland is highly reliant on the availability and quality of nature-based tourism experiences. Research undertaken in 2007 indicates that domestic nature-based tourism in Queensland is relatively more reliant on water activities than NSW, Victoria, or Australia as a whole (see Table 10).

[24] Forecasts are not available for the whole of SEQ.

[25] Tourism Queensland, 2009, *Tourism forecasts – updated December 2009*.

[26] Tourism Australia, 2009, *Nature based tourism in Australia 2008*.

**Table 10: Domestic nature-based tourism market – key activities**

| *Activity* | *% of nature-based tourists undertaking activities* | | | |
|---|---|---|---|---|
| | *Qld* | *NSW* | *Vic* | *Australia* |
| Bushwalking | 60% | 67% | 69% | 65% |
| Visit parks and reserves | 57% | 53% | 53% | 57% |
| Water activities | 22% | 6% | 3% | 9% |
| Wildlife watching | 7% | 7% | 2% | 5% |

*Source: Tourism Queensland, 2007, Nature based activities. Year ended December 2006.*

Direct spending by tourists visiting National Parks in Queensland totals approximately $4.43 billion annually. This accounts for about 28% of tourist spending in Queensland. Moreover, direct tourist spending that can be exclusively attributed to the existence of national parks is estimated at over $749 million annually. The economic contribution of national park-generated spending to the Gross State Product of Queensland is estimated to be about $345 million annually.[27] However, these figures are relatively narrow and do not consider the broader nature-based tourism sector.

Based on an assumption that nature based tourism accounts for 28%[28] of total tourism activity, and assuming that growth rates estimated by the Tourism Forecasting Council hold for the full term of the SEQ NRM Plan, it is possible to develop broad estimates of the level of nature based tourism in SEQ. This is shown in Table 11 below.

**Table 11: Estimated and forecast nature-based tourism activity in SEQ (million guest nights per annum)**

| | *Current* | *2016* | *2021* | *2026* | *2031* |
|---|---|---|---|---|---|
| International overnight | 7.8 | 9.9 | 11.7 | 13.9 | 16.6 |
| Domestic overnight | 11.5 | 11.7 | 11.9 | 12.1 | 12.3 |
| Total | 19.3 | 21.6 | 23.6 | 26.0 | 28.9 |

*Source: MJA.*

### 4.2.2. Potential impacts of a decline in nature-based tourism

Research that estimates the relationship between resource condition and tourism activity is limited and none has been formally undertaken in SEQ. This is largely due to the complexity of the drivers of tourism behaviour. Relevant examples include:

- Huybers and Bennett[29,30] report that visitor numbers to Far North Queensland from the United Kingdom are likely to fall by 27% if environmental conditions fall from 'unspoilt' to 'somewhat spoilt'. Visitor expenditure will fall by 30% under the same conditions. This indicates that deterioration in water quality could have a major impact

[27] Ballantyne, R., Brown, R., Pegg, S., Scott, N, 2008, Valuing Tourism Spend Arising from Visitation to Queensland's National Parks, Sustainable Tourism CRC.

[28] From Ballentyne at al, 2008

[29] Huber's, T. & Bennett, J. 2000, 'The impact of the environment on holiday destination choices of prospective UK tourists – implications for Tropical North Queensland', *Tourism Economics*, 6, pp. 21-46.

[30] Huybers, T, Bennett, J., 2003, Environmental management and the competitiveness of nature-based tourism destinations, *Environmental & Resource Economics*, 24, pp. 213-233.

on the tourist industry in the region. Given the labour intensive nature of the hospitality and tourism sector, job losses could be substantial.

- A contingent behaviour study undertaken by Roebelling in Port Douglas indicated that recreational diving and snorkelling visitors would reduce annual visits to the reef by around 60% given a combined 80% decrease in coral cover, a 30% decrease in coral diversity and a 70% decrease in fish diversity. If this impact occurred across the GBR, and the relationship with visits held, the report estimated that tourism expenditure could drop by almost $140 million per annum.
- A study by MJA into the economics of aquatic weed harvesters in Deception Bay and Easter Banks in SEQ found that localised commercial impacts from algal bloom impacts can be very substantial, reducing turnover, profitability and the value of businesses reliant on recreational values in the area (i.e. accommodation and retail centres adjacent to areas impacted). Furthermore, while the impacts of algal blooms may only occur for relatively short periods, the economic impacts can be longer lasting due to negative perceptions of regions at risk of algal blooms.[31]
- Furthermore, the Queensland Tourism Strategy identifies adverse impacts of tourism on the natural environment and the falling quality of natural resources and attractions as major threats to the future of Queensland tourism's industry. Consequently, Tourism Queensland has established a number of actions to address the sustainability of tourism.[32]

All research indicates that declining resource condition leads to substantially reduced tourism activity. However, the studies undertaken have looked at the specific locations in isolation and not considered the declines in relative terms and how that might impact on market share (e.g. while declines in condition in the GBR will have an impact on diving activity, what if the condition of competing sites in Thailand is declining faster?). Reductions in activity would have two principal impacts on the tourism sector: impacts on turnover; and impacts on investment. Each of these is discussed below.

### Potential impacts on industry turnover

Because the relationship between resource condition and turnover of the nature-based tourism sector is largely unknown, MJA has modelled scenarios of the impacts on turnover for a number of feasible reductions in nature based activity that could be attributable to a decline in resource condition. These reductions are applied to the proportion of the market that is estimated to rely directly on the natural resource base only.

**Table 12: Scenarios of potential impacts over the 2009 to 2031 period**

| *Indicator* | *Reductions in activity from business as usual levels by 2031* | | | | |
|---|---|---|---|---|---|
| | *1%* | *2%* | *5%* | *10%* | *20%* |
| Reduction in guest night equivalents (millions) | 2.9 | 5.8 | 14.5 | 29.1 | 58.1 |
| Reduction in turnover ($ millions) | 400 | 800 | 2,000 | 3,990 | 7,980 |
| Present value of reduction in turnover ($ millions) | 175 | 350 | 865 | 1,730 | 3,460 |

*Source: MJA.*

[31] MJA, 2008, Benefits and costs of aquatic weed harvesters.

[32] Tourism Queensland, undated, Tourism action plan to 2012.

**While these figures are only indicative, they demonstrate that any major decline in the resource base could have significant impacts on activity (guest nights and day trips for locals) and turnover in the nature-based tourism sector. For example, if nature based tourism was 20% lower in 2031 because of a decline in resource condition (broadly consistent with studies undertaken elsewhere), the reduction in turnover would be almost $8 billion over the life of the SEQ NRM Plan.** However, as the economy is dynamic, over the life of the plan, there is more likely to be a redistribution of expenditure and investment to other areas and sectors of the economy, rather than outright losses in tourism profit.

Given the potential for major declines in the condition of key assets (e.g. water quality in rivers and creeks, declines in coastal condition and an increase of the incidence of algal blooms, loss of scenic amenity etc) it would be reasonable to perceive declines in activity from a business as usual baseline within the orders of magnitude outlined above.

The declines from a business as usual case would not necessarily result in broad scale impacts on the viability of the tourism sector. Rather, tourism business operators would adjust inputs (e.g. labour, plant and equipment) to cater for any reductions in tourism activity and/or potentially delay or redirect investment.

For domestic overnight and international tourism, the ultimate impact on the nature-based tourism sector will also be highly reliant on the condition of competing/substitute regions. If the decline in resource condition in SEQ is greater, then it would be reasonable to expect SEQ would lose market share (all other things being equal).

### Potential impacts on investment

Any decline in resource condition that underpins the demand for nature-based tourism will also have an impact on investment in the sector. Profits in the tourism sector are already relatively low given the commercial risks and there is evidence to suggest that investment in the sector is already inhibited.

- Using Accommodation and Food Services industry as a proxy for the tourism sector, ABS data indicates that profit margins in 2007-08 were just 6.8%.[33]
- Analysis of the recreational diving and snorkelling industry in the Great Barrier Reef undertaken by MJA in 2008 revealed that returns in that industry are highly variable and insufficient to trigger major investment. This was particularly the case given market and environmental risks.[34]
- Research undertaken interstate has also indicated that the nature-based and eco-tourism industry is typified by tight profit margins and the industry tends to be fragmented.[35]

**Any material reduction in the extent and condition of the natural resource base, or increase in risks of poor condition (e.g. heightened risk of algal blooms) is likely to inhibit future investment in the nature-based tourism sector. Potential investment is likely to be channelled into competing regions where resource condition is relatively better, or into altogether different sectors.**

[33] ABS, 2009, Australian Industry Cat. No 8155.0

[34] MJA, 2008, Economic value of the dive industry in the Great Barrier Reef

[35] Victorian Environment and Natural Resources Committee, 2000, Inquiry into the Utilisation of Victorian Native Flora and Fauna.

## 4.3. Outdoor and nature-based recreation

Since 1998, a series of comprehensive surveys have been undertaken to determine the changes in demand for outdoor recreation activities in SEQ. [36] The table below provides details of current participation, with 2001 figures shown in brackets for comparison. The survey results show that outdoor and nature-based recreation in SEQ is significantly reliant on sufficient opportunities that are reasonably easy to access.

The survey also identified a number of key influences and **constraints on participation** in outdoor recreation. These include the following.

- A **lack of time** was identified as the most important impediment. For example, 75% of participants stated they would like to go camping more often, but are prevented mainly because of lack of time, and the bulk of those respondents (80%) would prefer opportunities to go camping in a very natural or totally natural setting.
- **Nowhere to go** also features as a constraint for several activities (particularly the case for horse riding and water activities).
- **Health** was an issue for those involved in walking or nature study, which may be a reflection of the older age group that would like to participate in this activity.

**Table 13: SEQ outdoor recreation participation and recreation setting - 2007**

| *Activities* | *Participation rates 2007 (%) (2001 figures in brackets)* | *Recreation setting (%) (2001 figures in brackets)* | | |
|---|---|---|---|---|
| | | *Somewhat natural (%)* | *Very natural (%)* | *Totally natural (%)* |
| Picnicking | 58 (67) | 66 (59) | 26 (33) | 8 (8) |
| Walking or nature study | 35 (49) | 47(49) | 36 (34) | 15 (17) |
| Camping | 30 (33) | 33 (29) | 45 (51) | 20 (20) |
| Bicycle riding | 29 (26) | 76 (83) | 18 (15) | 4 (2) |
| Horse riding | 7 (7) | 47 (27) | 44 (46) | 8 (27) |
| Water activities | 54 (56) | 71(62) | 21 (31) | 7 (7) |
| Motorised watercraft | 21 (27) | 52 (40) | 34 (46) | 14 (14) |
| Non-motorised watercraft | 17 (19) | 50 (39) | 36 (47) | 14 (14) |
| Abseiling/rock climbing | 6 (6) | 45 (52) | 32 (24) | 23 (24) |

*Source: 2007 South East Queensland Outdoor Recreation Demand Study*

Based on Tourism Research Australia surveys of activities undertaken by day trippers[37], it is estimated that outdoor and nature based recreation accounts for approximately 35% of the total day trips undertaken in SEQ. Using available data, MJA has estimated a range of scenarios to represent potential reductions in recreational expenditure attributable to lower levels of outdoor and nature-based recreational activity.

**While there is little relevant information to provide guidance to quantitatively estimate the relationship between the extent and condition of natural resources and actual levels of activity, modest declines in activity could be expected** given:

[36] Hames. R & Keiwa. J, 2007, South East Queensland Outdoor Recreation Demand Study

[37] Tourism Research Australia, 2009, Regional Expenditure 2008.

- that the area per capital available for outdoor recreation on public land is expected to almost half in the next 25 years without major expansions of the outdoor recreation network;
- much of the urban development is occurring in areas where the availability of and access to outdoor recreational opportunities is relatively poor; and
- as the population of SEQ grows, congestion for many sites (particularly in the coastal zone) may become a significant deterrent to participating in outdoor and nature-based recreation.

**Even a modest decline of 2% in activity by 2031 would result in a decline in expenditure of approximately $200 million over the 2009 to 2031 period.**

Table 14: Scenarios of potential impacts over the 2009 to 2031 period

| *Indicator* | *Reductions in activity from business as usual levels by 2031* | | | | |
|---|---|---|---|---|---|
| | *1%* | *2%* | *5%* | *10%* | *20%* |
| Reduction in recreational day trips (millions) | 1.0 | 1.8 | 4.9 | 9.8 | 19.6 |
| Reduction in expenditure ($ millions) | 100 | 200 | 500 | 1,000 | 1,990 |
| Present value of reduction in expenditure ($ millions) | 43 | 86 | 215 | 430 | 860 |

*Source: MJA.*

Some outdoor recreational activities can have quite significant economic benefits for specific communities and locations, and changes in resource condition can have acute impacts at a local scale. Surfing is one such example. It has been estimated that the amount of tourism surfing has brought into the small community of South Stradbroke Island is approximately $20 million.[38]

Declines in resource condition may also trigger expenditure in other areas in order to establish substitute recreational opportunities. For example, if water quality decreases substantially (perhaps algal blooms become more commonplace), it would become unsafe for activities such as swimming, particularly in some areas. This may trigger higher levels of private and public expenditure on recreational facilities (such as swimming pools) to compensate for the reduction in recreation choices in the natural environment.

### 4.3.1. Recreational fishing

The Australian Bureau of Statistics survey on the number of people who engaged in recreational activities during 1999-2000 indicated that recreational fishing ranked fifth highest for its participation rate out of fifty recreational activities reported. The highest levels of participation in recreational fishing were found in Queensland.[39] Primary Industries estimate the contribution to the Queensland economy from individual fishers (gross expenditure) is approximately $880 million, with $528 million of this attributable to fishers in estuaries.[40] The most comprehensive source of data on recreational fishing in Australia is

[38] Lazarow, N., Miller, M., Blackwell, B., Dropping in - *A Case Study Approach to Understanding The Socio-economic Impact of Recreational Surfing and its Value to the Tourism Industry.*

[39] Australian Bureau of Statistics. 2000. Participation in sport and physical activities. Canberra. Catalogue number: 4177.0

[40] Queensland Department of Primary Industries. Fishweb. http://www.dpi.qld.gov.au/fishweb/

the '*National Recreational and Indigenous Fishing Survey*'.[41] The results of that survey indicate that an estimated 475,000 people in SEQ participate in recreational fishing each year (a participation rate of 22.6%). These figures show an annual total expenditure by SEQ resident anglers of approximately $194.2 million. Approximately 98% of the expenditure occurred in the coastal local government areas.[42]

Updating these figures using population growth estimates, but assuming participation rates and real expenditure per capita remains constant, around 510,000 people in 2009 participated in recreational fishing, spending approximately $210 million. If it is assumed that recreational fishing activity would continue to grow at the rate of population growth, by 2031, participation levels would be around 760,000 people and expenditure would be around $310 million (in current day values).

Using available data, MJA has estimated a range of scenarios to represent potential reductions in recreational fishing expenditure attributable to lower levels of participation. While improvements in the management of fish habitat (e.g. green zones) and commercial fishing practices should enhance recreational fishing experiences, these gains will be offset by the negative impacts on participation attributable to:

- increased congestion at key fishing spots attributable to population growth deterring participation rates; and
- increasing pollutant loads and development pressures impacting on fish habitat and catch rates.

Even a 5% reduction in participation rates from business as usual levels by 2031 would result in a reduction in expenditure on recreational fishing by approximately $160 million over the 2009 to 2031 period.

**Table 15: Scenarios of potential impacts over the 2009 to 2031 period**

| *Indicator* | *Reductions in activity from business as usual levels by 2031* | | | | |
|---|---|---|---|---|---|
| | *1%* | *2%* | *5%* | *10%* | *20%* |
| Reduction in expenditure over ($ million) | 32 | 63 | 158 | 316 | 632 |
| Present value of reduction in expenditure ($ million) | 14 | 27 | 68 | 136 | 272 |

*Source: MJA.*

## 4.4. Government services

This section briefly outlines the potential for increases in costs of key government services attributable to declines in resource condition.

### 4.4.1. Health costs

There are three key areas where expected declines in resource condition could result in increased health service provision costs to the State.

[41] Henry, G., Lyle, J., 2003, *The National Recreational and Indigenous Fishing Survey*, Commonwealth Department of Agriculture, Fisheries and Forestry, Canberra.

[42] This estimate excludes major capital purchases (e.g. boats).

### Changes in air quality

Firstly air quality in some locations may have a detrimental impact on respiratory health and trigger additional expenditure (data sets for air quality targets in the SEQ NRM Plan have not been agreed upon at this stage). Added to this, the impacts of climate change through increasing GHG emissions may have very significant impacts on health costs.[43] These risks can probably not be materially reduced through meeting the targets in the SEQ NRM Plan as reducing GHG emissions requires actions at a much greater scale.

### Changes in water quality and aquatic weeds

Declining water quality has potential impacts on human health, together with the public and private costs of dealing with the health problems. This is particularly the case where the increased occurrence of aquatic weeds has been linked to land-sourced initiating nutrients transported into the marine environment from adjacent land catchments.[44] For example, physical contact with Lyngbya during recreational activities can cause skin irritations, and inhalation of volatilised Lyngbya toxins can cause respiratory problems.[45]

There are a variety of costs that might be incurred such as medical treatment costs, government control, avoidance and remediation costs, lost productivity, and the individual suffering costs borne by residents.

A study on the health effects of recreational exposure to Lyngbya blooms in Moreton Bay found that 35% of participants who had contact with Moreton Bay waters during the 7 month study period reported symptoms ranging from skin itchiness, sore eyes and skin redness.[46]

However, the study indicated that, although the reported symptoms were very similar to those reported for Lyngbya, there were multiple potential sources of those symptoms and that Lyngbya constituted a low public health risk.

**If there is a very significant increase in the incidence of toxic algal blooms and direct contact with the public increases sharply, public health risks and costs will rise accordingly.**

### Outdoor recreation and exercise

Undertaking outdoor recreation activities encourages individuals to become active and fitter. Physical and mental health benefits of physical activity include: reduced risks of chronic diseases, weight management, improved sleep patterns, reduced stress and depression, and improved motor skills development, concentration, memory and learning.[47]

While individuals benefit from enhanced levels of fitness, the broader community also accrues considerable economic benefits via the following channels.

- A reduced strain on health related expenditure. Increases in general fitness levels reduce the likelihood of health problems such as cardiovascular disease. This, in turn, reduces

43 Garnaut, R, 2008, *The Garnaut Climate Change review: Final Report.*

44 SEQ HWP, 2007, 'Coastal Algal Blooms Action Plan', South East Queensland Healthy Waterways Strategy 2007-2012, Brisbane

45 Osborne NJT, 2001, Webb PM, Shaw GR, 'The toxins of *Lyngbya majuscule* and their human and ecological health effects' Environment International 2001a;27:381-92

46 Osborne NJ, Shaw GR, Webb PM, 2007, 'Health effects of recreational exposure to Moreton Bay, Australia waters during a *Lyngbya majuscule* bloom', Environment International, 33:309-314

47 Baumann. A, et al, 2002, *Getting Australia active: Towards better practice for the promotion of physical activity.*

the cost to the community to the extent to which future health treatment costs can be avoided.

- Increased productivity. A healthier workforce is generally more productive, particularly as the risks of health related absences are reduced and output is generally increased through changes to attitudes and motivation.

Health expenditure is a major fiscal impost on the Queensland Government[48] and the provision of suitable and accessible areas for outdoor recreation is a fundamental prerequisite for participation in exercise for many people. Maintaining sufficient levels of health across the community can create significant budgetary benefits for the State.

A major study undertaken for the Commonwealth Department of Health and Aged Care and Australia Sports Commission[49] estimated that around $466 million per annum in direct health costs are currently attributable to a lack of physical activity.

Using these estimates and assuming that health outcomes in SEQ are consistent with national outcomes, MJA estimate that the annual direct health costs of insufficient physical activity in SEQ are around $63 million per annum.

The expected decline in the extent and condition of suitable sites for outdoor recreation, in conjunction with congestion at some sites, may provide a deterrent to participation in sufficient exercise for some SEQ residents. The potential increase in health expenditure attributable to reductions in the proportion of the SEQ population undertaking sufficient exercise is shown Table 16.

**Table 16: Scenarios of potential impacts over the total 2009 to 2031 period**

| *Indicator* | *Reductions in the proportion of the SEQ population undertaking sufficient exercise by 2031* | | | | |
|---|---|---|---|---|---|
| | *1%* | *2%* | *5%* | *10%* | *20%* |
| Increase in expenditure over life of plan ($ millions) | 9.6 | 19.1 | 47.8 | 95.7 | 191.4 |
| Present value of increase in expenditure ($ millions) | 4.1 | 8.2 | 20.6 | 41.2 | 82.4 |

*Source: MJA.*

**While the relationship between outdoor recreation opportunities and fitness levels are indirect and largely unknown, even a modest decline in participation rates of 1% would increase health costs by almost $10 million over the 2009 to 2031 period.**

### 4.4.2. Water service provision

While the availability of water for consumptive purposes in SEQ is managed via the Water Resource Plan and the Regional Water Supply Strategy, the cost of potable water is impacted by the quality of water in the catchments.

Demand in SEQ is expected to increase from around 330,000 ML per annum to almost 600,000 ML per annum between now and 2031. As demand grows, opportunities for low-cost supply options become limited, forcing water prices up for everybody. The majority of the augmentations identified in the SEQ Water Supply Strategy are not climate dependent

[48] Australian Institute of Health and Welfare, 2006, Health Expenditure Australia 2004-05

[49] Stephenson. J, Bauman. A, Armstrong. T, Smith. B, and Bellow. B, 2000, *The cost of illness attributable to inactivity in Australia.*

sources. Rather they are primarily desalination plants (Lytton, Marcoola, duplication of Tugen and Bribie Island).[50] Within five years, SEQ residents potentially face some of the highest water charges in Australia.[51]

The cost increases for supply will be further compounded over time as the quality of water in SEQ's catchments declines.[52] A number of studies have investigated the relationships between catchment water quality and water treatment costs. For example:

- A study by Webber found that reductions in water treatment chemical costs attributable to enhanced catchment condition in the Lockyer Valley were valued at around $275,000 per annum. That study also found that the water quality parameter that was best correlated with changes in treatment costs was turbidity.[53]
- A study undertaken for the National Land and Water Resources Audit[54] found that declining catchment condition that leads to increased turbidity (particularly) will increases the costs of water treatment in a number of ways. Firstly, the capital costs of new treatment plants increased significantly where water quality was poor. For example, for a 500,000 kL/day plant, capital costs would be almost 40% higher for a plant that treated solids of 200 mg/L, compared to a plant with input quality of 100 mg/L.

Recognising the relationship between water quality and treatment and health costs, SEQ Water is currently undertaking a major investigation into the environmental and economic benefits and costs of enhancing catchment condition.[55]

While the problem may not be major at the moment, isolated incidents of very high turbidity such as those that occurred at the end of 2007 and early 2008 give some indication of impacts from further decline in catchment condition. Based on information from the studies above and commercial in confidence discussion with industry, MJA estimate the current cost of water treatment in SEQ is around $42 million per annum (assuming current demand of around 300,000 ML per annum).

The SEQ Healthy Waterways Strategy 2007-2012 indicated that sediment loads could increase by in excess of 15% by 2026.[56] If this trend continues, increases of 20% within the life of the SEQ NRM Plan are possible.

Further, the research by Weber demonstrates a very strong correlation between sediment loads and turbidity (i.e. a 1% increase in TSS translates to a 1% increase in turbidity).[57] Therefore, increases of 20% in the turbidity of water sources for the major treatment plants in SEQ might reasonably be expected.

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50 Queensland Water Commission, 2009, Sourth East Queensland Water Supply Strategy – Revised Draft November 2009

51 MJA, 2007, Water Sector Overview: Issues, Impacts and Opportunities, for ABN-AMRO Morgan.

52 Healthy Waterways, 2007, SEQ Healthy Waterways Strategy 2007-12.

53 Weber. T, 2005, Using a catchment water quality model to quantify the value of an ecosystem service. Paper presented at MODSIM 05.

54 Thomas. J, 2001, National Land and Water Resources Audit. Ex-situ Costs of Australian Land and Water Resources Degradation to non-Agricultural Industries, Infrastructure and Households

55 Volders, a, 2010, pers com.

56 Healthy Waterways, 2007, SEQ Healthy Waterways Strategy 2007-12.

57 Weber. T, 2005, Using a catchment water quality model to quantify the value of an ecosystem service. Paper presented at MODSIM 05.

MJA developed a basic economic model to estimate the impacts of increases in turbidity on treatment costs over the life of the plan. The estimates assume all supply augmentations beyond the current augmentation will essentially be manufactured water (desalination and recycled) and the impacts are quarantined to current climate dependent sources.

**Results of the modelling indicate that even under a conservative assumption of a 10% increase in turbidity by 2031, annual treatment costs would be approximately $16 million (6.5%) higher per annum than current levels.**

Table 17: Scenarios of potential impacts over the total 2009 to 2031 period

| *Indicator* | *Increase in turbidity by 2031* | | | | |
|---|---|---|---|---|---|
| | *1%* | *2%* | *5%* | *10%* | *20%* |
| Increase in expenditure over life of plan ($ millions) | 1.6 | 3.3 | 8.1 | 16.2 | 32.6 |
| Present value of increase in expenditure ($ millions) | 0.8 | 1.5 | 3.7 | 7.4 | 14.7 |

*Source: MJA.*

While research indicates that the relationship between turbidity and treatment costs is the most direct, other water quality issues such as blue green algae, giardia and cryptosporidium also trigger significant increases in treatment costs.

It is important to note that depending on the mitigation measure used (e.g. enhanced coagulation, biological activated carbon etc.) treatment cost increases could be up to five times as high as costs associated with increased turbidity alone.

In addition, depending on the severity of the problem and specific water quality thresholds, significant capital investments may be required at the existing treatment plants.

### 4.4.3. Remediation costs

Declines in resource condition are also likely to result in increased remediation and repair costs faced by the government sector as environmental risks increase.

For example, as pollutant loads increase, so do the risks of algal blooms, impacting on budget expenditure on clean-ups. Between 2003 and 2007, the Moreton Bay Regional Council spent almost $750,000 on beach clean-ups.[58]

Costs of some typical natural resource management rehabilitation works are outlined in the table below.

[58] A survey in 2008 by the Queensland Environmental Protection Agency in Deception Bay found no Lyngbya blooms. Source: EPA, 2008 'Lyngbya Monitoring Update- 2008', Queensland Environmental Protection Agency, Brisbane

**Table 18: Selected remediation costs**

| *Cost item/unit* | *Lower bound estimate ($/unit)* | *Medium estimate ($/unit)* | *Upper bound estimate ($/unit)* |
|---|---|---|---|
| Revegetation (total cost per ha)[59] | 905 | 2,809 | 8,474 |
| Weed eradication (per ha)[60] | 15 | 1,528 | 4,000 |
| Establishing replacement wetlands (cost /ha)[61] | 800,000 | 900,000 | 1,000,000 |
| Gulley treatment ($/km)[62] | 5,000 | 27,500 | 50,000 |
| Salinity mitigation ($/tonne of salt removed)[63] | | | |
| Evaporative Basin (100 ha) | 1,800 | 2,158 | 2,516 |
| Reverse osmosis | 1,580 | 2,385 | 3,189 |
| Tree plantation | 4,200 | 7,150 | 10,100 |
| Cap and pipe bores | 1,850 | 2,565 | 3,280 |

*Source: MJA.*

## 4.5. Housing values

The extent and condition of the natural resource base can also have an indirect financial impact on house values. This is due to the value of changing the visual and aesthetic amenity. This is particularly the case for properties with close proximity to waterways and beaches.

- There is clear evidence that properties with waterfront access command market premiums. A KPMG[64] report found that water frontage residential allotments had an average 97% premium on unimproved capital value compared with non-waterfront properties.
- More recent reports confirm that prices in waterfront areas command substantial premiums.[65]
- Read, Sturgess and Associates[66] report that algal blooms in Australia have been shown to affect property prices and a recent study[67] using the hedonic property pricing

59 Source: Schirmer, J. and Field, J., 2000, *The cost of revegetation*. These costs are based on a ten ha. project. The lowest, highest and average of median costs for all types of revegetation projects are used here.

60 Source: Schirmer, J. and Field, J., 2000, *The cost of revegetation*. The lowest, highest and average of median costs for all types of weed eradication are used here.

61 Source: CRC Catchment hydrology. Inputs for MUSIC model.

62 Source: WBM Oceanics, 2005, *Diffuse Source Best Management Practices: Review of Efficacy and Costs*.

63 Source: Patrick, I. and Wise, R., 2005, *Technical, Economic and Institutional Assessment Of Environmental Offsets to Reduce Saline Water Discharge*, University of New England.

64 KPMG 1998, Brisbane River and Moreton Bay Wastewater Management Study: Preliminary Economic Analysis of Proposed Expenditures and Strategies, Report prepared for the Queensland Government, Brisbane.

65 Rolfe, J., Donaghy, P., Alam, K., O'Dea, G., Miles, R., 2005, *Considering the economic and social impacts of protecting environmental values in specific Moreton Bay / SEQ, Mary River Basin / Great Sandy Strait Region and Douglas Shire waters*, Institute for Sustainable Regional Development, Central Queensland University, Rockhampton.

66 Read Sturgess & Associates, 2000, *Rapid appraisal of the economic benefits and costs of nutrient management*, Report for the Victorian Department of Natural Resource and Environment, August.

67 Leggett, C., Bocksael, N., 2000, Evidence of the effects of water quality on residential land prices, *Journal of Environmental Economics & Management*, 39, pp. 121-144.

technique shows that water quality has a significant effect on property values along the Chesapeake Bay, Maryland (USA). Specifically, this study found that an increase of 100 fecal coliform counts per hundred millilitres of water reduced property prices by 1.5%. The authors conclude that setting a county-wide standard of 200 counts per hundred millilitres would have benefits, measured in terms of increased property values, of up to US$12.1 M.

**The existence and condition of waterway attributes is a key driver of house values in SEQ. Where resource condition is expected to decline, this will have a negative impact on house prices.**

In addition, open space also has a significant impact on property values. A study undertaken for Ipswich City Council in 2007 by MJA used the hedonic pricing methodology to estimate the economic impacts of public open space on property prices. The research found that the proximity to local, 'strategic' and sports parks had a significant impact on median house prices.[68] Results of that analysis are shown in the table below.

**Table 19: Impact of parks on property prices**

| *Category* | *Price premium ($)* | *Price premium relative to median house price* |
|---|---|---|
| Local parks (<500 metres) | $20,000 (if < 500m) | 10.0% |
| Each kilometre to strategic park | $2,800 (per km closer) | 1.4% |
| Each kilometre to a district sports park | $1,400 (per km closer) | 0.7% |

*Source: MJA*

The study indicates that the provision of open space has a significant amenity and recreational value to the community and this is reflected in property prices. Significant price premiums (a reflection of economic benefits) are observed for properties closer to local and regionally significant parks and sporting facilities. This also has an impact directly on council rates revenues. **Where this open space is lost to development, there will be a detrimental impact on property prices.**

It should be realised that the impacts on housing prices represents a capitalised value of many of the other impacts outlined in this report (e.g. changes in resource condition, loss of outdoor recreational opportunities). Therefore, impacts on housing prices should not be added to the other impacts identified as that would result in double counting of the impacts.

[68] MJA, 2007, Economic *Values and Impacts of Public Open Space in Ipswich.*

# 5. Community and social values

As outlined in Section 3.3 there are many economic values associated with the use and condition of the natural environment that fall outside the scope of typical markets for goods and services (i.e. non-market values). Despite the fact that these values are not incorporated into market prices, they are still very important.

Because these values are not observable through market transactions, a choice modelling survey was conducted by DBM Consulting of 921 households in December 2009. A major component of this survey was to elicit each household's willingness to pay to meet specific resource condition levels and avoid the cost of further decline in resource condition.[69]

Within the survey a number of levels for resource condition were outlined including: current levels; levels expected in SEQ if nothing more was done; the levels consistent with the targets established in the SEQ NRM Plan; and a range of levels around the targets. The survey also included a cost to households that they would have to pay to achieve various levels of resource condition (payments via higher rates, charges and sometimes higher prices for goods and services).

By undertaking econometric analysis of the survey results, it is possible to estimate a household's annual willingness to pay for marginal improvements in resource condition (e.g. a 1% improvement) compared to a business as usual base case. Because the survey was sufficiently large and representative of the population characteristics of SEQ, the household values can be aggregated-up based on the number of households to estimate annual values for the whole SEQ community. If we assume that these values hold from year to year, it is then possible to estimate the social cost of a decline in resource condition over the life of the plan.

## 5.1. Community and social values assessed

The SEQ NRM Plan includes a total of 37 resource condition targets across 8 classes of assets.[70] However, of those targets, virtually none have quantitative forecasts of condition for the period covered by the SEQ NRM Plan. In addition, it is not practical to elicit economic values for each of the 37 targets through a survey mechanism.

Based on the scoping study for this project[71], a decision was made to concentrate on asset classes that are at greater risk and may actually be manageable through the implementation of the SEQ NRM Plan. Therefore it was decided to concentrate on the following assets:

- coastal and marine;
- land and nature, particularly biodiversity;
- water, particularly water quality; and
- open space.

[69] A more detailed outline of the survey approach was provided in Section 3.4.2.

[70] A full outline of the targets is outlined in the report, SEQ RCG Mapping Group, SEQ Natural Resource Management Plan Atlas: Part One: The Benchmark Atlas, Version 1.0, 2 April 2009.

[71] MJA, 2009, Economics of NRM targets in SEQ: Scoping Study.

### 5.1.1. Indicative asset condition used in analysis

Based on those broad asset classes, SEQ Catchments technical staff and MJA undertook an exercise to develop 'headline' resource condition measures that: were more understandable to the broader community; enabled estimation of current extent/condition; and allowed for estimation of extent/condition from available information sources. These are outlined in Table 20.

Table 20: Community values - assets assessed

| *Natural assets & attributes* | *Current measure* | *Potential in 2031(business as usual)* | *Target for 2031* |
|---|---|---|---|
| ***Coastal and marine*** | | | |
| Area of coastal vegetation and seagrass | 48,000 ha | 30,000 ha | 48,000 ha |
| ***Land and nature*** | | | |
| Land with woody or remnant vegetation | 700,000 ha | 600,000 ha | 900,000 ha |
| Area of inland wetlands | 100,000 ha | 80,000 ha | 100,000 ha |
| ***Water*** | | | |
| Creeks and rivers with acceptable water quality | 60% | 40% | 75% |
| ***Open space*** | | | |
| Land of significant scenic amenity | 600,000 ha | 450,000 ha | 600,000 ha |
| Land available for outdoor recreation | 0.2 ha/person | 0.1 ha/person | 0.3 ha/person |

*Source: MJA & SEQC*

## 5.2. Social costs of doing nothing more

The survey data was analysed to enable annual per household values relating to marginal changes in the condition of the natural assets. These household values were then aggregated to a whole of community estimate using the State Government estimates of households and household growth. This then enables the estimation of a social cost of a do nothing more scenario. For the sake of this assessment, it is assumed that per household marginal values do not change in real terms over the life of the plan.

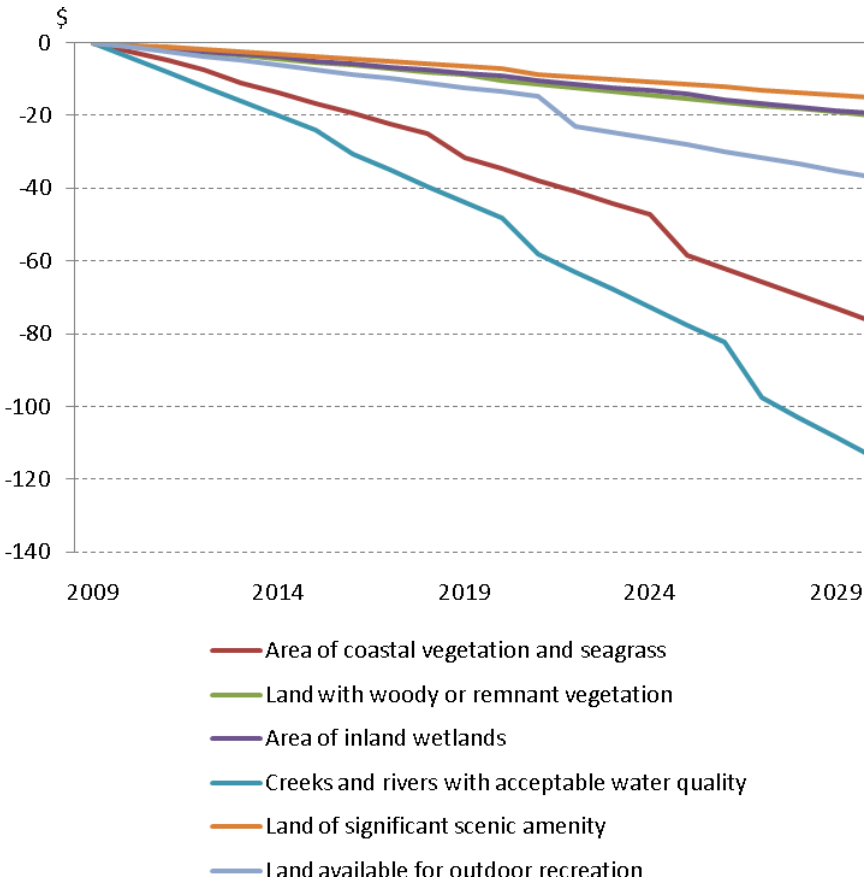
### 5.2.1. Costs at a household scale

There are significant social costs to households from a decline in resource condition. These are shown in Figure 12. The analysis indicates the following:

- **By 2031, the annual costs to each household attributable to a decline in resource condition could be as high as $290. The survey results indicate that SEQ households are willing to pay that amount (about $5.60/week) via higher rates, taxes and costs for goods and services to maintain the current level of social values attributable to the natural environment.**
- The highest values relate to water quality in creeks and rivers and coastal condition. Survey data reveals that households would be willing to pay approximately $120 per annum to avoid the expected declines in these assets.
- Values for scenic amenity, maintenance of woody vegetation and inland wetlands were relatively lower.

- Further analysis of the survey results indicated that the values of marginal changes in resource condition were not linear. The marginal values tended to get higher as resource condition worsened.
- There was no statistically significant difference between values elicited from survey respondents in the coastal and inland zones. This even holds for the coastal natural assets. This was further reinforced through focus groups held prior to the finalisation of the survey instrument in Gatton where participants held very high values for coastal environments as they wished to maintain them for future use and for their existence values.

**Figure 12: Annual household social costs of declining resource condition (by asset and attribute)**

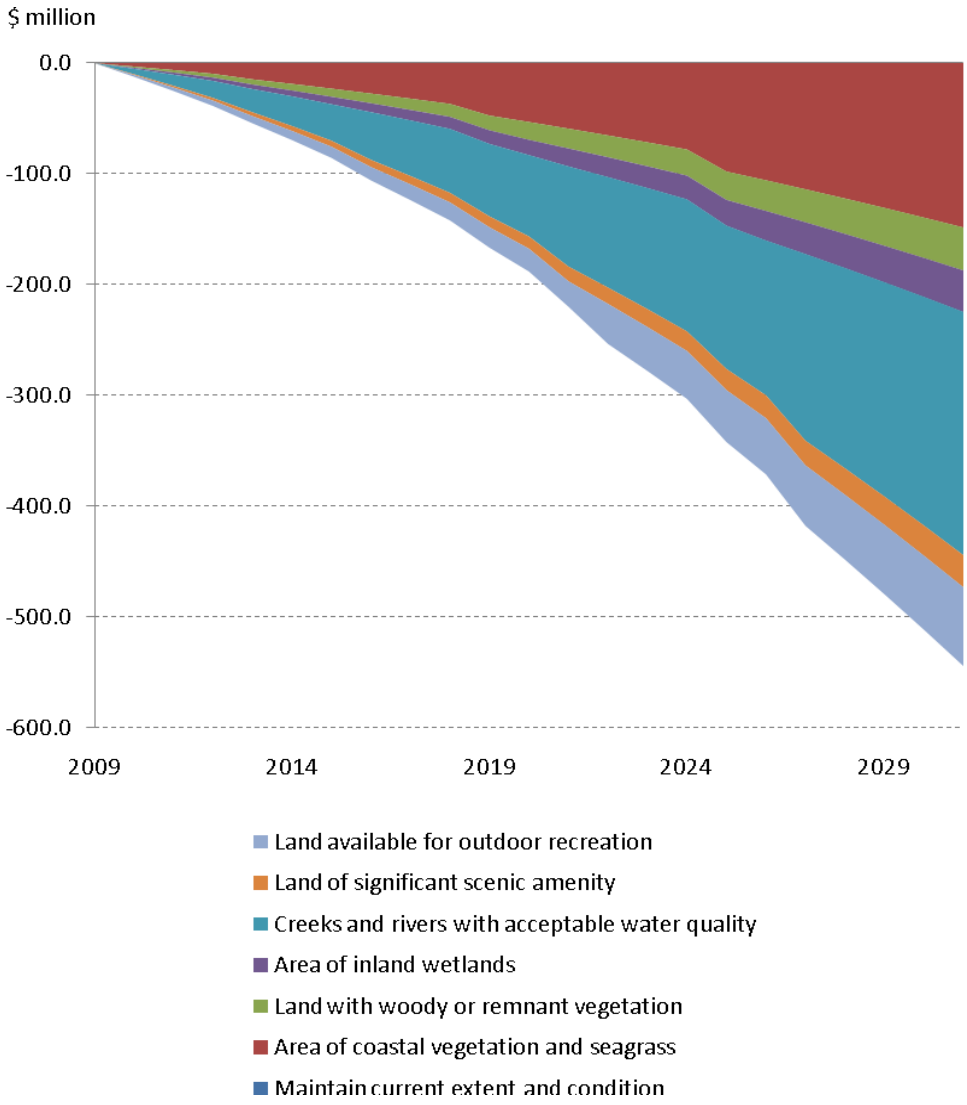



*Source: MJA analysis*

### 5.2.2. Costs to the SEQ community

Using the results outlined in Section 5.2.1 and estimates of household growth, the costs to the SEQ community of a do nothing more scenario can be estimated. These are shown in Figure 13.

**Figure 13: Annual social costs of declining resource condition**




*Source: MJA analysis*

The analysis indicates that the social costs to the community of a do nothing more scenario are very significant. **While costs are relatively modest in the short term (e.g. $25 million in 2011), by 2031, the annual cost could be in excess of $500 million per annum. The reason for the sharp increase in community costs is due to the compounding effects of higher marginal costs per household as resource condition declines and the fact that these costs will be borne by a significantly larger number of people.**

**Over the period 2009 to 2031, the social costs could be as high as $5.2 billion.** To put this in perspective, if you work on the assumption that population growth is the primary driver of the decline in resource condition, then the social cost attributable to each new SEQ citizen is around $3,400.

The present value of these costs is approximately $2.2 billion.[72] This is significantly lower than total costs over the period as the majority of the costs occur in the later years of the planning period.

The major costs relate to potential losses of creek and river water quality and coastal condition, which jointly equate to $2.4 billion over the period of 2009 to 2031. In present value terms, the social values of avoiding this degradation are approximately $1.5 billion, less than the cost estimates of maintaining waterway health from all diffuse sources from the business case for the current Healthy Waterways strategy.[73]

Given the fact that the expected decline in resource condition is the result of market failure, and the resources impacted are largely public goods, if the current condition could be maintained for an investment of less than $2.2 billion (present value terms), the social values alone may be sufficient to justify the necessary government intervention.

## 5.3. Social values of enhancing resource condition from current levels

Section 5.2 outlined the social costs of resource condition decline from current levels (i.e. a do nothing more scenario). However, the targets in the SEQ NRM Plan outline improvements from current levels with respect to some asset classes, specifically:

- land with woody remnant vegetation;
- water quality in creeks and rivers; and
- land available for outdoor recreation.

The social values of enhancing the condition of these assets were also estimated in the choice modelling survey.[74] Key results and points to note include:

- Enhancing resource condition from current levels also provides significant social benefits to households. For example, by 2031 the value of the enhancements proposed in the Plan could be as high as $100 per annum on average for SEQ households. Of the enhancements proposed, in excess of 50% of the benefits are attributable to enhancing water quality in creeks and rivers.
- The values of marginal *enhancements* are lower than values for marginal *declines* of the same magnitude (at the current level of resource condition). This indicates that households would pay more to avoid further decline in resource condition than they are prepared to pay to enhance resource condition at a later date through rehabilitation. This has important policy implications (i.e. the community has a strong economic preference in investing in actions that stop the current decline now, rather than try and rehabilitate later).
- Where the survey also included resource condition levels that were higher than those proposed in the SEQ NRM Plan, corresponding marginal values dropped off significantly once Plan targets were achieved. This indicates that society was much less

[72] Calculated using a 5.5% (real) discount rate. This rate is typical for discounted cashflow analysis undertaken for public policy analysis.

[73] MJA, 2006, Business Case for Investment in Healthy Waterways in South East Queensland.

[74] For the purposes of this report it was assumed that these enhancements would be achieved in a linear rate over the life of the SEQ NRM Plan.

willing to pay for improvements beyond those contemplated in the Plan, and potentially that they were providing an economic endorsement for the targets in the Plan.

The aggregate community values of the enhancements are approximately $1.9 billion over the life of the SEQ NRM Plan, or about $830 million in present value terms.

## 5.4. Total social benefit of achieving NRM targets

The total social benefit of achieving the NRM targets is made up of:

- the value of avoiding the decline in resource condition under a do nothing more scenario (Section 5.2); plus
- the value of the enhancements (Section 5.3).

Table 21 summarises the estimates of the social benefits of achieving the NRM targets.

Table 21: Estimated social benefits of achieving NRM targets ($ millions)

| | | | Annual estimates | | | |
|---|---|---|---|---|---|---|
| *Natural assets & attributes* | *Present value* | *Total (2009-31)* | *2016* | *2021* | *2026* | *2031* |
| ***Coastal and marine*** | | | | | | |
| Area of coastal vegetation & seagrass | 590 | 1,400 | 30 | 60 | 110 | 150 |
| ***Land and nature*** | | | | | | |
| Land with woody or remnant vegetation | 420 | 980 | 20 | 40 | 70 | 90 |
| Area of inland wetlands | 160 | 370 | 10 | 20 | 30 | 40 |
| ***Water*** | | | | | | |
| Creeks and rivers with acceptable water quality | 1,300 | 3,060 | 70 | 140 | 210 | 310 |
| ***Open space*** | | | | | | |
| Land of significant scenic amenity | 130 | 290 | 10 | 10 | 20 | 30 |
| Land available for outdoor recreation | 420 | 1,000 | 20 | 40 | 70 | 100 |
| **Total** | **3,010** | **7,090** | **160** | **300** | **500** | **720** |

*Source: MJA*

**The total social benefits of achieving the targets in the SEQ NRM Plan are very significant. Over the life of the plan they are estimated at in excess of $7 billion. In present value terms, the benefits are in excess of $3 billion.**

Enhanced water quality in creeks and rivers is the dominant benefit (43% of total), while maintaining coastal condition provides the next largest benefit (20% of total). Given the fact that these two targets are not mutually exclusive and reducing loads in major river systems (e.g. Bremer, Brisbane, Logan, etc) would significantly enhance the resilience of the coastal zone, interventions (policies, investments, etc) to reduce pollutant loads in waterways are likely to provide significant benefits to society, particularly if actions are cost effective.

The maintenance and enhancement of terrestrial biodiversity (woody remnant vegetation and inland wetlands) also provide significant existence benefits, but also contribute significantly to enhanced landscape amenity and potentially to land available for outdoor recreation.

# 6. Policy responses

The declining condition of our natural resource base is not just an environmental problem. It is also an economic problem. While a market economy like Australia's is generally quite efficient in allocating resources, sometime the market fails to allocate resources to achieve the greatest possible good. The economists call this 'market failure'. While there are many different ways in which market failure can occur, the bottom line is that various forms of market failure have resulted in an under-provision of the protection and maintenance of our environment.

## 6.1. Policy interventions

Market failure is a key rationale for government intervention to enhance the protection and management of our environment. Environmental policy interventions generally fall into four broad categories:

- **Public provision.** This would involve a government owning and maintaining the environmental asset on behalf of the community (e.g. a national park). This approach is common for highly endangered biodiversity assets.
- **Regulation.** Regulatory approaches such as restrictive planning regulations, development controls and regulation on the use of natural resources can be an effective tool to reduce the risks to resource condition. However, regulation is often a rigid policy approach that does not encourage innovation or environmental management initiatives above the minimal regulatory requirements. Because it usually applies to all relevant land, it can be very inefficient, particularly where only a portion of landholders need to act to achieve a policy goal.
- **Suasion.** Suasive approaches encourage positive behaviour through the provision of information and other tools that will enable households and landowners to enhance environmental management (e.g. best management practices for farming). Suasive approaches can work well in promoting a voluntary increase in environmental management practices, but their effectiveness is often uncertain and limited.
- **Economic and market based instrument** (MBI) approaches. These approaches use market signals to positively and voluntarily influence the behaviour of a business or individuals. MBIs do this by changing the price of goods or services, changing the quantity available, or by making an existing market work more efficiently. These approaches can be highly efficient as they can allow for targeted application and provide continuous incentives for innovation and to reduce the cost of meeting environmental objectives.

Different policy interventions suit different circumstances. No one intervention is superior and different interventions are often used in conjunction for greatest effect.

## 6.2. Adequacy of current interventions to reverse decline in resource condition

Over the past two decades there has been a constant and significant trend in enhancing natural resource management regulations, policies, planning instruments, market regulation, and service provision by the government and non-government sector. In addition, industry and the community have responded in terms of changed practices and behaviour such as

reducing erosion from agricultural activities. The improvements from historical trends are obvious, even if they have not been measured.

**The natural resource management gains of the past need to be acknowledged. However, it also needs to be acknowledged that existing interventions (i.e. a do nothing more scenario) will still result in a decline in resource condition (albeit a slower decline).** This is largely because, even with the existing interventions in place, there is still residual damage to the natural resource base of SEQ attributable to population growth and the associated economic activity. For example, the design objectives being established for water sensitive urban design in greenfield developments only partially mitigate ongoing increases in pollutant loads, and loads attributable to the construction phase will continue to be high as feasible on-site management options are limited.

**Even with the most stringent of interventions designed to mitigate damage attributable to development, an implicit and unmeasured tradeoff between mainstream economic development and resource condition will still occur.** This report makes that tradeoff somewhat more explicit.

In effect, in the absence of a comprehensive approach to offset all *residual* impacts of *all* new population-driven development, further declines in resource condition are still inevitable.

## 6.3. Community preferences for intervention approaches

While the scope of this report does not include a comprehensive assessment of interventions required to achieve the targets established in the SEQ NRM Plan, as a general rule of thumb, any interventions should be effective (i.e. they actually work) and efficient (i.e. they achieve the environmental gains at the lowest possible cost to the community).

As part of the survey of households, a number of broad policy principles were raised to determine the community's views on policy preferences. The results of the policy questions are shown in Table 22.

The survey of households revealed strong community preferences for particular policy principles, and these preferences are sometimes inconsistent with the current approach to natural resource management in SEQ.

- Taking a regional approach to achieving NRM is preferred (60% endorsed) where it is more efficient, even if local rates were spent elsewhere in the region. This is somewhat inconsistent with the approach to NRM adopted by most local governments in SEQ that only allow for expenditure within their own boundaries.
- Paying farmers to provide ecosystem services where it is the most efficient means to achieve targets is preferred (68% endorsed). Currently there is only limited and occasional funding available for landholders to enhance resource condition. The fact that many practices involve a net private cost to landholders, while providing a net gain to the broader public, is a major impediment to enhanced NRM.
- Taking preventative action now to reduce the decline in resource condition, rather than rehabilitate later (60% endorsed). Current interventions only partially prevent declines in resource condition, creating a potential need for expensive rehabilitation in the future.
- All future housing and other development should be required to compensate for negative environmental impacts, through actions such as offsets (80% endorsement). The current application of offsets in SEQ only applies to a subset of development projects and most

other environmental regulatory approaches still result in residual damage from development.

**Table 22: Community views on policy principles**

| *Issue and statement* | *% of respondents* |
|---|---|
| **Regional coordination:** Where it is more effective, a regional approach should be taken to protecting the natural environment even if money raised from your rates is spent elsewhere in SEQ. | |
| Agree with approach | 59.2 |
| Disagree with approach | 16.1 |
| Unsure / no opinion | 24.7 |
| **Paying for efficient ecosystem services:** Where farmers have the ability to enhance environmental outcomes at the lowest cost (e.g. reducing erosion to reduce sediment loads in major river systems), but insufficient private incentives, urban areas should provide financial assistance to cover some of the costs faced by farmers. | |
| Agree with approach | 67.9 |
| Disagree with approach | 15.3 |
| Unsure / no opinion | 16.8 |
| **Taking preventative action:** Where it is more cost effective in the long run to take actions now to prevent declines in environmental condition rather than rehabilitate the environment later, the government and the community should take action now? | |
| Agree providing short-term costs are covered by a reprioritisation of existing government expenditure | 59.8 |
| Agree, even if I need to pay more to help cover the additional costs | 31.3 |
| Disagree | 1.5 |
| Unsure / no opinion | 7.4 |
| **Internalise the externalities:** Do you believe that all future housing and other major developments should be required to compensate for any environmental impacts caused by undertaking actions that offset their impacts (for example restoring other natural environments). It is likely that the additional costs of doing so would be passed on to consumers and the community. | |
| Agree | 80.1 |
| Disagree | 19.9 |

*Source: DBM and MJA*

**It would be prudent to undertake a comprehensive review of the adequacy, effectiveness, efficiencies and synergies of current and potential NRM interventions to determine the most efficient means to achieve the targets established in the SEQ NRM Plan.**

# Appendix: Targets in the SEQ NRM Plan and notes on asset condition

## Targets in SEQ Plan

There has been recognition of the need for a single natural resource management (NRM) strategy for the SEQ Region since the mid-1900s, largely to coordinate NRM activities at the regional level. The SEQ NRM Plan supports the sustainability framework as outlined in the SEQ Regional Plan 2009-2031, and is the pre-eminent non-statutory NRM plan for the region. It builds on the region's history of broad community and government involvement in NRM planning and policy activities by establishing regional targets to coordinate existing and future plans, strategies and activities in agreement with stakeholders to enhance community, economic and environmental values.

### Rationale for targets

Measurable targets are set for air and atmosphere resources, coastal and marine, community engagement, land, nature conservation, regional landscape areas, Traditional Owner engagement and water. As stated in the SEQ NRM Plan, its primary purposes include:

- *"to inform preparation of local government planning schemes and policies, state government policy, government and non-government corporate plans, property plans;*
- *to inform planning and investment associated with yearly and long term business cycles at regional, sub-regional and property levels to ensure funding and community actions contribute to the achievement of regional targets; and*
- *to advise state agencies and local governments in assessing development applications that may significantly constrain the achievement of regional natural resource targets.*[75]"

In addition, the SEQ NRM Plan recognises the importance of the provision of ecosystem services for long term economic, social, cultural and environmental sustainability and community well being.

### Approach to establishing targets

The current plan was developed following a number of activities by the State Government, including a gap analysis to align different strategies, policies and actions, a revision of the SEQ Healthy Waterways Strategy and a review of the institutional arrangements for the Healthy Waterways Partnership.

The institutional review formed the basis for the conceptual logic for the SEQ NRM Plan, with targets set for the SEQ Healthy Waterways Strategy becoming outcome statements (based on measurable baseline information) for the region's water quality targets under the SEQ NRM Plan. This approach was adopted for the other natural resource assets identified in the SEQ NRM Plan, based on expert knowledge and information.

Two workshops and a series of consultations were used to develop and refine the regional targets, including with local government, regional NRM groups and the community.

[75] SEQ NRM Plan.

## Notes on asset condition

The following are working notes drafted as background material for the economic assessment.

### Air and atmosphere

**Air and atmosphere targets**

| *Asset and target* | *Dataset available?* | *Benchmark?* |
|---|---|---|
| **A 1 Greenhouse Gases**<br>By 2031, the region will make an equitable contribution to the national and regional targets for reduction in greenhouse gas emissions. | ✗ | ✗ |
| **A 2 Air Quality**<br>By 2031, the levels of air pollutants in the SEQ air shed will be at or below the quality objectives in the appropriate Schedule of the Environmental Protection (Air) Policy 2008. | ✗ | ✗ |
| **A 3 Thermal pollution**<br>By 2031, SEQ thermal pollution will be at or below 2003 levels. | ✗ | ✗ |
| **A 4 Noise Pollution**<br>By 2031, SEQ noise pollution will be at or below 1998 levels. | ✗ | ✗ |
| **A 5 Light Pollution**<br>By 2031, SEQ light pollution will be at or below 1998 levels. | ✗ | ✗ |

*Source: SEQ Natural Resource Management Plan Atlas*

No datasets or benchmarks have been agreed to for air and atmosphere resource condition targets (RCT) in the SEQ NRM Plan.

#### SEQ Context

Air pollution in SEQ is influenced by landscape and weather, as the region is ringed by hills and ranges that can block and trap pollution occurring at lower levels, until dispersed by strong wind or rain. Prevailing winds can transport pollution around the region.[76]

The region has a history of relatively low air pollution levels due to a comparatively low population and small industrial base. Regional specifics such as topography, high amount of sunshine and prevailing wind patterns suggest a high potential for pollution. As a result, air pollution (particularly photochemical smog) could become a significant problem in the future due to population growth and increased industrial and other economic activities.

This growth, combined with other regionally significant sources of air pollution emissions such as bushfires, hazard reduction and agricultural burning, suggests that air quality in the region could be put at risk in the future unless appropriately managed.[77]

Queensland's largest four contributors to GHG emissions are stationary energy, land use, agricultural sectors and transport (dominated by road transport).[78]

[76] http://www.epa.qld.gov.au/environmental_management/air/air_quality_in_south_east_queensland/index.html

[77] http://www.epa.qld.gov.au/register/p00564aa.pdf

[78] http://www.transport.qld.gov.au/Home/General_information/Environment/Climate_change_and_greenhouse_gas_emissions/

### Summary

Population growth and development will be the main cause of increased GHG emissions (through stationary energy, land use and agricultural sectors, and transportation) and increased risks of other air pollutions.

Climate change itself may increase the risk of bushfires, adding to both.

## Coastal and marine

**Coastal and marine targets**

| *Asset and target* | *Dataset* | *Benchmark* |
|---|---|---|
| **CM 1 Seagrass, saltmarsh and mangroves**<br>By 2031, the extent of seagrass AND mangrove ecosystem (including saltmarsh) in bays and estuaries is greater than or equal to that in 1988 and 2001 respectively. | ✓ | Total area of seagrass meadows in 1988: 27,085 ha.<br>Coastal vegetation (mangroves, saltmarsh and samphire) 2001 extent: 21,287 ha. |
| **CM 2 Coral**<br>By 2031, the condition and spatial distribution of soft and hard | ✓ | 2,856ha of reef. Recorded coral was 1,351 ha in 2004. |
| **CM 3 Headlands, Beaches and Dunes**<br>By 2031, the condition of open coastlines (headlands, beaches and dunes) is at or better than in 2006. | ✓ | The area of the Beach Buffer Zone that was disturbed has been used as an indicator of coastline condition A total of 310.55 ha was disturbed within the Beach Buffer zone including non vegetated (218.69 ha), road (62.09 ha), canal (0.73ha), and irrigated crop and pasture (29.04 ha).<br>Total of 4,009 ha of beaches and sand. |
| **CM 4 Fish Stocks**<br>By 2031, wild fishery stock condition will be sustained at sufficiently high levels to support commercial, recreational and indigenous cultural fisheries, based on the 1995–2005 benchmark (ten-year rolling average). | ✗ | Benchmark and monitoring program to be developed based on Fisheries Performance Measurement System for recreational and commercial catch data (Queensland Primary Industries and Fisheries). |
| **CM 5 Marine Species**<br>By 2031, the extent and condition of the habitat of bottlenose and indo pacific humpback dolphins, dugongs, sharks, turtles and wader birds is equal to or greater than that in 2001 for each species. | ✓ | As mapped. Eg. Total Wader habitat 63,588 ha includes Pumicestone Passage and beaches etc. of which 445 ha is Critical Wader Habitat including high roost sites. |
| **CM 6 Coastal Algal Blooms**<br>By 2031, the extent and frequency of coastal algal blooms (CAB) are reduced from 2002-2005 benchmark (5 year rolling average). | ✓ | ✗ |
| **CM 7 Coastal Wetlands**<br>By 2031, the extent (ha) of SEQ coastal wetlands connecting fresh and marine habitat (including fish passage) is equal or greater than that in 2007. | ✓ | Total Coastal Wetlands is 459,335 ha. This includes Estuarine (212,954 ha), Marine (203,363 ha) and Palustrine (43,018 ha). |

*Source: SEQ Natural Resource Management Plan Atlas*

Datasets and benchmarks exist for most coastal and marine RCTs.

### SEQ context

Significant areas of SEQ coastal catchments are now used for agricultural or residential purposes. The region's high rate of population growth means most of SEQ is now developed and important coastal resources have been lost or severely degraded. Considerable areas of

intertidal and coastal habitat have been modified for human uses and activities. For example, half of the melaleuca wetlands present in 1974 were cleared by 1989 and an estimated 2400 hectares of mangrove wetland habitat destroyed between 1974 and 1998.[79]

The key coastal management issues identified by the SEQ Coastal Plan include:

- *potential ongoing impacts on Moreton Bay Marine Park's water marine environment (such as seagrass) from the disposal of dredge-material;*
- *adverse impacts that developing low-lying coastal land for canals, dry land marinas and non-tidal artificial waterways have on water quality, tidal processes and coastal wetlands;*
- *loss of biodiversity and coastal wetlands associated with urban and rural development and management of possible future losses, including those from significant projects such as the proposed Brisbane Airport Parallel Runway Project and Gateway arterial duplication;*
- *loss of public access to the foreshore and tidal waterways due to development and private maritime infrastructure;*
- *ongoing erosion which threatens private land;*
- *need to retain undeveloped tidal waterways or undeveloped sections of tidal waterways to help buffer the effects of erosion and support coastal wildlife habitats;*
- *Increasing outbreaks of algal blooms, in particular Lyngbya majuscula (Lyngbya), in Moreton Bay and the need for further research; and*
- *loss of seagrass beds and increasing incidence of the viral disease which causes Fibropapillomas on green turtles (an endangered species) that may be the result of declining water quality within the Bay and its tributaries.*[80]

The chart below shows the trend in health of Moreton Bay over the period 2002-2009. The rapid decline from 2008-09 is largely attributable to increasing rainfall over this period, which results in negative outcomes for estuarine and marine environments.

### Summary

Coastal and marine assets are clearly of vital importance to the SEQ community and economy. As noted in the above list, most management issues relate to development pressures associated with population growth and a community preference for coastal living.

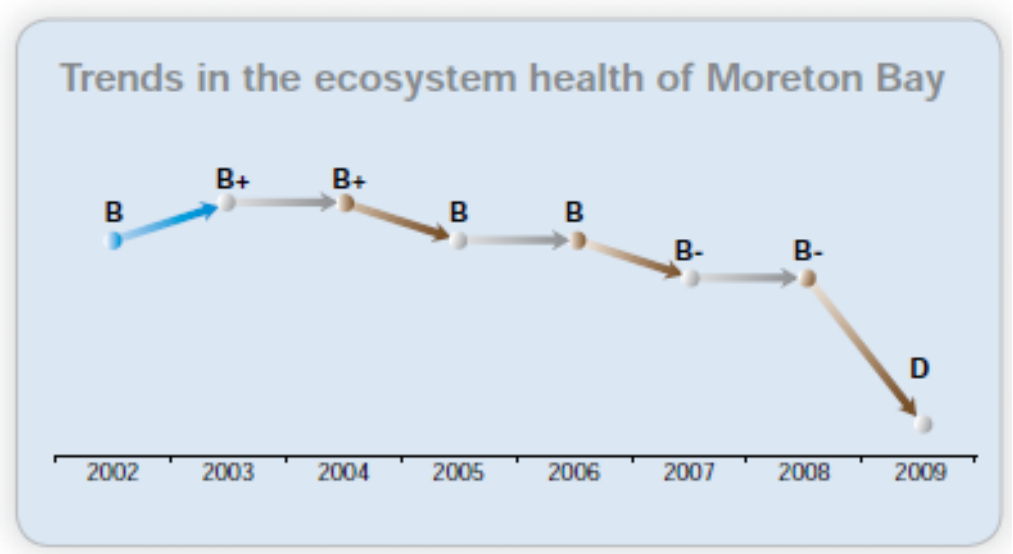
These will be compounded by the expected coastal impacts of climate change – storm surge and windiness, combined with sea level rise.

There are issues in Moreton Bay associated with water quality, impacting key species, increasing algal blooms and affecting seagrass.

[79] http://www.epa.qld.gov.au/register/p01361aa.pdf

[80] http://www.epa.qld.gov.au/register/p01361aa.pdf

**Trend in ecosystem health of Moreton Bay, 2002-09**




*Source: Freshwater Report Card 2009 - http://www.health-e-waterways.org/*

## Community

**Community targets**

| *Asset and target* | *Dataset available?* | *Benchmark?* |
|---|---|---|
| **C1** By 2031, natural resource managers, government and non-government organisations will be resourced and working together to implement the SEQ NRM Plan. | ✗ | ✗ |

*Source: SEQ Natural Resource Management Plan Atlas*

### SEQ Context

The region has a history of voluntary community action supported by industry and government investment. The majority of the region is managed by private landholders. Enhancing and maintaining the capacity and ability of the community to engage in planning, implementation and monitoring of local actions to support achievement of regional targets is therefore a priority.[81]

### Summary

While the consideration of community issues are important as part of the broader planning and implementation process, these issues are outside the scope of the current project.

81 *Source: SEQ Natural Resource Management Plan Atlas*

## Land

**Land targets**

| *Asset and target* | *Dataset* | *Benchmark* |
|---|---|---|
| **L 1 Secondary Salinity**<br>By 2031, the area of secondary salinity in SEQ will be at least 10% less than in 2008. | ✓ | Total area of salinity identified as 9,976 hectares. To achieve target of 10% less salinity, extent must be 8978 hectares. |
| **L 2 Good Agricultural land**<br>By 2031, >90% (>266,667ha) of SEQ good agricultural land at 2004 is available for sustainable agriculture. | ✓ | Total area of A, B and C Class lands equates to 1,414,185 ha. Target of 90% is 1,272,766 ha.<br>(19,050 ha of agricultural lots less than or equal to 1 ha). |
| **L 3 Soil Acidity**<br>By 2031, the area of acidified agricultural soils within SEQ will be reduced by 50% from the 2008 baseline. | ✗ | Total of 57,110 ha high risk soil acidity area.<br>Target of 50% as per target is 28,555 ha. |
| **L4 Organic Matter**<br>By 2031, the level of soil organic matter (carbon in t/ha) in agricultural soils will be higher than in 2008 or baseline year. | ✗ | ✗ |
| **L 5 Acid Sulfate Soils**<br>By 2031, the area of "severe" soil acidification caused by the disturbance of ASS is lower than that in 2008. | ✓ | Non Vegetated/Disturbed 28,743 ha (40%) of total risk area. |
| **L6 Soil Erosion**<br>By 2031, the extent of erosion from hill slopes and gullies will be reduced by 50% from the 2008 baseline. | ✓ | Total area of high and very high soil erosion risk is 255,026 ha.<br>Target is to reduce risk area by 127,513 ha. |
| **L 7 Grass Land Condition**<br>By 2031, 75% of grazing land in SEQ will be in a „good" condition. | ✗ | ✗ |
| **L8 Soil Contamination**<br>By 2031, existing contamination sites and off-site impacts will be reduced; and no new sites will be created over the 2008 baseline data. | ✗ | ✗ |
| **L9 Extractive Resources**<br>By 2031, extractive resources within "Key Resource Areas" in SEQ will be available for their highest use with no net loss of other environmental and landscape values. | ✓ | Total Key Resource Area is 10,329 ha. The Separation Area is 18,536 ha which provides a buffer to the KRA"s. |

*Source: SEQ Natural Resource Management Plan Atlas*

Agreed datasets exist for some but not all land assets. For most land asset types with agreed datasets, benchmarks exist.

### SEQ context

The bioregion of SEQ is characterised by metamorphic and acid to basic volcanic hills and ranges (Beenleigh, D'Aguilar, Gympie, Yarraman Blocks), sediments of the Moreton, Nambour and Maryborough Basins, extensive alluvial valleys and Quaternary coastal deposits including high dunes on the sand islands such as Fraser Island.[82]

Data on land affected by secondary salinity has recently been migrated to a single, state-wide database, allowing easier statistical and spatial analysis. The majority of sites are in

[82] http://www.anra.gov.au/topics/vegetation/assessment/qld/ibra-south-eastern-queensland.html

agricultural lands of south-east Queensland, varying in size from square metres to many tens of hectares. However, many catchments known to have salt affected areas have not been systematically studied. Furthermore, the extent and severity of sites is expected to increase following the next wet climate phase.

Some commentators suggest a misdirected focus on the agricultural sector and secondary salinity. For example:

> *The lack of attention to the interactions between civil infrastructure and secondary salinity has been a potential oversight, as the economic cost is likely to be far greater than the cost of lost agricultural production in salt affected rural areas. This is particularly the case in south-east Queensland, for it is in this area where the rapid expansion of urban populations into old agricultural lands with many existing salinity sites will create the greatest potential for impacts.*[83]

In recent years, the interface between urban and rural regions (the 'peri-urban fringe') has become the focus of increased planning attention and research. This is largely due to the rapid land use changes and conflicts that occur in rural areas subject to pressures from urbanisation. Competing rural land uses, including incompatible rural enterprises forced into closer proximity by the decreasing availability of strategically located land (e.g. aquaculture and horticulture), can also cause problems.

The spatial fragmentation of the peri- urban area into a wide range of uses, lot sizes and social groups makes it difficult to establish institutional arrangements that deal effectively with the long-term management of the natural resources in these areas (Buxton, M. et al 2006).[84]

### Summary

Population growth and associated developmental pressures on the peri-urban fringe impacts upon the area of land available to agriculture, and the agricultural activities permitted in areas of residential development. Soil quality, salinity and acid sulphate soils do not appear as major threats in strategy documents, suggesting their extent and trend are not key drivers of risk. This remains to be confirmed. The impacts of climate change on these issues is also unknown at this stage.

## Nature conservation

**Nature conservation targets**

| *Asset and target* | *Dataset* | *Benchmark* |
|---|---|---|
| **NC1 Remnant and Woody vegetation**<br>By 2031, the 2001 extent of regional vegetation cover – including both remnant vegetation (35%) and additional non-remnant woody vegetation (22%) – will be maintained or increased. | ✓ | Total Remnant is 810,685 ha (35.4%).<br>Total Woody Vegetation is 366,365 ha (16%).<br>(2003 is the most reliable historical benchmark data set available). |
| **NC2 – Vegetation Fragmentation and Connectivity**<br>By 2031, there will be no net fragmentation of larger tracts (greater than 5000 ha), and 20% of priority smaller tracts (less than 5000 ha) will be better connected than the 2003 baseline. | ✓ | Larger tracts ie >5000ha – 24 in SEQ.<br>Total number of priority smaller tracts 100ha – 5000 ha is 380 in SEQ.<br>20% of 380 priority smaller tracts is 76 ie. need to connect at least 76 tracts to the 24 larger tracts. |

[83] http://www.internationalsalinityforum.org/Final%20Papers/biggs_E1.pdf

[84] http://www.dip.qld.gov.au/regional-planning/rural-futures.html

| *Asset and target* | *Dataset* | *Benchmark* |
|---|---|---|
| **NC3 Wetlands**<br>By 2031, the 2008 extent and condition of SEQ wetlands will be maintained or increased. | ✓ | Total extent of wetlands is 512,939 ha. Marine 203,363 ha, Estuarine 212,954 ha, Palustrine 43,018 ha, Lacustrine 28,333 ha, Riverine 25,271 ha. |
| **NC4 Vulnerable Ecosystems**<br>By 2031, at least 4% of the original pre-clearing extents of vulnerable regional ecosystems will be represented in protective measures. | ✓ | 154 Regional Ecosystems (REs) in SEQ;<br>▪ 106 of these are identified as Not of Concern and have greater than 4% in reserve (protected);<br>▪ The remaining 48 are vulnerable REs made up of:<br>▪ 29 REs have less than 4% in reserve (protected) including 10 Endangered, 12 Of Concern and 7 Not of Concern;<br>▪ 19 REs are Of Concern. |
| **NC5 Threatened Species**<br>In 2031, the 2008 conservation status of native species will be maintained or improved. | ✓ | Refer to Appendix C for full list of Endangered Vulnerable and Rare (EVR) and Back on Track species. |
| **NC6 Habitat for Priority Taxa**<br>By 2031, the 2001 extent and condition of habitat for priority taxa will be maintained or increased. | ✓ | Total area is 689,610 ha which includes Core Habitat for EVR (165,628.5 ha) and Priority Taxa (632,740.5 ha). |

*Source: SEQ Natural Resource Management Plan Atlas*

Datasets and benchmarks exist for all nature conservation RCTs.

### SEQ context

The SEQ region is recognised for its high number of rare and threatened, and endemic flora species, with many species reaching their northern and southern distributional limits within this bioregion. The bioregion supports subtropical rainforests and coastal heathlands of significance, and includes the World Heritage listed Fraser Island.

There are thirteen wetlands identified as nationally significant within this bioregion. These range from mountain creeks, perched lakes, heath and freshwater ephemeral swamps to tidal flats, seagrass meadows and salt marshes. They contain areas of world heritage value and provide habitat for threatened fauna, wader bird feeding areas, drought refuge and corridors between remnants.

The wetlands within this bioregion are in fair to good condition, requiring some degree of intervention. The trend in condition is static. The main threatening processes are pollution and broad scale habitat clearing. Fragmentation of remnants and changes in hydrology are also significant threats.

There are 44 other wetlands of regional significance in this bioregion. No trend or condition have been assigned to these systems due to inadequate information.[85]

As is well documented, SEQ has one of the highest rates of population growth in Australia. The overall condition of the bioregion was considered fair in a 2001-02 report, although requiring significant intervention. The declining trend in condition suggests that actions are needed immediately to prevent further decline in biodiversity values.

Although the park system within the bioregion (together with the addition of the proposed SEQ Forest Agreement parks) ranks comparatively highly for comprehensiveness and adequacy, significant off park conservation actions are considered to be required to protect the biodiversity values of the region.

[85] http://www.anra.gov.au/topics/vegetation/assessment/qld/ibra-south-eastern-queensland.html

The continental landscape stress classes range from one to six as assessed by the Landscape Health report (1 is most stressed, 6 is least stressed). The Moreton Basin subregion is class 1 and is extensively cleared and developed for agriculture and urban facilities. The Great Sandy subregion is class 6 and includes Fraser Island and Cooloola National Park. Most of the other subregions are class 3. [86]

Conservation priorities for the region include the protection of coastal heathlands and lowland forests such as melaleuca wetlands and forest red gum further inland. These areas are considered highly fragmented and under strong pressure from development. Even where areas are not developed, the impact of adjacent land uses can impact significantly on biodiversity values. Further development of incentives for landholders to protect remnant areas and rehabilitate riparian areas are recommended.

### Summary

Development pressure is the key driver of risk to nature conservation in SEQ. Areas with high biodiversity and native vegetation values are being used for urban development, resulting in a loss of biodiversity conservation. Wetlands are threatened by urban development, resulting in loss of biodiversity and habitat protection.

## Regional landscape areas

**Regional landscape targets**

| *Asset and target* | *Dataset* | *Benchmark* |
|---|---|---|
| **RLA 1 – Landscape Heritage**<br>By 2031, at least 90% of the 2011 area of regionally important landscape heritage will be retained within each local government area. | ✓ | Combined area is 586,783 ha. |
| **RLA 2 – Outdoor Recreation Settings**<br>By 2031, the 2011 extent of regional outdoor recreation settings will be maintained or increased. | ✗ | ✗ |
| **RLA 3 – Outdoor Recreation Demand**<br>By 2031, 90% of the demand for outdoor recreation will be met through a mix of public land, waterways and the voluntary provision of opportunities on private land. | ✗ | ✗ |
| **RLA 4 – Regionally High Scenic Amenity**<br>By 2031, the area of regionally high scenic amenity will be maintained or improved from the 2004 baseline. | ✓ | Total area of Regionally Significant (Value 9-10) Scenic Amenity is 637,607 ha. |
| **RLA 5 – Locally Important Scenic Amenity**<br>By 2031, at least 80% of the 2004 area of locally important scenic amenity within each local government area will be retained. | ✗ | ✗ |

*Source: SEQ Natural Resource Management Plan Atlas*

Datasets and benchmarks do not exist for most regional landscape RCTs.

### SEQ context

Regional landscapes are a key provider of amenity values to residents, underpin outdoor recreation and provide a significant drawcard for domestic and international tourism.

[86] http://www.anra.gov.au/topics/vegetation/assessment/qld/ibra-south-eastern-queensland.html

### Summary

Population growth and development pressures are clearly the main driver of risk in this asset category. As population and population density of SEQ increases, landscapes are adapted to provide housing and support services, necessarily affecting landscapes and reducing the area of recreation facilities per capita.

Satisfying demand for recreation expressed as a percentage will be a difficult target to assess.

## Traditional Owners

**Traditional Owner target**

| *Asset and target* | *Dataset available?* | *Bench mark?* |
|---|---|---|
| **T01**<br>By 2031, Traditional Owners and Aboriginal people will be resourced and working together with natural resource managers, government and non-government organisations to implement the SEQ Natural Resource Management Plan and the Cultural Resource Management Plan. | The capacity of Traditional Owners and Aboriginal People will be enhanced as part of the implementation of SEQTO Cultural Resource Management Plan and suitable indicators identified to benchmark and measure this target. | ✗ |

*Source: SEQ Natural Resource Management Plan Atlas*

### SEQ context

The SEQ NRM Plan notes:

> *Recognition of Traditional Owners as natural resource managers is one of the Guiding Principles of the SEQ NRM Plan. Although shaped by human occupants for tens of thousands of years prior to 1824, the region's lands, waters, atmosphere and biodiversity were unaffected by the impacts of development.*
>
> *Non-Aboriginal settlement has had impacts. Natural resource planning, management and action can be guided by holistic traditional knowledge and values: the spiritual and respectful attitudes to "country" of the Traditional Owners are a key to the recovery of significant values.*
>
> *A key activity is to achieve active involvement of Aboriginal and Torres Strait Islander peoples in community planning and decision making and ensuring they are engaged in business about their country.*[87]

### Summary

While the consideration of Traditional Owner issues is important as part of the broader planning and implementation process, these issues are outside the scope of the current project.

[87] SEQ Natural Resource Management Plan Atlas

## Water (quantity and quality)

**Water targets**

| *Asset and target* | *Dataset* | *Benchmark* |
|---|---|---|
| **W 1 Environmental flows** By 2031, environmental flows will meet aquatic ecosystem health and ecological process requirements. | ✗ | ✗ |
| **W 2 Groundwater levels** By 2031, 75% of SEQ Groundwater Resource Units will have ground water levels within identified acceptable annual ranges. | ✗ | ✗ |
| **W 3 Groundwater quality** By 2031, ground water quality (nutrients and EC measurements) in all SEQ Groundwater Resource Units will be within identified acceptable annual ranges. | ✗ | ✗ |
| **W4 Groundwater dependent ecosystems** By 2031, the condition of groundwater ecosystems and groundwater dependent ecosystems will be within identified acceptable annual ranges. | ✓ | Combined total is 103,248 ha. |
| **W 5 High Ecological Waterways** In 2031, High Ecological Value waterways in SEQ will maintain their 2008 classification. | ✓ | As mapped |
| **W 6 Waterways maintenance and enhancement** In 2031, scheduled water quality objectives for all SEQ waterways will be achieved or exceeded. | ✓ | As mapped |
| **W 7 Waterways Restoration** By 2031, waterways classified as ranging from slightly to moderately disturbed and/or highly disturbed will have ecosystem health and ecological processes restored. | ✗ | ✗ |

*Source: SEQ Natural Resource Management Plan Atlas*

Datasets and benchmarks associated with water related to the environment are lacking in most cases, especially those associated with groundwater.

### SEQ Context

There is a divergent impact of increased rainfall on freshwater and estuarine/marine environments. Increasing rainfall can have slightly positive impacts on inland waterways, but negative impacts on estuarine and marine areas as nutrients and sediments are flushed into receiving waters. The Freshwater Report Card 2009[88] reveals:

> *In 2008-2009, the catchments of South East Queensland received significant rainfall; the highest rainfall in the last decade. While the freshwater streams showed improvements in biological indicators (macroinvertebrates and fish), reflecting the positive influence of more flows, there were declines in nutrient processing due to the high nutrient and sediment loads (diffuse source pollution) entering the waterways. The receiving waters of the estuaries and Moreton Bay took the impact of this diffuse source pollution and showed*

[88] http://www.epa.qld.gov.au/register/p01361aa.pdf

> *significant declines in ecosystem health with the overall health of Moreton Bay declining from B- (in 2008) to D (in 2009).*

Significant investments in reducing point source pollution through wastewater treatment have resulted in improvements in the ecosystem health of the estuaries and Moreton Bay, especially Western Moreton Bay. However, these improvements in 2009 have been overshadowed by the impacts of major flood events, relating to nutrient and sediment loads.

The results of the 2009 Ecosystem Health Report Card highlight that diffuse source pollution is currently the key challenge for managing the health of South East Queensland's waterways. As such, the focus for management efforts are in minimising the negative impacts of high flow rainfall events. These include investment in protection and restoration particularly in the catchment areas that are under development pressures such as expanding urban centres and changing agricultural areas and practices.

The Healthy Country project[89], a collaboration between the SEQ Healthy Waterways Partnership, SEQ Catchments, Queensland Government and the SEQ Traditional Owners Alliance, is a proof-of concept initiative which focuses on ways to reduce non-urban diffuse source pollution entering waterways from catchments. Also, Water Sensitive Urban Design (WSUD) initiatives on new developments and existing urban areas can also reduce diffuse source pollution entering streams and waterways.

### Groundwater

Groundwater availability in South East Queensland is generally limited. The major available resources are the large sand dune areas, particularly the Cooloola region, Bribie Island, Moreton Island and North Stradbroke Island. At present, groundwater supplies have been developed on Bribie Island (by Caboolture Shire Council) and on North Stradbroke Island (by Redland Shire Council). In the case of North Stradbroke, there are three separate supplies for Point Lookout, Dunwich and the mainland. Water is transferred from the Island to Redland Bay in a trans-bay pipeline that runs through what is now the Moreton Bay Marine Park.

Inland, groundwater is used in Toowoomba (licensed for 2,000ML/a) and for rural applications in the Lockyer and Warrill Valleys. In recent times, Toowoomba reserves have become stressed as inflows decrease, and existing demands on the aquifers in the Warrill and Lockyer Valleys are not considered to be sustainable in the long term.

The sustainable abstraction rate from North Stradbroke Island has been estimated by DERM to be around 100,000ML/a based on their allocation model. Redland Shire Council is currently licensed to take 21,800ML/a. DERM have indicated that full development of this resource is unlikely to be approved, and there are significant indigenous culture issues in relation to the development of bore fields across the island.

Caboolture Water reports a reliable abstraction rate from its existing Bribie Island bores of 840ML/a. The council is seeking to develop further supplies of approximately 2900ML/a on the island, but approval is uncertain.

Both Moreton Island and the Cooloola sand dunes are National Parks. The groundwater regimes in both cases are considered significant parts of the ecosystem and it is unlikely that approvals will be given for the development of these sources.

[89] http://healthycountry.com.au/HealthyCountry.aspx

Apart from these sources, Brisbane City Council has identified potential groundwater opportunities in the "Oxley Wedge" near where Oxley Creek crosses the Brisbane/Logan boundary, but availability has not been quantified. Groundwater is also used along the near-coastal strip of the Gold Coast from shallow spear pumps, but these supplies are generally opportunistic and saltwater intrusion is common.

### Summary

The condition of ecosystem health of aquatic ecosystems in SEQ appears to be steady, and under greatest threat in areas of high population density and growth.

Population growth and urban water supply shortages place extractive pressures on SEQ waterways. As areas outside of Brisbane and Gold Coast cities realise population growth, pressures to extract water supplies from regional waterways also increases (such as Bogimbah Creek on Fraser Island, Cooloola National Park, Six Mile Creek in the Mary River Catchment. Flows in these waterways sustain ecosystems within the waterways and in receiving waters such as Hervey Bay.

As with water flows in most parts of Australia, climate change is expected to reduce average flows and place greater stress on existing waterways and groundwater levels. Also, extreme weather events are likely to increase, providing shocks to waterways that increase phytoplankton abundance, nitrogen levels and turbidity in delivery environments.