

# Costs of achieving the water quality targets for the Great Barrier Reef

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## Key Points

- The total costs required for achieving two key regional water quality targets for the Great Barrier Reef (GBR) are estimated at \$8.2B. This includes \$7.8B for achieving the fine sediment targets and \$0.4 billion to achieve dissolved inorganic nitrogen targets.
- The efficient policy solution are regionally specific, as there is significant variance on the marginal abatement costs for the different policy solution sets and their actions. For some regions, achieving the final few percentages accounts for significant proportion of the cost.
- Generally, land practice improvement is most cost-effective solution and should be considered first.

## Abstract

The Great Barrier Reef (GBR) is arguably Australia's most iconic natural asset, but virtually all the relevant science indicates that the GBR is in decline. This paper provides an overview of research from a multi-disciplinary team to estimate the cost of achieving the GBR water quality targets. This was done through an assessment of seven policy solution sets identified for evaluation, their abatement contributions in meeting the regional targets, and their associated costs. By integrating physical modelling approaches and economic analysis based on marginal abatement cost curve (MACC) and total abatement cost curve (TACC) approaches, this work enables the identification of a least cost pathway to achieving the targets. Recommendations relating to the future management and funding of waterway and catchment management programs are outlined.

## Keywords

Great Barrier Reef; water quality; fine sediments; dissolved inorganic nitrogen; costs; targets

## Introduction

This paper summarises a project that was funded by the Queensland Government's Department of Environment and Heritage Protection (DEHP) and completed in August 2016 (Alluvium 2016). The purpose of the project was to estimate the costs of achieving two key regional water quality targets for the Great Barrier Reef (GBR) catchments as set out in the Reef 2050 Long-Term Sustainability Plan (Reef 2050 Plan) (Commonwealth of Australia 2015). This was done through an assessment of seven existing policy solution sets (identified by DEHP for evaluation) to examine their abatement contributions in meeting the regional targets and their associated costs.

The water quality targets selected from the Reef 2050 Plan related to anthropogenic end-of-catchment fine sediment loads and dissolved inorganic nitrogen (DIN). In particular the selected targets were:

- A 20 per cent reduction in anthropogenic end-of-catchment fine sediment loads for the Mackay Whitsunday and Burnett Mary catchments, with a 50 per cent reduction in the Fitzroy, Burdekin and Wet Tropics catchments by 2025.

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- A 50 per cent reduction in anthropogenic end-of-catchment DIN for the Mackay Whitsunday and Burnett Mary catchments and an 80 per cent reduction in the Burdekin and Wet Tropics catchments by 2025.

In addition, the project also estimated the costs of achieving a number of interim targets (i.e. 50% and 75% of the stated targets).

The seven existing policy solution sets selected by DEHP for investigation were land management practice change, improved irrigation practices, gully remediation, streambank repair, wetland construction, changes to land use (including conversion to conservation uses) and improvements in urban stormwater management.

## **Approach**

A consistent process was used across GBR catchments to evaluate the cost effectiveness of the seven existing policy solution sets for achieving regional water quality targets. The process built on and extended approaches used in previous evaluations of the cost-effectiveness of a narrower range of policy options to achieve water quality targets in GBR catchments (e.g. the work of Beher et al. 2016, Department of Environment and Heritage Protection 2016, Star et al. 2015, van Grieken et al. 2014 and others). The process used physical modelling approaches - typically used for estimating reduction in pollution loads attributable to policy solution sets - and economic analysis based on marginal abatement cost curve (MACC) and total abatement cost curve (TACC) approaches. By bringing quantitative physical modelling and economic analysis together it is possible to determine a least cost pathway to achieving regional water quality targets.

Given the inherent uncertainties in input data, a range of costs were estimated for actions within each policy solution set, and for the total costs of achieving regional targets. The costs included are the capital costs, operational and management costs, transaction costs, program management costs and enforcement costs of each action, net of any increase in revenue.

## **Headline results**

The process provided a strong science-based approach, based on the best information available, upon which future impact and cost-effectiveness evaluations can be built. Key headline results from our analysis are:

- The project sought to estimate the costs out to 2025 to meet the fine sediment and DIN regional targets for the GBR using the existing policy solution sets. The relative breakup of these costs across the regions evaluated is indicated in Table 1.
- The total costs required for the regions investigated are estimated at \$8.2B. This includes \$7.8B for achieving the fine sediment targets in four of the five regions investigated. For DIN, the total cost is estimated at \$0.4 billion to achieve the targets, also in four of the five regions investigated. For the Wet Tropics, the existing policy solution sets only achieve 75% of the DIN target and 80% of the fine sediment target, and will require additional solutions.
- In addition, the costs of meeting 50% and 75% of the regional Reef 2050 Plan targets have been calculated and these are presented in Table 2. The cost of achieving 50% of this load reduction is \$623M and the cost of achieving 75% of this target is \$3.86B. These are significantly lower than their proportional contribution to the full target would suggest. This is because the lower targets can be met through a broader selection of lower unit cost actions, whereas full achievement of the target requires uptake of actions with relatively high unit costs. For the same reason, it was found that in some regions achieving the final few percentages of the abatement target accounted for a significant proportion of the cost.
- The seven policy solution sets assessed in this analysis can meet the two 2025 water quality targets in most of the GBR catchments. In some areas such as the Wet Tropics (fine sediment and DIN) the relevant policy solution sets and the actions contained within them (as previously defined) cannot be

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applied widely enough, or they simply cannot address the scale of load reductions required to meet the targets. Meeting targets in this region will require an expansion of the scope of policy solution sets and/or actions.

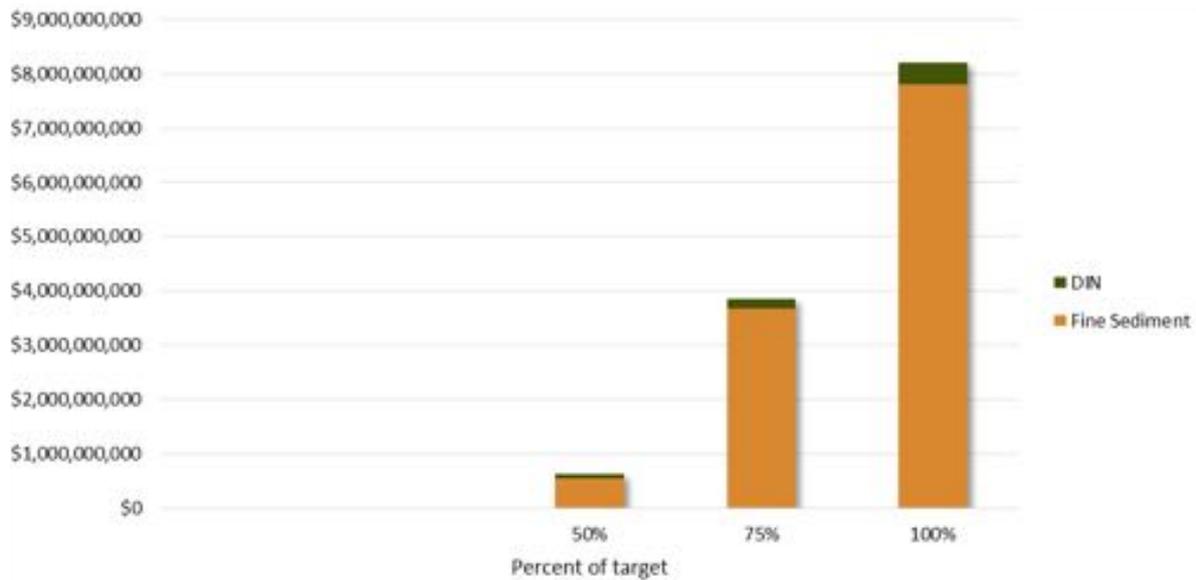
Table 1 shows the high-level region estimates of targets, loads, and the costs of meeting desired reductions in loads for both fine sediment and DIN. The costs for achieving 50%, 75% and 100% of the target load reductions are also presented in Table 2 and Figure 1. Note that, in the Wet Tropics, only 75% of the DIN target and 80% of the fine sediment target can be achieved based on the policy solution sets modelled.

**Table 1. Cost of achieving the targets (100%) per region**

| Region            | Fine sediment                           |   |                              | DIN                                     |  |                              | Total Cost             |
|-------------------|---|---|------------------------------|---|--|------------------------------|------------------------|
|                   | Target Load to reef by 2025 (tonnes/yr) | Load delivered to reef at 2025 with policy solution sets in place (tonnes/yr) | Costs of policy solution set | Target Load to reef by 2025 (tonnes/yr) | Load delivered to reef at 2025 with solution sets in place (tonnes/yr) | Costs of policy solution set |                        |
| Wet Tropics       | 1,170,000                               | 1,270,000   | \$242,000,000                | 3,280                                   | 3,740  | \$56,100,000                 | \$298,000,000          |
| Burdekin          | 2,160,000                               | 2,160,000   | \$1,090,000,000              | 1,460                                   | 1,460  | \$304,000,000                | \$1,390,000,000        |
| Mackay Whitsunday | 539,000                                 | 539,000   | \$8,290,000                  | 770                                     | 770  | \$28,800,000                 | \$37,100,000           |
| Fitzroy           | 1,030,000                               | 1,030,000   | \$6,460,000,000              | -                                       | -  | -                            | \$6,460,000,000        |
| Burnett Mary      | 1,110,000                               | 1,110,000   | \$11,600,000                 | 616                                     | 616  | \$1,730,000                  | \$13,300,000           |
| <b>Totals</b>     | <b>6,009,000</b>                        | <b>6,110,000</b>  | <b>\$7,820,000,000</b>       | <b>6,130</b>                            | <b>6,590</b>   | <b>\$391,000,000</b>         | <b>\$8,210,000,000</b> |

**Table 2. Total costs of meeting 50%, 75% and 100% of the fine sediment and DIN targets in each region**

|               | Region               | 50% of target | 75% of target   | Full target     |
|---------------|----------------------|---------------|-----------------|-----------------|
| Fine sediment | Wet Tropics          | \$48,600,000  | 126,000,000     | 242,000,000     |
|               | Burdekin             | \$8,240,000   | \$553,000,000   | \$1,090,000,000 |
|               | Mackay Whitsunday    | \$660,000     | \$3,960,000     | \$8,290,000     |
|               | Fitzroy              | \$476,000,000 | \$2,980,000,000 | \$6,460,000,000 |
|               | Burnett Mary         | \$4,760,000   | \$8,160,000     | \$11,600,000    |
| DIN           | Wet Tropics *        | \$29,200,000  | \$56,100,000    | \$56,100,000    |
|               | Burdekin Dry Tropics | \$55,900,000  | \$126,000,000   | \$304,000,000   |
|               | Mackay Whitsunday    | \$55,800      | \$2,770,000     | \$28,800,000    |
|               | Burnett Mary         | \$0           | \$741,000       | \$1,730,000     |
| Total         |                      | \$623,000,000 | \$3,860,000,000 | \$8,200,000,000 |



**Figure 1. Steps to target – fine sediment and DIN costs, for whole of the GBR (except Cape York)**

The study highlights the need for greater innovation and research and development to validate new practices that could reduce the overall economic cost for society. However, it should be noted that there is significant uncertainty in the costs estimates due to the availability, variability and quality of data used to generate these estimates. The accuracy of the estimates is also constrained by resource constraints on this project, and the impact that policy design and implementation will have on the final costs. It is therefore suggested that the results are viewed as being indicative and illustrative only in any future application for policy work and investment towards meeting the Reef 2050 Plan targets. Furthermore, the variance in cost estimates reinforces the need to establish a cohesive suite of innovative policies that can ensure the targets are met at the lowest economic cost.

The study is also limited in that it only considered a relatively narrow suite of policy solution sets. Other variations and combinations of the existing policy solution sets, and indeed other policy solution sets or actions outside the scope of this analysis, also warrant further investigation. A failure to increase existing levels of investment could result in costs that are higher than the most likely estimate, so efficient policies should result in costs closer to, or potentially lower than, the most likely estimate.

Our analysis shows that the efficient policy solution sets are actually regionally specific, as there is significant variance on the marginal abatement costs for the different policy solution sets and their actions. Therefore, policies, regulations and decisions need to be cognisant of regional circumstances and the efficient pathway to achieve targets for specific regions and loads. Generic Reef-wide and inflexible policies may inadvertently increase the cost of meeting the targets.

For most regions, significant progress towards targets could be achieved at a relatively low cost. Across the seven policy solution sets, land practice improvement was nearly always the most cost-effective solution. However, as the abatement targets are approached, policy solution sets with significantly higher marginal costs are often required (as the ‘low hanging fruit’ will have already been addressed), so the total cost of achieving the target increases significantly. This reinforces the need to implement low cost investments now and identify how we can enhance the efficiency of other measures as policies and programs are rolled out. This is a prudent strategy.

Marginal costs of poorly managed future urban development are very high. All of the cost curves developed show sharp inclines as the targets are approached. Poorly managed development that creates a net increase

in loads increases the volume of abatement required to meet the targets, forcing the community to invest into a circumstance where either the targets are less likely to be met, or the cost of meeting the targets is significantly higher. This reinforces the need to ensure policies are in place to avoid and mitigate the impacts of future development.

## **Implications**

The scale of investment required is commensurate with the scale of the challenge. The catchments flowing into the GBR lagoon are some of Australia's largest, with the Burdekin catchment alone almost double the size of Tasmania. Across catchments like the Burdekin, the extent of ecological repair work required is extensive. And as with any asset management program, the costs of delivering successful asset management, asset repair, asset renewal and asset maintenance is both expensive and ongoing. Natural assets are no different. The necessary science and implementation techniques required to deliver this asset management program do exist, although further effort is required to improve existing investment processes and policy choices that minimize the cost of meeting the targets. Furthermore, the scale of investment required will also be dictated by the policies and investment approaches adopted to meet the regional targets.

Importantly, the key tools developed during this project (a meta-model based on the outputs from the Department of Natural Resources and Mines' Reef Source Catchments Models and the abatement curves) will be able to support future policy and investment decision making processes linked to the long-term protection of the GBR. Key project learnings can also inform other GBR planning, prioritization and investment-related processes.

The regional capacity required to deliver the necessary on-ground works within the timeframe is also considered to be a key issue. This project has not assessed whether it is technically or politically feasible or socially acceptable to implement the policy solution sets. Further work is required to consider what can be practically achieved within the required timeframes, current governance structures and existing capacities of program delivery partners.

It should be noted that the policy solution sets investigated here only address some of the catchment-based issues placing pressures upon the GBR. Clearly other significant issues such as climate change (warmer water, increased extreme weather events) and other catchment-based factors such as land use intensity and land clearing all impact the Reef's health. However, these were not the focus of this costings project.

## **Conclusions**

Our key findings, which we believe should be considered in relevant future works within the GBR catchments, are:

- For some regions and their respective targets, achieving the final few percentage of the abatement target accounted for a significant proportion of the cost. Therefore, the targets need to consider cost-effectiveness and the marginal abatement gains as targets are approached. It also reinforces the need to ensure targets are robust and reflect regional assimilative capacities for loads into the marine environment and likely thresholds.
- Land practice improvement was nearly always the most cost-effective solution and should be considered first in most cases. However, in many regions, land management improvements alone are insufficient to meet the targets and more costly actions are also required.
- When implementing any actions, it is very important to consider the sequence they are delivered in, as the most cost-effective solution may not be the one that needs to be delivered first. In some circumstances more expensive on-ground actions are required as prerequisites to more cost effective actions later. Furthermore, to actually achieve stated abatement targets, the sequencing and packaging of actions and overall policy solution sets becomes vital as the inclusion of some actions may exclude the opportunities to adopt others (e.g. there is no point in enhancing nutrient practices

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on land that would need to be retired in order to actually meet the abatement target). This requires a slight departure from the typical use of abatement curves when designing efficient policies as the policy solution sets are not mutually exclusive.

- There are likely to be trade-offs between regions where more cost-effective actions could be delivered in one region in preference to another, but only if looking across the whole of the GBR. This would require considering the implications of what those trade-offs mean in terms of local and regional outcomes, as well as impact to the GBR.

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