Regional Economic Impacts of the Makauri Managed Aquifer Recharge Scheme, Gisborne

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Contents

Figures

Tables

Glossary

Computable General Equilibrium (CGE): A class of applied economic models typically used to illustrate an economy's responses to changes in policy, technology or other external shocks. These models capture not only direct and flow-on effects, but also general equilibrium effects such as those caused by price change, substitution and factor constraints. The data requirements to create these types of models are substantial and, thus, their use is typically limited to events that cause significant changes within an economy.

Households: New Zealand resident individuals and families, and Private Non-Profit Organisation (PNPO) serving households.

Input-Output Model (IO): A quantitative economic technique that represents the interdependencies between different branches (industries or sectors) of a national economy or different regional economies. The technique depends on a matrix of raw economic data collected by companies and governments to study the relationship between suppliers and producers within an economy. Of particular interest is the extent that the outputs of one industry become the inputs to another.

Industry Value Added: Value added summed according to industry groups.

Modified Employment Counts (MECs): Statistics New Zealand typically reports employment data according to the Employee Count (EC) measure. ECs are a head count of all salary and wage earners for a reference period. This includes most employees but does not capture all working proprietors – individuals who pay themselves a salary or wage. The modified employment count or MEC measure is based on ECs but includes an adjustment to incorporate an estimate of the number of working proprietors.

Value Added: The value added to goods and services by the contributions of capital and labour, i.e. the value of output after the cost of bought-in materials and services has been deducted. It includes the national accounts categories 'gross operating surplus', 'compensation of employees', 'other taxes on productions' and 'subsidies'. The sum of all value added is equal to gross domestic product (GDP), excluding taxes on products and import taxes net of subsidies. Thus, in New Zealand, total value added is equal to approximately 88% of GDP.

Executive Summary

Background

With the aim of preventing further deterioration of the Makauri aquifer, the largest aquifer underneath the Poverty Bay flats, Gisborne District Council (GDC) is currently investigating options for a Managed Aquifer Recharge (MAR) scheme. The assessment detailed in this report is part of a wider programme of work concerned with evaluating the economic effects of the Makauri MAR scheme. Changes in horticulture farm systems, modelled by Lewis Wright Valuation and Consultancy Ltd, and costs of establishing the MAR scheme, modelled by Prof. Graeme Doole (University of Waikato), constitute a direct input to the regional- and national-level economic modelling described in this report.

Using input-output analysis this assessment calculated economic impacts, in terms of changes in industry value added and employment, for the regional and national economies arising out of changes to horticulture farming systems ('high value' vs. 'low value' crops). To provide a comprehensive evaluation of the economic impacts of the MAR and because a mechanism has not yet been decided on we have assumed that the Makauri aquifer consent holders will pay for the MAR on a per hectare of use basis.

The following four management scenarios were considered involving alternative assumptions about water availability and/or land area availability for Makauri aquifer consent holders.

1. MAR implemented, 30% increase in water, no aquifer decline
2. No MAR implemented, 30% decrease in water
3. No MAR implemented, 60% decrease in water
4. MAR implemented, 30 % increase in irrigable area, no aquifer decline

Results

The economy wide impacts from the scenarios were small, with impacts confined to the Gisborne District (Table 1). This was due to the large impacts on the Makauri aquifer consent holders (HVA, HVP, LVA, LVP). Monetary flows to/from these growers from other regions were relatively small compared to the rest of the economy.

Makauri high value crop growers (HVA, HVP) benefited most from the MAR scheme. In addition, positive flow-on impacts were seen in the utilities sector e.g. electricity providers.

Overall, regional and national economic impacts were positive with the MAR scheme and negative without (Table 1). Scenarios with the largest changes in water/land availability (Scenarios 3 and 4) caused the largest changes in value added and employment. This was driven by the direct impacts on the Makauri aquifer consent holders (HVA, HVP, LVA, LVP) and the conversion between low value (unirrigated) crops and high value (irrigated) crops.

Table 1. Change in Value Added ($\$_{2016}$m) and Employment (MECs) by scenario and region.

	Change in Value Added $\$_{2016}$m	Change in Employment MECs[1]
Totals as at 31 March 2016 (Gisborne District)	1,880	23,310
Gisborne District		
1: MAR 30% increase in water, no aquifer decline	20.5	301
2: No MAR 30% decrease in water	-17.1	-234
3: No MAR 60% decrease in water	-28.6	-434
4: MAR 30 % increase in irrigable area, no aquifer decline	61.1	959
Rest of North Island		
1: MAR 30% increase in water, no aquifer decline	4.3	41
2: No MAR 30% decrease in water	-3.3	-33
3: No MAR 60% decrease in water	-5.8	-59
4: MAR 30 % increase in irrigable area, no aquifer decline	4.9	52
Rest of New Zealand		
1: MAR 30% increase in water, no aquifer decline	0.8	9
2: No MAR 30% decrease in water	-0.6	-7
3: No MAR 60% decrease in water	-1.1	-13
4: MAR 30 % increase in irrigable area, no aquifer decline	1.2	14

1. Modified Employment Count. This includes both employment counts and working proprietors over February.

1 Introduction

The Poverty Bay flats in the Gisborne District are primarily used for fruit and vegetable growing which are an important sector in the region's economy. With the aim of preventing further deterioration of the Makauri aquifer, the largest aquifer underneath the Poverty Bay flats, Gisborne District Council (GDC) is currently investigating options for Managed Aquifer Recharge (MAR). The MAR will require injecting water from the Waipaoa River into the aquifer through a number of injection wells. This report describes methods employed to assess regional economy-wide impacts resulting from proposed management scenarios with and without the Makauri MAR scheme.

This report has been commissioned by GDC, and is part of a wider programme of work concerned with evaluating the economic effects of the Makauri MAR scheme. Various management scenarios have been considered, involving alternative assumptions about water availability and/or land area availability for Makauri aquifer consent holders. This report concentrates on presenting economic outcomes, in terms of value added and employment change, across the full range of industry sectors within the Gisborne District, Rest of North Island, and Rest of New Zealand. Reference should also be made to the horticulture farm system modelling work undertaken on behalf of GDC by Lewis Wright Valuation and Consultancy Ltd and Prof. Graeme Doole (University of Waikato). The changes in farm systems (Lupton, 2017) and the costs of establishing the MAR system (Doole *et al.*, 2017), constitute a direct input to the regional- and national-level economic modelling described in this report.

This study of regional and national economic impacts has been undertaken through a modelling framework that is based primarily on Input-Output (IO) analysis. Today, IO analysis is one of the most widely applied methods in economics, with the approach being especially popular in the study of regional-level economic impacts (Miller and Blair, 2009). One of the core strengths of IO analysis is that it captures the complex interactions and interdependencies occurring between different actors within an economy. This means that it is possible to consider the indirect or flow-on effects that occur throughout an economy as a result of any type of economic change. IO analysis also enables economic impacts to be evaluated at the level of individual sectors or industries, thus providing a disaggregate picture of the nature of economic impacts.

It is important to note that other methods do exist for assessing regional and national economic impacts of management strategies. The key alternative, which is also based on IO analysis, is Computable General Equilibrium (CGE) modelling. Market Economics has specialist skills in the application of both IO and CGE models, particularly multi-regional and fully dynamic CGE modelling. The selection of an IO rather than dynamic CGE modelling framework for use in this study is primarily a consequence of the need to ensure compatibility with the farm systeml modelling work and the relatively small economic impacts likely to be experienced.

Other supporting reasons for adopting an IO rather than CGE framework for use in this study are:

- *Disaggregation* – The IO approach readily produces results that are disaggregated by study regions (in this case the Gisborne District, Rest of North Island and Rest of New Zealand) and economic sectors (52 economic sectors or 'industries' are reported in the model), thus providing important information on the distribution of economic impacts.

- *Paucity of data* – Creation of a multi-regional CGE model that reports down to the level of the Gisborne District would necessitate the construction of a Social Accounting Matrix (SAM) for the local area. There is a lack of information pertaining to interregional investment flows upon which to complete this task

- *Full analysis of 'circular flow of income'* – Although based on IO, a concerted attempt is made in this study to take full consideration of the 'circular flow of income' within an economy, much like an analysis based on a SAM or CGE. Thus, it is an example of an extensive application of IO for the purposes of economic impact assessment.

- *Timeframe and budget* – It was feasible to couple an IO-based model to the selected farm system models, so as to produce a picture of regional and national economic impacts, while keeping within the timeframe and budget of the project. Linking a CGE model to the outputs of the farm system models is a major piece of work and is beyond the scope of this project.

2 Background

2.1 Scenarios Evaluated

The following four scenarios were considered in the farm system modelling and regional/national economic analysis, each involving alternative assumptions about water availability and/or land area availability for Makauri aquifer consent holders.

1. MAR implemented, 30% increase in water, no aquifer decline
2. No MAR implemented, 30% decrease in water
3. No MAR implemented, 60% decrease in water
4. MAR implemented, 30 % increase in irrigable area, no aquifer decline

A status quo or 'baseline' scenario was assessed in the farm system modelling as a counterfactual. When undertaking the regional and national economic modelling for each scenario, we consider the net changes from this baseline (i.e. counterfactual) scenario. Specifically, the baseline is for the financial year ending 31 March 2016.

The total area of farms using the Makauri aquifer, by crop type, were provided by Lupton (2017). Crops were aggregated into the following groups:

- High Value Annual (HVA) e.g. lettuce, cabbage
- High Value Permanent (HVP) e.g. apples, kiwifruit, persimmon
- Low Value Annual (LVA) e.g. maize, sweetcorn, seed maize
- Low Value Permanent (LVP) e.g. lemons, oranges, grapes

Under Scenarios 1 and 4, funding of $\$_{2016}$610,000 and $\$_{2016}$720,000 per year respectively for the capital and operation costs of the MAR were included, using estimates in Doole (2017). It is important to note however that construction impacts would only occur in the year[1] the construction took place. While this may lead to positive impacts, they are not sustained through time.

To provide a comprehensive evaluation of the economic impacts of the MAR, we have assumed Makauri aquifer consent holders would fund the MAR i.e. HVA, HVP, LVA, LVP sectors. We have assumed the growers pay for the scheme on a per hectare of use basis.[2]

[1] The need to annualize capital costs is a result of the selection of a 'comparative static' IO framework. Comparative statics refers to analysis that compares an economy at two points in time e.g. before and after the MAR. The use of comparative statics however restricts our ability to model economic impacts through time i.e. as in the case of capital costs associated with development of the MAR.

[2] This is only one possible option and is only included in the analysis as a 'placeholder' to account for the fact that someone must pay for the MAR, and importantly, it would also be incorrect to ignore the question of who pays for the scheme. Moreover, the selection of ha, rather than, say, water use (m^3) is arbitrary and simply based on available data. Further modelling work is certainly required to refine this.

Table 2.1 Total Area (ha) of Makauri Aquifer Consent Holder Farms by Crop Type and Scenario (Lupton, 2017).

Crop Type	Scenario				
	Status Quo	1: MAR 30% increase in water, no aquifer decline	2: No MAR 30% decrease in water	3: No MAR 60% decrease in water	4: MAR 30 % increase in irrigable area, no aquifer decline
High Value Annual	797	956	397	0	1240
High Value Permanent	160	300	107	107	600
Low Value Annual	460	161	895	1292	260
Low Value Permanent	269	269	287	287	200

2.2 An Introduction to Input-Output Analysis

Prior to describing the specifics of the methodology, it is helpful to provide readers, particularly those not familiar with IO analysis, with a brief introduction to the IO framework. This introduction is provided below. The remaining sections of the methodology describe the way the different scenarios are incorporated into an IO framework, including the major assumptions that are applied.

At the core of any IO analysis is a set of data that measures, for a given year, the flows of money or goods among various sectors or industrial groups within an economy. These flows are recorded in a matrix or 'IO table' summarising the purchases made by each industry (its inputs) and the sales of each industry (its outputs) from and to all other industries both within Gisborne and in-and-out of the rest of New Zealand. By using the information contained within such a matrix, IO practitioners calculate mathematical relationships for the economy in question. These relationships describe the interactions between industries – specifically, the way in which each industry's production requirements depend on the supply of goods and services from other industries. With this information it is possible to calculate, given a proposed alteration to a selected industry (a scenario), all of the necessary changes in production that are likely to occur throughout supporting industries within the wider economy. For example, if one of the changes anticipated for the Gisborne region were to be a loss in the amount of horticulture, the IO model would calculate all losses in output that would also occur in industries supporting horticulture (e.g. fertilizer production, farm contractors), as well as the industries that, in turn, support these industries.

As with all modelling approaches, IO analysis relies on certain assumptions for its operation. Among the most important is the assumption that the input structures of industries (i.e. the mix of commodities or industry outputs used in producing output for a specific industry) are fixed. In the real world, however, these 'technical coefficients' will change over time as a result of new technologies, relative price shifts causing substitutions, and the introduction of new industries. For this reason, IO analysis is generally regarded as most suitable for short-run analysis, where economic systems are unlikely to change greatly from the initial snapshot of data used to generate the baseline IO tables.

3 Method

3.1 Overview of Impacts Assessed

The study of economy-wide economic impacts commenced with identifying four key categories of likely economic effects associated with the four management scenarios:

1. *Changes to horticulture farming systems – backward linkage supply chain impacts*. Water availability causes changes in land use for certain horticulture farms using the Makauri Aquifer. For example, replacing unirrigated, low value annual crops with irrigated, high value annual crops. These increases/decreases in crop area result in changes to the purchase patterns of horticulture farms, creating flow-on upstream impacts through economic supply chain linkages. Businesses that are responsible for providing direct inputs to the low value annual crops will be negatively impacted by conversion to high value annual crops. Businesses involved indirectly in high value annual crop supply chains will also be positively impacted. This information was taken from the Gross Margins analysis undertaken by Lewis Wright Ltd in conjunction with Prof. Graeme Doole.

2. *Changes in incomes for land owners*. For each of the scenarios evaluated, there will be changes in income for landowners in the form of wages/salaries and profits. This will cause changes in expenditure patterns of these land owners, hence creating impacts through the rest of the economy. Again, this information was taken directly from the analysis of Gross Margins undertaken by Lewis Wright Ltd and Prof. Graeme Doole. Some adjustments to the Gross Margins were however required to account for debt and depreciation of fixed capital.[3]

3. *MAR funding*. As noted above, the capital and operational costs of the MAR were based on data provided by Prof. Graeme Doole. Specifically, it was assumed that under Scenario 1 the costs would be $\$_{2016}$610,000 per year and under Scenario 4 $\$_{2016}$720,000 per year. It was assumed that this cost was funded by Makauri aquifer consent holders based on land use. There is also opportunity cost associated with the establishment of this fund in terms of reduced ability to purchase other goods and services.

4. *Conversion between land uses – backward supply chain impacts*. In scenario 4, a 30% increase in land area available for horticulture for Makauri aquifer consent holders is assumed to replace land area available for horticulture for non-Makauri aquifer consent holders. This will create impacts for industries involved in supplying goods and services to new Makauri consent holders and the replaced non-Makauri consent holders, i.e. we net out the existing land uses and their economic contributions when accounting for the new Makauri consent holders.

[3] The Gross Margins provided by Lewis Wright were for the most part based on 10-year operational forecasts. Incorporating this information into our IO framework is a critical step necessary to accurately estimating the economic outputs. Nevertheless, we must however account for real world realities faced by many farmers, e.g. debt based borrowing and capital depreciation. These components reduce operating surplus or Earnings Before Income and Tax including Rent (EBIT-R). These were estimated based on parent industry weighted averages, i.e. for the Horticulture and Fruit Growing industries. We however recommend that this be further refined through further work by Lewis Wright Ltd.

3.2 Incorporation of the Scenarios within the Modelling Framework

Overview

The process used to calculate regional and national economic impacts is provided in Figure 3.1 below. Information obtained from the farm systems modelling that flows in as inputs to the modelling exercise, is depicted in the circles. The primary components of the IO framework are depicted in the grey boxes. The final results produced by the model (depicted in the black box) are the value added and employment impacts associated with each scenario. All results are reported in terms of the net change from the baseline scenario. For example, the value added impact of reducing water availability by 30% is not the total value added in the economy under this scenario, but rather the difference in value added between that scenario and the baseline scenario.

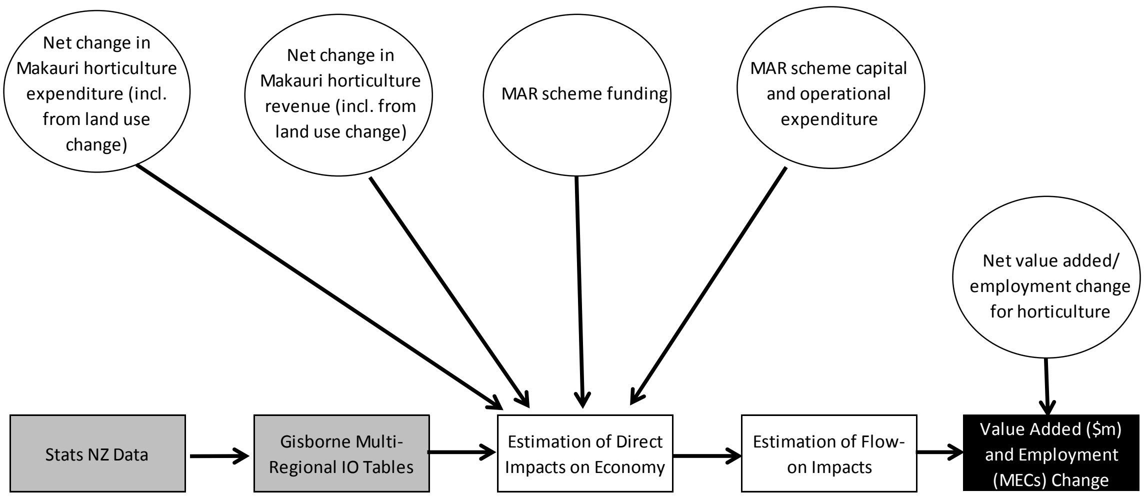

Figure 3.1 Summary of IO modelling approach.

Step 1: Production of multi-regional input–output (MRIO) table

At the core of an IO modelling framework is a matrix recording transactions between different actors within an economy. Each column of the matrix reports the monetary value of an industry's inputs, while each row represents the value of an industry's outputs. Sales by each industry to final demand categories (i.e. households, local and central government, gross fixed capital formation, etc) are also recorded, along with each industry's expenditure on primary inputs (wages and salaries, consumption of fixed capital, gross operating surplus, etc). The industry production mixes used in this study are based on 2006-07 information, but updated using the value added components of regional Gross Domestic Product available directly from

Statistics New Zealand estimates. Changes in technology and/or production techniques that have occurred since 2006-07 are not considered.

The first major step required for the assessment of economy-wide effects is regionalisation of Statistics NZ's national IO table so as to produce tables for the following regions or study areas:

1. Gisborne Region,
2. Rest of North Island,
3. Rest of New Zealand.

The process adopted to disaggregate Statistics New Zealand's 2006-07 IO tables into New Zealand's 16 regional councils is described in Smith *et al*. (2015). The IO model used in this study considers not only the relationships between economic actors within a given region, but also the relationships between regions. This multi-regional approach provides a means to evaluate the nation-wide implications.

For each region, the 48 industries from the Statistics New Zealand IO table were used. In addition, the horticulture and fruit growing sector was split into 5 sectors (High Value Annual, High Value Permanent, Low Value Annual, Low Value Permanent and Other fruit growing and horticulture) based on the revenue and expenditure information in Lupton (2017).

Step 2: Calculation of technical coefficients and allocation coefficients tables

The multi-regional IO tables created for the study areas are translated into tables of technical coefficients and tables of allocation coefficients. The technical coefficients indicate, for each industry, how much input is required to produce one dollar's worth of output, and are derived from the MRIO tables assuming continuous, linear relationships between inputs and outputs of each industry. Allocation coefficients can also be calculated from IO tables in a similar manner to the calculation of technical coefficients. However, whereas technical coefficients describe the value of inputs purchased from each industry per unit of input, allocation coefficients detail the value of outputs sold to each industry per unit of output.

Step 3: Calculation of output change vectors (Y and M)

The purpose of this Step is to devise a set of industry output change vectors, for which we wish to trace the backward-linkage impacts. This is a summation of:

1. *Net changes in purchases by Makauri aquifer consent holders.* These changes in input purchases include those brought about by changes in water and land area availability causing changes in farming practices or switching from one type of farming activity to another (point 1 and 4 in Section 3.1). The magnitude of these input changes is derived directly from the results of the farm system modelling. The revenue/expenditure line items from the farm system modelling accounts are matched to the input categories (i.e. different types of commodities/services as well as primary inputs such as wages and salaries) specified in the multi-regional IO table.

2. *Net changes in expenditure resulting from loss or gain in household income of Makauri aquifer consent holders*. The outputs of the farm system modelling are used to determine the net changes in income for land owners and employees. It is assumed that any income loss (or gain) will result in a corresponding loss (or gain) in household expenditure. To translate income changes into spending changes, average household expenditure shares generated from the national Social Accounting Matrix (see Smith *at al*. (2015)) are used. In generating these average household expenditure shares, consideration is given to the proportion of household income that is used to purchase goods and services overseas, and is thus effectively lost from the New Zealand economy.

3. *Net changes in expenditure resulting from funding of the MAR scheme* (points 3 in Section 3.1). As with (2) above, the income of Makauri aquifer consent holders changes when funding of the MAR is included. This will result in a corresponding change in expenditure.

Step 4: Calculation of backward–linkage impacts

As previously explained, the direct changes in output occurring in each industry will create indirect economic impacts that flow through the wider New Zealand economy. For example, reductions in fertiliser use by farmers is a reduction in demand for fertiliser manufacturers. In turn, the industries that supply fertiliser manufacturers will experience some loss in demand, and so on. Very simply, the vector of direct and indirect output effects by industry, X, is calculated according to the equation,

$$X = (I - A)^{-1}Y \quad (1)$$

where A is the matrix of technical coefficients (refer to Miller and Blair (2009) for further explanation), I is the identity matrix and the vector Y is a set of exogenous output changes by industry, the impacts of which are sought to be measured. The inverse matrix $(I – A)^{-1}$ is termed the 'Leontief Inverse Matrix'.

There is some debate within IO literature and applications of the degree to which an IO model should be 'closed' with respect to the household sector when calculating the impacts according to Equation (1) above (Miller and Blair, 2009), so as to capture the relationships between income and consumer spending. This study uses a model that is 'open' with regards to the household and other final demand sectors. The primary reasons are:

- The method described above already captures some income effects associated with changes in profits and wages/salaries for Makauri aquifer consent holders. These are likely to be the most significant income related effects.

- The IO approach can in some cases overestimate impacts, primarily due to the absence of price-related feedback mechanisms that help to regulate economies. The use of the open Leontief Inverse Matrix helps to therefore moderate the economic impact estimates generated by the analysis.

Step 5: Translation of output impacts into value added and employment impacts

The final stage of the analysis is to transform estimates of net output change into value added and employment impacts. This occurs by multiplying the output change for each industry by the industry's ratio of (1) value added per unit of output, and (2) employment per unit of output. These ratios are assumed to be constant and are obtained from data for the 2016 financial year.

3.3 Caveats

The following assumptions or caveats were made in the analysis:

- *Depreciation of fixed capital*. The operating surplus (profit) for the HVA, HVP, LVA and LVP sectors from Lupton (2017) were modified to include depreciation of fixed capital. We made an assumption that businesses in these sectors were paying off loans e.g. mortgages on land. This slightly reduced the flow-on impacts associated with household expenditure and makes for a fairer comparison with other sectors.

- *MAR capital costs.* We have used the annualised capital costs for the MAR from Doole (2017). However, it is important to note that construction impacts only occur in the year the construction takes place.

- *MAR funding regime*. To provide a comprehensive evaluation of the economic impacts of the MAR and because a mechanism has not yet been decided on we have assumed a particular funding regime. It was assumed that the Makauri aquifer consent holders will pay for the MAR on a per hectare of use basis.

- *Scenario 4, 30% increase in land area*. For Scenario 4, we have assumed the 30% increase in area for Makauri aquifer consent holders will replace land area from the "Other horticulture and fruit growing" sector in the Gisborne region, i.e. non-Makauri consent holders.

4 Results

4.1 Without Managed Aquifer Recharge

Overall, scenarios which did not include the MAR caused a negative impact on national and regional value added and employment (Figs 4.1 and 4.2). The largest negative impacts occurred under Scenario 3, with a loss of $\$_{2016}$36m in national value added and 507 Modified Employee Counts (MECs). The Gisborne District was impacted most, contributing 80% or $\$_{2016}$29m to the loss in national value added and 86% or 434 MECs to the loss in national employment under Scenario 3.

Driving these results were impacts to individual sectors in the Gisborne District economy. Again, the largest impacts occurred under Scenario 3, with value added of the High Value Annual and High Value Permanent sectors decreasing by 100% ($\$_{2016}$5.5m) and 39% ($\$_{2016}$5.9m) respectively (Table 4.1). Similarly, employment in these sectors decreased by 100% (214 MECs) and 37% (38 MECs) (Table 4.2). In addition, the utilities sector decreased by 25% ($\$_{2016}$5.1m) in value added. These losses were slightly offset by the Low Value Annual sector which increased 184% ($\$_{2016}$1.7m) in value added and 166% (24 MECs) in employment.

Similarly, under Scenario 2, the High Value Annual sector was negatively impacted and the Low Value Annual sector was positively impacted, but to a lesser extent. The value added of the High Value Annual and High Value Permanent sectors decreased by 50% ($\$_{2016}$2.8m) and 39% ($\$_{2016}$5.9m) respectively. Similarly, employment in these sectors decreased by 50% (107 MECs) and 37% (38 MECs). In addition, the utilities sector decreased by 13% ($\$_{2016}$2.6m) in value added.

For changes in value added and employment for other regions see Appendix B.

4.2 With Managed Aquifer Recharge

Value added and employment were positively impacted overall under scenarios where the MAR was implemented (Figs 4.1 and 4.2). The largest positive impacts, and the largest impacts overall, were under Scenario 4 (Figs 4.1 and 4.2). National value added increased $\$_{2016}$26m and $\$_{2016}$67m under Scenarios 1 and 4 respectively, while employment rose by 352 and 1025 MECs. Again the Gisborne District was the most impacted, contributing 80% ($\$_{2016}$21m) and 91% ($\$_{2016}$61m) to the loss in value added under Scenarios 1 and 4 respectively (Table 4.1).

In terms of individual sectors within the Gisborne economy, the largest impacts were to the High Value Permanent sector (Tables 4.1 and 4.2). Under Scenario 4, the value added of the High Value Permanent and High Value Annual sectors increased by 294% ($\$_{2016}$44.2m) and 48% ($\$_{2016}$2.7m) respectively (Table 4.1). Similarly, employment in these sectors increased by 704% (707 MECs) and 56% (119 MECs) (Table 4.2). In addition, the utilities sector increased by 19% ($\$_{2016}$3.8m) in value added. However, this was slightly offset by the Low Value Annual sector which decreased by 77% ($\$_{2016}$0.7m) in value added and 73% (11 MECs) in employment.

Similarly, under Scenario 1, the High Value Permanent and High Value Annual sectors were positively impacted and the Low Value Annual sector was negatively impacted. However, these impacts were larger than Scenario 2 which had an equivalent decrease in water available. Under Scenario 1, the value added of the High Value Permanent and High Value Annual sectors increased 91% ($\$_{2016}$13.6m) and 13% ($\$_{2016}$0.7m) respectively (Table 4.1). Similarly, employment in these sectors increased 193% (194 MECs) and 20% (43 MECs) (Table 4.2). In addition, the utilities sector increased 6% ($\$_{2016}$1.2m) in value added.

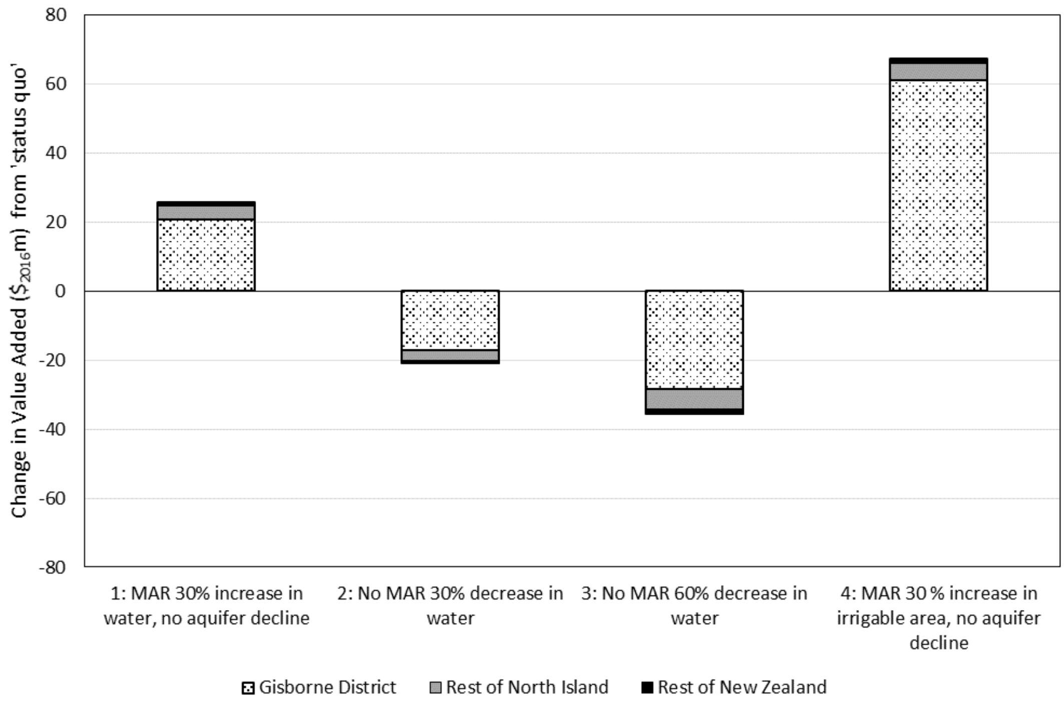

Figure 4.1 Change in Value Added ($\$_{2016}$m) from 'Status Quo' by Region and Scenario.

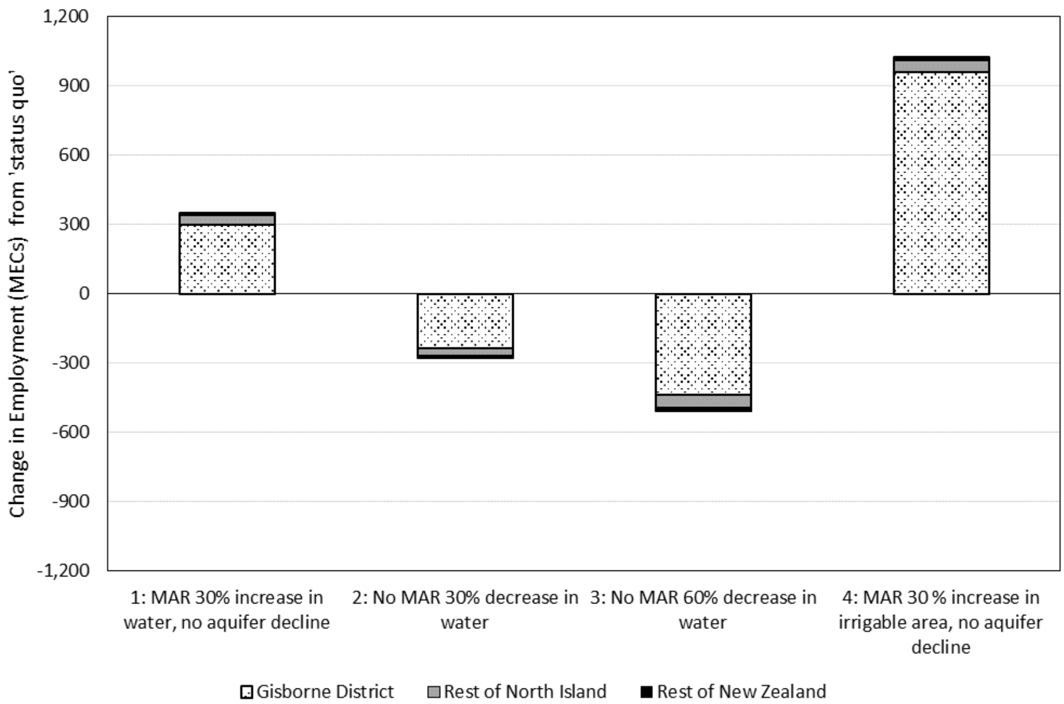

Figure 4.2 Change in Employment (MECs) from 'Status Quo' by Region and Scenario.

Table 4.1. Change in Industry Value Added ($\$_{2016}$m) from 'Status Quo' in the Gisborne District by Scenario

	Total Value Added as at 31 March 2016	1: MAR 30% increase in water, no aquifer decline	2: No MAR 30% decrease in water	3: No MAR 60% decrease in water	4: MAR 30 % increase in irrigable area, no aquifer decline
	$\$_{2016}$m	$\$_{2016}$m	$\$_{2016}$m	$\$_{2016}$m	$\$_{2016}$m
Gisborne District					
High Value Annual	6	0.7	-2.8	-5.5	2.7
High Value Permanent	15	13.6	-5.9	-5.9	44.2
Low Value Annual	1	-0.7	0.9	1.7	-0.7
Low Value Permanent	7	-0.1	0.9	0.9	-0.7
Other farming and services to agriculture	120	1.7	-3.8	-7.6	3.6
Livestock and cropping farming	180	0.0	0.0	0.0	-0.3
Dairy cattle farming	4	0.0	0.0	0.0	0.0
Forestry and logging	101	0.1	-0.3	-0.6	0.3
Other primary industries	7	0.0	0.0	0.0	0.0
Meat and meat product manufacturing	15	0.0	0.0	0.0	0.0
Dairy product manufacturing	10	0.0	0.0	0.0	0.0
Other food and beverage manufacturing	87	0.0	0.0	0.0	0.1
Other manufacturing	55	0.1	-0.1	-0.2	0.3
Wood and paper manufacturing	20	0.0	0.0	0.0	0.0
Utilities	20	1.2	-2.6	-5.1	3.8
Construction	113	0.1	-0.1	-0.1	0.1
Wholesale and retail trade	172	0.5	-0.3	-0.5	1.2
Transport	75	0.3	-0.6	-1.2	0.8
Communication, finance, insurance, real estate and business services	490	1.9	-1.5	-2.6	3.3
Government	58	0.2	-0.1	-0.3	0.3
Other services	325	0.8	-0.8	-1.5	2.1
Total	**1,880**	**20.5**	**-17.1**	**-28.6**	**61.1**

Table 4.2 Change in Industry Employment (MECs) from 'Status Quo' in the Gisborne District by Scenario

	Total Employment as at 31 March 2016	1: MAR 30% increase in water, no aquifer decline	2: No MAR 30% decrease in water	3: No MAR 60% decrease in water	4: MAR 30 % increase in irrigable area, no aquifer decline
	MECs[1]	MECs[1]	MECs[1]	MECs[1]	MECs[1]
Gisborne District					
High Value Annual	214	43	-107	-214	119
High Value Permanent	100	194	-38	-38	707
Low Value Annual	15	-11	13	24	-11
Low Value Permanent	75	0	11	11	-2
Other farming and services to agriculture	2,552	30	-66	-132	59
Livestock and cropping farming	2,581	1	0	0	-4
Dairy cattle farming	31	0	0	0	0
Forestry and logging	451	1	-1	-2	1
Other primary industries	77	0	0	0	0
Meat and meat product manufacturing	232	0	0	0	0
Dairy product manufacturing	47	0	0	0	0
Other food and beverage manufacturing	808	0	0	0	1
Other manufacturing	636	1	-1	-2	3
Wood and paper manufacturing	262	0	0	0	0
Utilities	65	1	-2	-5	3
Construction	1,467	1	-1	-2	2
Wholesale and retail trade	3,459	12	-7	-12	29
Transport	797	4	-9	-18	12
Communication, finance, insurance, real estate and business services	3,203	9	-9	-17	1
Government	780	3	-2	-4	5
Other services	5,457	14	-14	-25	35
Total	23,310	301	-234	-434	959

1. Modified Employment Count. This includes both employment counts and working proprietors over February.

5 Conclusions

IO analysis was used to calculate economic impacts, in terms of changes in regional and national value added and employment arising out of changes in water and land availability under different MAR management scenarios.

Overall, regional and national economic impacts were positive with the MAR scheme and negative without. The largest economic impacts occurred under scenarios with the largest changes in water/land availability (Scenarios 3 and 4). This was driven by the direct impacts on the Makauri aquifer consent holders (HVA, HVP, LVA, LVP) and the conversion between low value (unirrigated) crops and high value (irrigated) crops.

Under scenarios where water availability increased and decreased by 30%, larger impacts to value added and employment were found when water availability increased. This was driven by the direct impacts on the HVP sector, which increased 88% in area when water availability increased 30% but only decreased 33% when water availability decreased 30%.

Makauri high value crop growers (HVA, HVP) benefited most from the MAR scheme. In addition, positive flow-on impacts were seen in the utilities sector e.g. electricity providers.

The economy wide impacts were small, with impacts confined to the Gisborne District. This was due to the large impacts on the Makauri aquifer consent holders (HVA, HVP, LVA, LVP). Monetary flows to/from other these growers from other regions in the country were relatively small compared to the rest of the economy.

While the impact and costs of the MAR scheme are not likely to have an impact on the Gisborne regional economy, at a farm or organisation level the costs will be significant to those who pay for it.

6 References

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7 Appendix A Additional Results

Table A.1 Change in Industry Value Added ($\$_{2016}$m) from 'Status Quo' in the Rest of the North Island by Scenario.

	Total Value Added as at 31 March 2016	1: MAR 30% increase in water, no aquifer decline	2: No MAR 30% decrease in water	3: No MAR 60% decrease in water	4: MAR 30 % increase in irrigable area, no aquifer decline
	$\$_{2016}$m	$\$_{2016}$m	$\$_{2016}$m	$\$_{2016}$m	$\$_{2016}$m
Rest of North Island					
Other farming and services to agriculture	2,299	0.0	0.0	-0.1	0.1
Livestock and cropping farming	1,587	0.0	0.0	0.0	0.0
Dairy cattle farming	3,757	0.1	0.0	-0.1	0.1
Forestry and logging	781	0.0	0.0	0.0	0.0
Other primary industries	5,112	0.1	0.0	0.0	0.0
Meat and meat product manufacturing	1,103	0.0	0.0	0.0	0.1
Dairy product manufacturing	2,015	0.0	0.0	0.0	0.1
Other food and beverage manufacturing	3,129	0.1	-0.1	-0.1	0.3
Other manufacturing	10,406	0.2	-0.2	-0.3	0.1
Wood and paper manufacturing	1,512	0.0	0.0	0.0	0.0
Utilities	6,240	0.2	-0.1	-0.1	0.0
Construction	10,282	0.1	0.0	-0.1	0.1
Wholesale and retail trade	20,541	0.6	-0.4	-0.7	0.6
Transport	7,717	0.3	-0.3	-0.5	0.4
Communication, finance, insurance, real estate and business services	60,766	1.9	-1.5	-2.7	2.1
Government	8,739	0.2	-0.2	-0.3	0.2
Other services	25,487	0.5	-0.4	-0.7	0.8
Total	**171,472**	**4.3**	**-3.3**	**-5.8**	**4.9**

Table A.2 Change in Industry Value Added ($2016m) from 'Status Quo' in the Rest of the New Zealand by Scenario.

	Total Value Added as at 31 March 2016	1: MAR 30% increase in water, no aquifer decline	2: No MAR 30% decrease in water	3: No MAR 60% decrease in water	4: MAR 30 % increase in irrigable area, no aquifer decline
	$2016m	$2016m	$2016m	$2016m	$2016m
Rest of New Zealand					
Other farming and services to agriculture	1,223	0.0	0.0	0.0	0.0
Livestock and cropping farming	1,333	0.0	0.0	0.0	0.0
Dairy cattle farming	2,076	0.0	0.0	0.0	0.0
Forestry and logging	400	0.0	0.0	0.0	0.0
Other primary industries	747	0.0	0.0	0.0	0.0
Meat and meat product manufacturing	805	0.0	0.0	0.0	0.0
Dairy product manufacturing	706	0.0	0.0	0.0	0.0
Other food and beverage manufacturing	1,422	0.0	0.0	-0.1	0.1
Other manufacturing	3,119	0.1	0.0	-0.1	0.1
Wood and paper manufacturing	453	0.0	0.0	0.0	0.0
Utilities	1,811	0.0	0.0	0.0	0.0
Construction	4,632	0.0	0.0	0.0	0.0
Wholesale and retail trade	6,740	0.1	-0.1	-0.1	0.2
Transport	2,703	0.1	-0.1	-0.2	0.1
Communication, finance, insurance, real estate and business services	15,227	0.2	-0.2	-0.3	0.3
Government	1,743	0.0	0.0	0.0	0.0
Other services	8,189	0.1	-0.1	-0.2	0.3
Total	**53,328**	**4.3**	**-3.3**	**-5.8**	**4.9**

Table A.3 Change in Industry Employment (MECs) from 'Status Quo' in the Rest of the North Island by Scenario.

	Total Value Added as at 31 March 2016	1: MAR 30% increase in water, no aquifer decline	2: No MAR 30% decrease in water	3: No MAR 60% decrease in water	4: MAR 30 % increase in irrigable area, no aquifer decline
	MECs[1]	MECs[1]	MECs[1]	MECs[1]	MECs[1]
Rest of North Island					
Other farming and services to agriculture	47,130	1	-1	-1	1
Livestock and cropping farming	22,323	0	0	0	1
Dairy cattle farming	26,537	0	0	0	1
Forestry and logging	3,484	0	0	0	0
Other primary industries	4,808	0	0	0	0
Meat and meat product manufacturing	17,503	0	0	0	1
Dairy product manufacturing	9,020	0	0	0	0
Other food and beverage manufacturing	27,713	1	-1	-1	2
Other manufacturing	98,106	2	-2	-3	1
Wood and paper manufacturing	16,426	0	0	0	0
Utilities	11,997	0	0	0	0
Construction	137,897	1	-1	-1	1
Wholesale and retail trade	369,738	9	-7	-11	12
Transport	74,527	3	-3	-5	4
Communication, finance, insurance, real estate and business services	397,443	14	-12	-21	12
Government	98,007	2	-2	-3	2
Other services	403,504	8	-6	-11	12
Total	**1,766,161**	**41**	**-33**	**-59**	**52**

1. Modified Employment Count. This includes both employment counts and working proprietors over February.

Table A.4 Change in Industry Employment (MECs) from 'Status Quo' in the Rest of the New Zealand by Scenario.

	Total Value Added as at 31 March 2016	1: MAR 30% increase in water, no aquifer decline	2: No MAR 30% decrease in water	3: No MAR 60% decrease in water	4: MAR 30 % increase in irrigable area, no aquifer decline
	MECs[1]	**MECs[1]**	**MECs[1]**	**MECs[1]**	**MECs[1]**
Rest of New Zealand					
Other farming and services to agriculture	25,820	0	0	0	0
Livestock and cropping farming	18,700	0	0	0	-1
Dairy cattle farming	14,663	0	0	0	0
Forestry and logging	1,783	0	0	0	0
Other primary industries	4,760	0	0	0	0
Meat and meat product manufacturing	12,776	0	0	0	0
Dairy product manufacturing	3,807	0	0	0	0
Other food and beverage manufacturing	12,332	0	0	0	1
Other manufacturing	32,104	1	0	-1	1
Wood and paper manufacturing	5,732	0	0	0	0
Utilities	3,419	0	0	0	0
Construction	63,080	0	0	0	0
Wholesale and retail trade	130,854	2	-2	-3	4
Transport	25,561	1	-1	-2	1
Communication, finance, insurance, real estate and business services	96,576	1	-1	-2	2
Government	21,555	0	0	0	0
Other services	127,471	2	-2	-4	4
Total	**600,992**	**9**	**-7**	**-13**	**14**

1. Modified Employment Count. This includes both employment counts and working proprietors over February.