Integrated Freshwater Solutions

Evaluation of Regional and National Economic Impacts of Mitigation Scenarios

Prepared for: Massey University

Date: April 2013

m.e environment

Integrated Freshwater Solutions

Evaluation of Regional and National Economic Impacts of Mitigation Scenarios

Massey University

Document reference: MAS 013.11 IFS\Final Model and Presentations\130406 Regional and National Economic Impacts of MRC Mitigation Scenarios.docx

Date of this version: April 2013

Report author(s): Garry McDonald, Nicola Smith

www.me.co.nz

Market Economics Limited
Level 5, 507 Lake Road
PO Box 331 297, Takapuna
Auckland 0740, NZ
P 09 915 5510

Contents

1 Introduction

This report constitutes part of the outputs of the Integrated Freshwater Solutions research programme. The work follows on directly from the Cost Benefit Analysis (CBA) of selected options to improve water quality in the Manawatū River Catchment (MRC), undertaken by Ecological Economics Research New Zealand (EERNZ) at Massey University. The specific focus of this report is on the evaluation of economy-wide impacts associated with the proposed mitigation options, over the next 20 years. The economic impact analysis covers all sectors of the economy, not just those directly impacted. Furthermore, the economic model used for evaluation covers not only the Manawatu catchment or Manawatū-Wanganui region, but the whole of NZ.

So as to be consistent with the EERNZ CBA study, the analysis is undertaken for five different scenarios or sets of mitigation options, referred to as Actions A-E. The direct costs and benefits estimated for each of these Actions are taken directly from the EERNZ CBA study. The particular methods, assumptions and limitations that apply to the EERNZ study thus also apply to this study.

2 Background

2.1 Selection of an Appropriate Modelling Framework

This study of economy wide impacts has been undertaken through a modelling framework that is based primarily on economic 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 economics (Miller and Blair, 2009). Other methods exist for assessing economic impacts; with the key alternative being Computable General Equilibrium (CGE). The authors are widely published in both IO and CGE. Key studies undertaken by the authors include the official 1999 and 2003 America's Cup Economic Impact Assessments (EIAs), the official EIA of the 2011 Rugby World Cup, along with numerous other EIAs. Based on this experience the authors have favoured the use of IO because: (a) a paucity of regional/national data for CGE analysis exists, (2) we are dissatisfied with the typical approach of recursive-CGE analysis where it is simply assumed that an economy equilibriates between each model run (usually a short period of just one year) (3) the *scenario* rather than optimization approach of this study (e.g. land use is defined according to scenarios rather than as a mobile factor of production) and (4) time and budget constraints.

In addition to comparisons of IO analysis with CGE analysis, it is worth noting that the input-output modelling that was undertaken in this study involved a number of extensions to the usual 'multiplier' analysis often employed in EIAs. In particular special attention is given to:

1. *The circular flow of income*. Very often multiplier-type analyses undertake only a partial assessment of an economic shock – for example, the upstream impacts of increased investment in community infrastructure, or the loss to a community resulting from the closure of a manufacturing plant. However, when calculating impacts across an economy as a whole it is very important to recognise that a change in income/expenses incurred by one agent is usually balanced by an equal change in income/expenses for another agent(s). For example, in the case of increased infrastructure investment, the funds required for the infrastructure must be derived from some agent (e.g. government) and the next best or alternative use of those funds is the opportunity cost of the investment. A concerted attempt is made in this study to trace the circular flow of income through the economy, and to devise a counterfactual scenario that fairly accounts for these types of national transfer effects. Reference is made particularly to a base year New Zealand Social Accounting Matrix (SAM)[1] for this purpose.

2. *Forward linkage or downstream supply chain impacts*. In most multiplier analysis the focus is on estimating backward-linkage or demand side effects. In this study we have endeavoured to also capture the most important supply-side or forward linkage effects associated with the Actions.

[1] A SAM can be viewed as an extended Input-Output table.

2.2 An Introduction to Input-Output Analysis

Prior to describing the specifics of the method, it is helpful to provide readers, particularly those not familiar with input-output analysis, with a brief introduction to the IO framework.[2] 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' by arrays that summarize the purchases made by each industry (its inputs) and the sales of each industry (its outputs) from and to all other industries. By using the information contained within such a matrix, IO practitioners are able to 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 then possible to calculate, given a proposed alteration to a selected industry (a 'shock'), 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 as a result of the Actions is a decrease in sheep and beef farming, the IO model would calculate all of the associated decreases in output that would occur in industries supporting sheep and beef farming (e.g. fencing contractors, farm machinery suppliers), as well as the industries that, in turn, support these industries.

The sum of all of these upstream or backward supply-chain effects are often called the *indirect* economic impacts. In addition to indirect impacts, economists also often estimate the *induced* impacts arising out of an economic shock. Induced impacts are those that occur when changes in economic activities cause changes in household incomes (i.e. through changes in wages and salaries, business profits) and this subsequently leads to changes in household expenditures. The relationships contained within IO tables, and particularly in a form of extended IO table known as a social accounting matrix (SAM), are used to help estimate induced economic impacts.

[2] Those who wish to learn more about Input-Output analysis can refer to authors such as Miller and Blair (2009).

3 Method

The Actions are incorporated into the model using (1) the discounted cash flows financial information produced by EERNZ's CBA analysis (Table 9 of report) (2) a series of assumptions regarding the funding and expenditure arrangements for the mitigation options proposed. Very broadly, the calculation of economic impacts is undertaken through four steps:

Step 1: Generate a multi-regional input-output (MRIO) model for the study

Step 2: Analyse operating expenditure (Opex) and capital expenditure (Capex) net changes for each industry (livestock and cropping, dairy cattle farming, forestry and local government)

Step 3: Calculate flow-on (indirect and induced) impacts in others industries using the MRIO model through time

Step 4: Calculate impacts associated with land use change through time using the MRIO model

Figure 1 below shows the way in which information derived from the EERNZ CBA study (depicted in the green boxes in the diagram) flows into the MRIO model. The primary components of the MRIO model are depicted in the brown boxes. The final results that are produced by the model (depicted in orange at the centre of the diagram) are the value added and employment effects associated with each Action. Note that all results are reported in terms of the net change from a business-as-usual (BAU) scenario.

3.1 Development of a Manawatū River Catchment MRIO Model

The MRIO model used in the study was generated by Market Economics Ltd using the Generating Regional Input-Output Tables (GRIT) methodology developed at the University of Queensland (Jensen et al., 1979; West et al., 1980). The table is for the 2007 year and contains three regions, namely: MRC, rest of the North Island and South Island. Each region has 48 economic sectors along with 7 primary inputs (wages and salaries, operating surplus, consumption of fixed capital, imports, subsidies, taxes of production and other taxes) and 7 final demands (household consumption, central government, local government, gross fixed capital formation, exports, net increases in stocks, and not for profit organizations)

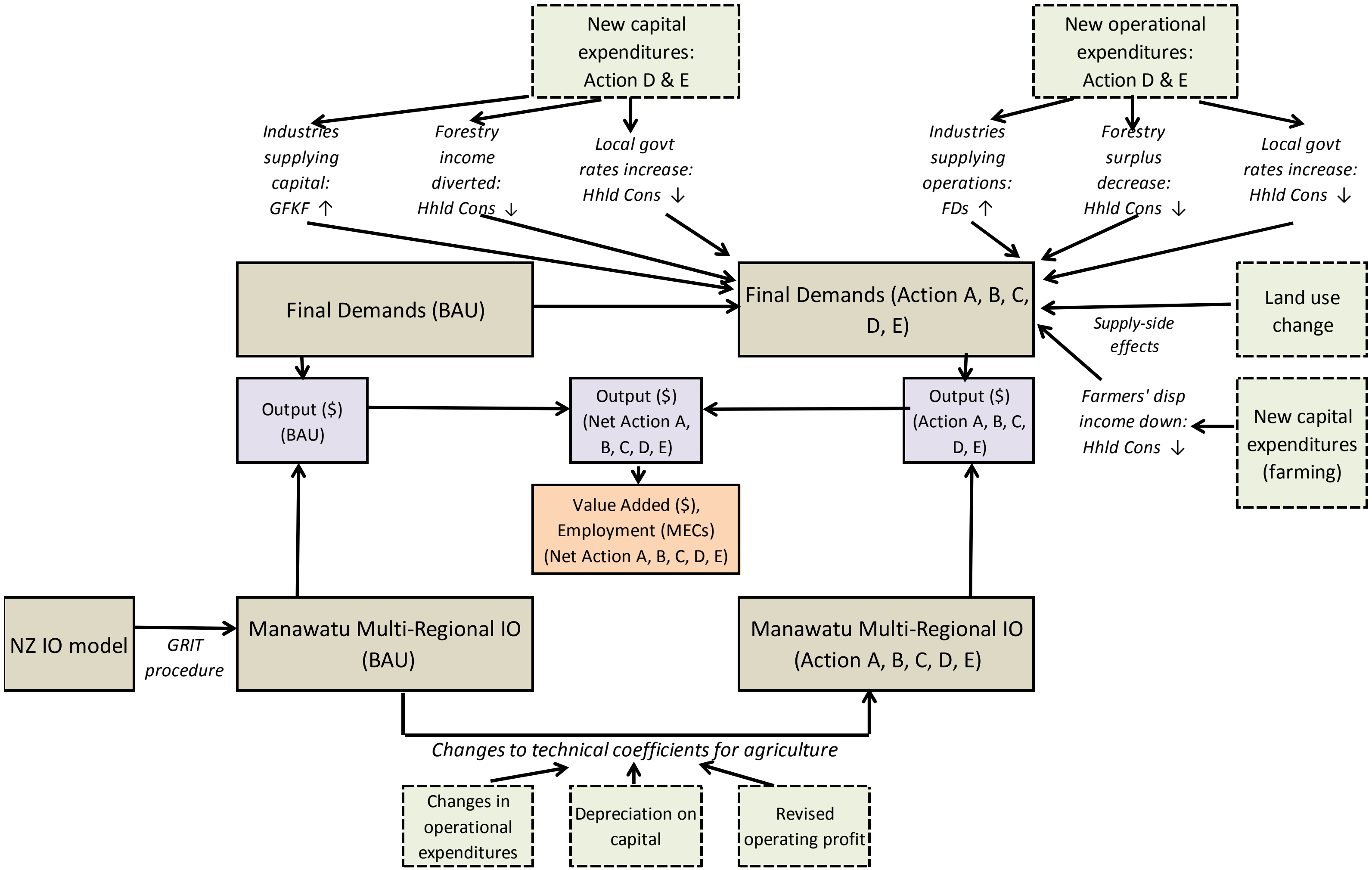

Figure 3.1 Summary of the Modelling Framework and Input Data used to Estimate the Economic Impacts of Selected Mitigation Actions

3.2 Incorporating Economic Structural Changes into the MRIO Model

The various Actions that have been proposed involve changes in land management and farming practices within both dairy and sheep and beef farming within MRC. Examples include reductions in P fertilizer use and increased use of nitrification inhibitors. These measures will result in changes to the purchase patterns of dairy and sheep and beef farms, thereby creating flow-on upstream impacts through economic supply chain linkages.

The inclusion of structural changes into the IO table was performed by changing the input-mixes of the agricultural sectors to better reflect scenarios put forward for each Action. The input-mix of an industry refers to the recipe of goods and services that it must buy from other sectors to produce its output. Adjustments were made for changes in operating profit, operating expenditure, and capital expenditure, with the later including funding of capital and depreciation.

3.3 Estimating Future Final Demands

For each Action investigated, a set of annual final demand projections by economic industry, covering the period 2011 to 2031, was developed. The projections were derived by taking the final demand data from the BAU IO table, and then making appropriate additions and subtractions to capture the implications associated with the mitigation actions occurring in each scenario. In brief, the following influences were accounted for:

- *Increased industry output for the provision of new capital* –There are numerous new capital items that are proposed to be introduced under the various Actions. Examples include additional fencing, effluent storage areas, herd homes and wastewater treatment infrastructure. When an industry sells output for the purposes of forming new fixed capital items, this sale is included in the final demands category called gross fixed capital formation (GFKF). The first step required is thus to determine the industry or industries most likely to be responsible for supplying each of the new capital items, and then increase sales to GFKF by those industries by a value equivalent to the costs of the capital items supplied.

- *Allocation of funding for the provision of new capital* – The next step is to derive and apply assumptions around the funding of capital items. All capital items are assumed to be funded by a loan system over 20 years, with real interest rates of 5.51 % p.a. It is assumed that land owners are responsible for servicing the loans on new capital items for farms. Similarly, it is assumed that land owners are responsible for servicing loans for new forestry capital (primarily land preparation and planting costs). In regards to the capital required under Action E to improve wastewater treatment, this is assumed to be funded by local government out of a loan scheme.

Where farmers/ foresters are responsible for funding loans, it is further assumed that they do so by reducing investment (i.e. demands for GFKF) elsewhere. Where however local government is assigned responsibility for a loan, it assumed that the funds are generated via a rates increase, leading to reductions in other forms of consumption by Manawatū-Wanganui households.

- *Increased industry output associated with the provision of operational activities* – Many of the changes in operational activities are already captured through changes to the input mix of agriculture (see Section 3.2 above). Additionally, new operational activities are associated with increases in forestry (e.g. tree pruning and thinning) and the on-going operation of wastewater treatment facilities (i.e Action E). The industries most likely to be undertaking these operational activities were identified, and then the final demands for these industries' output were increased.

- *Allocation of funding for operational activities* – The funding of operational expenditures for farming and forestry is assigned to land owners. New operational expenditures associated with wastewater treatment facilities (Action E) are assigned to local government. Operational expenditures paid for by local government are assumed to be funded by a rates increase, leading to reduction in other household consumption on a pro-rata basis.

- *Changes to farming and forestry operating surplus* – This results from changes in management practices, capital inputs and/or operational expenditures and ultimately leads to changes in income. The effects of reduced income are implemented by adjusting up/down the household column of final demands.

3.4 Depreciation on Capital Items

In order to complete the treatment of capital items depreciation was accounted for. Depreciation was incorporated in the MRIO by simply adding depreciation to value added (which includes consumption of fixed capital) for each year of the study.

3.5 Incorporating Land Use Changes

Under Action D there are significant land use changes associated with the conversion of sheep and beef farming into forestry. This conversion may have substantial down-stream effects, particularly in regards to meat processing and textile manufacturing. In order to capture the supply side effects resulting from land use change, reference is made to Ghosh multipliers (Ghosh, 1958, 1964; Miller and Blair, 2009) that are derived from the base IO table. Essentially these multipliers measure, for every unit of output change in a selected industry *i*, the corresponding changes in output of all sectors that depend on sector *i*'s product as an input to their own production processes.[3]

In short, three steps are required for the incorporation of supply-side effects. The first is to estimate the loss or gain in agricultural output for each agricultural industry resulting from land use change. An assumed constant relationship between output and land use is used for this purpose. Second, the change in output for all down-stream industries is estimated through application of the Ghosh multipliers. Finally, reference is made to mathematical identities to determine the change in final demands necessary to affect the calculated change in output resulting from supply-side impacts (i.e. land use change). Note that the final step is to translate the supply-side impacts into changes in final demands, as it is final demands that are used as inputs into the IO model for the purposes of calculating the final results for each scenario (see Figure 3.1).

3.6 Calculating Economic Impacts

Having derived an IO table and set of final demand projects for each scenario, it is now possible to calculate the economic output ($\$_{2007}$) for each economic industry, both within the MRC and the rest of New Zealand. Very simply, the vector of output by industry, X, is calculated according to the equation,

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

where A is a matrix of technical coefficients, I is an identify matrix and Y is the vector of final demands by industry. The calculated vector of economic output, X, is then translated into the final reporting variables i.e. value added ($\$_{2007}$) and employment (modified employee counts or 'MECs')[4] through the use of impact ratios relating output to the two reporting variables. Note in the equation above the $(I - A^*)^{-1}$ matrix, the so-called Leontief inverse matrix is closed, capturing not only ***indirect*** (i.e. backward linkage) flow-on implications, but also ***induced*** impacts associated with consumer spending.

[3] A core assumption in applying this supply-side approach is that the output distributions within the economic system are stable. This means that if the output of a sector is, say, doubled, sales from that industry to all other industries that purchase from that industry will also be doubled. Although this assumption is unlikely to hold for many economic situations (see, for example, Giarrantani 1980, 1981), it is considered to be a relatively reasonable assumption to apply in the assessment of changes to agricultural and forestry industries. This is because the industries that will be primarily affected by the supply-side effects are those that use commodities produced by agriculture and forestry to produce manufactured products (e.g. wood product manufacturing, meat product manufacturing etc). For these industries it is likely that there will be a relatively constant relationship between the availability of commodities for processing and the value of manufactured products produced.

[4] Modified Employee Counts or MECs are a measure of employment developed by Market Economics Ltd (M.E) based on Statistics New Zealand's (SNZ's Employee Counts (ECs). According to SNZ, the number of ECs is 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 MEC statistics developed by ME thus include an estimate of the number of working proprietors.

4 Results

Table 4.1 presents a summary of the cumulative (i.e. summed over all study years) and average (i.e. the cumulative results divided by 21 years) economic impacts calculated for the five Actions investigated. The results are also spatially disaggregated between the MRC and the rest of New Zealand. So as to obtain an idea of the way in which these economic impacts are distributed across time, Table 4.2 presents annual net changes in value added and employment under each Action for five different years within the study period. Baseline (2007) value added and employment indicators are furthermore provided to help put these results in context. To view the distribution of economic impacts across economic industries, reference can be made to Appendix A.

Table 4.1 Cumulative Net and Average Economic Impacts, 2011-2031

	Cumulative Net Economic Impacts			Average Net Economic Impacts Per Year		
	Gross Output	**Value Added**	**Jobs**	**Gross Output**	**Value Added**	**Jobs**
	$\$_{2007}$m	$\$_{2007}$m	MEC[1] Years	$\$_{2007}$m	$\$_{2007}$m	MEC[1] Years
Action A						
Manawatu Catchment	82	37	570	3.9	1.7	27.1
Rest of New Zealand	-199	-82	-1,180	-9.5	-3.9	-56.2
Total	**-117**	**-45**	**-610**	**-5.6**	**-2.1**	**-29.0**
Action B						
Manawatu Catchment	679	335	4,450	32.3	16.0	211.9
Rest of New Zealand	-220	-77	-1,280	-10.5	-3.7	-61.0
Total	**458**	**258**	**3,170**	**21.8**	**12.3**	**151.0**
Action C						
Manawatu Catchment	2,456	1,125	17,430	116.9	53.6	830.0
Rest of New Zealand	-3,933	-1,616	-23,380	-187.3	-76.9	-1,113.3
Total	**-1,477**	**-491**	**-5,950**	**-70.3**	**-23.4**	**-283.3**
Action D						
Manawatu Catchment	-525	-380	-4,320	-25.0	-18.1	-205.7
Rest of New Zealand	-430	-196	-2,590	-20.5	-9.3	-123.3
Total	**-955**	**-576**	**-6,910**	**-45.5**	**-27.5**	**-329.0**
Action E						
Manawatu Catchment	-11	5	-200	-0.5	0.2	-9.5
Rest of New Zealand	-15	-7	-90	-0.7	-0.4	-4.3
Total	**-26**	**-2**	**-290**	**-1.3**	**-0.1**	**-13.8**

Notes

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

Table 4.2 Net Annual Economic Impacts, 2011-31

	Value Added	Change in Value Added				
	2007	2011	2015	2020	2025	2030
Value Added	$\$_{2007}$m	$\$_{2007}$m	$\$_{2007}$m	$\$_{2007}$m	$\$_{2007}$m	$\$_{2007}$m
Manawatu Catchment						
Action A	4,842	4	4	4	0	0
Action B	4,842	20	20	20	13	13
Action C	4,842	97	95	93	16	16
Action D	4,842	5	-29	-15	-22	-22
Action E	4,842	24	-1	-1	-1	-2
New Zealand						
Action A	168,331	6	3	0	-7	-7
Action B	168,331	28	23	16	3	3
Action C	168,331	150	91	16	-122	-122
Action D	168,331	9	-25	-27	-39	-38
Action E	168,331	42	-2	-2	-3	-3
	Employment	**Change in Employment**				
	2007	**2011**	**2015**	**2020**	**2025**	**2030**
Employment	**MECs[1]**	**MECs[1]**	**MECs[1]**	**MECs[1]**	**MECs[1]**	**MECs[1]**
Manawatu Catchment						
Action A	62,208	4	56	55	1	1
Action B	62,208	20	273	271	156	156
Action C	62,208	97	1,524	1,496	201	201
Action D	62,208	5	-183	-210	-283	-283
Action E	62,208	24	-31	-31	-31	-31
New Zealand						
Action A	2,222,579	89	47	-4	-95	-95
Action B	2,222,579	378	301	205	21	21
Action C	2,222,579	2,179	1,359	336	-1,702	-1,702
Action D	2,222,579	85	-140	-361	-496	-496
Action E	2,222,579	617	-48	-48	-48	-48

Key findings for each Action are as follows:

Action A

In terms of the MRC, the results show that there is a small positive economic impact (eg $\$_{2007}$37mil in cumulative value added or an average of $\$_{2007}$1.7mil in value added per year). The major reason for the positive impact is that the works required to implement the action create demand for goods and services produced within the catchment (e.g. $\$_{2007}$37mil in cumulative value added) and this has flow-on effects throughout the economy. There is also a relatively small positive impact (c$\$_{2007}$17 mil in cumulative value added over whole period) associated with a slight increase in the operating surplus generated from dairy farming which then creates additional spend in the economy. For the MRC, these positive impacts outweigh the small negative impact (c-$\$_{2007}$11 mil cumulative value added impact) associated with less inputs purchased by farming, which also has flow on impacts in the economy.

For the rest of the country, the estimated economic impact of Action A is negative (-$\$_{2007}$82 mil cumulative value added). This impact is associated primarily with the need to finance the mitigation works which will redirect moneys from other capital-type investments. As much of the current patterns of capital investment occur outside of the catchment, the impact is assumed to be felt primarily in the rest of New Zealand. On the positive side, the rest of New Zealand does benefit from additional economic activity facilitated by the mitigation works (mainly indirect impacts flowing to outside of the catchment) plus the flow on effects of increased profitability in dairy farming (which leads to additional purchases by households including purchases outside of the region).

Action B

There is quite a substantial positive gain estimated for MRC ($\$_{2007}$335mil in cumulative value added) under this Action. The two most significant reasons for this are: (1) substantial increases in the cash operating profit generated from dairy farming - this enables additional household expenditures, particularly within the catchment (c$\$_{2007}$135mil cumulative value added); and (2) additional input purchases by farming (maintenance, fertilizers) which has flow on impacts through the economy (c$\$_{2007}$140mil cumulative value added). Additionally there is a relatively significant impact ($\$_{2007}$71 mil cumulative value added) generated from additional purchases of goods and services in the catchment (fencing contractors, native plantings etc) required to put in place the mitigation works.

Overall a negative impact is calculated for the rest of New Zealand under Action B (-$\$_{2007}$77 mil cumulative). The explanation is similar to Action A. Again, the negative impact is associated primarily with the need to finance the mitigation works (impact of -$\$_{2007}$222mil cumulative value added estimated). As above it is assumed that the moneys required to finance these works will be redirected from savings/investments elsewhere. The negative impact of financing mitigation works is to some extent countered by the additional activities required to undertake the works ($\$_{2007}$56mil cumulative), plus the effects of increased profitability in dairy farming which also has positive effects for the rest of NZ economy ($\$_{2007}$88mil cumulative value added).

Action C

Action C incorporates Action A and Action B. Additionally it incorporates very substantial capital investments in herd shelters for dairy farming and fencing and riparian planting for sheep and beef farming. Furthermore, there are some on-going operating costs required with maintaining herd homes. Quite substantial positive value added and employment impacts are estimated for the catchment (e.g. average net impact of $\$_{2007}$53.6 mil or 830 MECs). This is because it is assumed that much of the labour and materials required for the additional actions will be sourced from within the catchment. Additionally there are quite substantial increases in the operating surplus generated from dairy farming (which more than offsets losses in operating surplus for sheep and beef). Again the model distributes the additional household income generated into expenditures particularly within the catchment.

There is a very substantial negative impact calculated for the rest of NZ (-$\$_{2007}$2,370 cumulative) associated with the financing of the additional works. As above it is assumed that the moneys required to finance these works will be redirected from savings/investments elsewhere and that the negative value added and employment impacts associated with this occur primarily outside of the catchment. On the positive side, the additional expenditure on labour and materials in order to put in place the new herd homes and riparian areas is estimated to create a direct, indirect and induced value added impact of \$603mil (cumulative) outside of the catchment.

Action D

This Action involves the conversion of 39,000 ha of erosion prone sheep and beef land to forestry over a 10 year period. The negative forward linkage impacts associated with this land use change are estimated to be quite substantial, both within the catchment (-$\$_{2007}$277mil cumulative value added) as well as the rest of New Zealand (-$\$_{2007}$166mil cumulative value added). There are also quite substantial negative impacts for the catchment and the rest of New Zealand associated with losses in operating surplus for landowners, and thus loss in household expenditures. ***Important to note is that incomes generated from harvests are not included in model, as these are outside of the study period.***

Action E

Action E relates to waste water treatment plant upgrades. The estimated economic impacts are relatively small compared with the other options ($\$_{2007}$5mil and -$\$_{2007}$7mil cumulative value for MRC and rest of New Zealand, respectively). There is a small positive impact for the catchment associated particularly with the supply of goods and services for the capital and on-going operations of these facilities. There is also a small negative impact for the catchment and the rest of New Zealand associated with the financing of these works. As explained above, it is assumed that this requires increased expenditures by local government which are financed through rates increases. This ultimately leads to reductions in household expenditure.

5 Caveats

This section outlines some of the important caveats and matters for further consideration relating to this study.

(1) Funding Sources for new Operational and Capital Expenditures

When reviewing the results of this study, a matter that requires particular consideration is the issue of funding for mitigation options. The way in which the new expenditures are funded will impact on the distribution of effects across the NZ economy (e.g. the percentage of costs worn by households versus businesses, the percentage of costs worn by local households versus households in the rest of NZ), and even whether the net effects of the mitigation measures are overall negative or positive for the economy.

In this study we have made a set of assumptions determining which organizations/persons will be responsible for funding each mitigation measure and the budget reallocations that will occur to provide this funding. It has, for example, been assumed that farmers will be responsible for funding all farming-related capital and operational expenditures, and that these additional expenditures will be financed through reductions in farmers' household consumption.[5] It is, important to recognize that these assumptions that have been made regarding funding of expenditures are only one set of many plausible funding arrangement options. It is therefore recommended that the study is undertaken again once there is more information available as to the likely funding structures, and for testing out the implications of alternative funding arrangements.

(2) Loans

Related to the above section on funding, it is important to note that all capital expenditures are assumed to be paid for using loans. No attempt has been made to assess whether or not land owners are able to absorb the loans necessary to pay for the capital-based mitigation measures. It is indeed possible that many land owners will not have sufficient income or collateral to secure the loans necessary to undertake the proposed mitigation measures (e.g. construction of herd shelters). Although it has been assumed that loan based borrowing by local government will be funded through across-the-board rates increases, other possibilities exist (e.g. targeted rates, user charges, financial contributions and so on).

(3) Forestry Harvest Costs and Revenues

This assessment of economic impacts has not incorporated any costs or revenues associated with harvesting the new forest stands proposed under Action D, as these are likely to mostly occur outside of the 20 year study horizon. Future forestry revenues will not only generate income for the Forestry and Logging industry, it will also result in flow on impacts to consumer spending thus generating increases in value added and employment for other

[5] It is worth noting however that in the case of SLUI this was funded a third by farmers, a third by ratepayers and a third by central government.

industries. Furthermore, like the CBA study, this study has not attempted to assess any of the additional benefits that accrue from pine afforestation, particularly improved water infiltration and access to carbon credits.

6 References

Ghosh, A. 1958. Input-Output Approach to an Allocation System. Economica, 25, 58-64.

Giarrantani, F. 1980. The Scientific Basis for Explanation of Regional Analysis. Papers of the Regional Science Association, 45, 185-196.

Giarrantani, F. 1981. A Supply-Constrained Interindustry Model: Forecasting Performance and Evaluation. In Buhr, W. and Friedrich, P. (eds) Regional Development under Stagnation. Baden-Baden: Nomos, pp281-291.

Jensen, R.C., Mandeville, T.D. and Karunarantne, N.D. 1979. Regional Economic Planning: London: Croom Helm.

Miller, R.E. and Blair, P.D. 2009. Input-Output Analysis: Foundations and Extensions (2nd ed). New York: Cambridge University Press.

West, G.R., Wilkinson, J.T. and Jensen, R.C. 1980. Generation of Input-Output Tables for the Northern Territory GRIT II. Report to the Northern Territory Department of the Chief Minister. St Lucia, Queensland: Department of Economics, University of Sydney.

Appendix A

Table A.1: Net Economic Impacts for Selected Manawatū River Catchment Industries, 2011-2031

	Action A					Action B				
	2011	2015	2020	2025	2030	2011	2015	2020	2025	2030
	$\$_{2007}$m	$\$_{2007}$m	$\$_{2007}$m	$\$_{2007}$m	$\$_{2007}$m	$\$_{2007}$m	$\$_{2007}$m	$\$_{2007}$m	$\$_{2007}$m	$\$_{2007}$m
Action A										
1 Other farming and servs to agr.	0.0	0.0	0.0	0.0	0.0	0.8	0.8	0.8	0.1	0.1
2 Livestock and cropping farming	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1
3 Dairy cattle farming	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1
4 Forestry and logging	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5 Other primary industries	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1
6 Meat and meat product manuf.	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1
7 Dairy product manuf.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8 Other food and beverage manuf.	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.2	0.2	0.2
9 Other manuf.	2.2	2.2	2.2	-0.4	-0.4	8.5	8.5	8.5	4.2	4.2
10 Wood and paper manuf.	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1
11 Utilities	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1
12 Construction	0.2	0.2	0.1	0.0	0.0	1.2	1.1	1.1	0.9	0.9
13 Wholesale and retail trade	0.5	0.5	0.5	0.1	0.1	2.7	2.7	2.6	1.9	1.9
14 Transport	0.1	0.1	0.1	0.0	0.0	0.6	0.6	0.6	0.5	0.5
15 Communication, finance, insurance, real estate and business services	0.6	0.6	0.5	0.2	0.2	4.2	4.2	4.1	3.3	3.3
16 Government	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1
17 Other services	0.1	0.1	0.1	0.1	0.1	0.9	0.9	0.9	0.8	0.8
Total	**3.8**	**3.8**	**3.7**	**-0.1**	**-0.1**	**19.9**	**19.8**	**19.6**	**12.5**	**12.5**

Table A.1 (cont): Net Economic Impacts for Selected Manawatū River Catchment Industries, 2011-2031

	Action C					Action D				
	2011	2015	2020	2025	2030	2011	2015	2020	2025	2030
	$\$_{2007}$m	$\$_{2007}$m	$\$_{2007}$m	$\$_{2007}$m	$\$_{2007}$m	$\$_{2007}$m	$\$_{2007}$m	$\$_{2007}$m	$\$_{2007}$m	$\$_{2007}$m
Action A										
1 Other farming and servs to agr.	9.9	9.9	9.9	0.1	0.1	0.0	0.0	0.1	0.1	0.1
2 Livestock and cropping farming	0.5	0.5	0.4	0.1	0.1	0.0	-5.0	-10.5	-11.7	-11.7
3 Dairy cattle farming	0.3	0.3	0.2	0.1	0.1	0.0	-0.5	-0.7	-0.7	-0.7
4 Forestry and logging	0.1	0.1	0.1	0.0	0.0	3.1	-9.3	0.0	-2.8	-2.4
5 Other primary industries	0.2	0.2	0.2	0.1	0.1	0.0	0.0	0.0	0.0	0.0
6 Meat and meat product manuf.	0.3	0.3	0.3	0.2	0.2	0.0	-2.0	-3.7	-4.1	-4.1
7 Dairy product manuf.	0.1	0.1	0.1	0.0	0.0	0.0	-0.2	-0.3	-0.4	-0.4
8 Other food and beverage manuf.	0.4	0.4	0.3	0.2	0.2	0.0	-0.5	-0.1	-0.1	-0.1
9 Other manuf.	43.9	43.8	43.6	4.3	4.3	0.1	-0.8	-0.2	-0.4	-0.4
10 Wood and paper manuf.	0.6	0.6	0.6	0.1	0.1	0.0	0.0	0.0	0.0	0.0
11 Utilities	0.5	0.4	0.4	0.1	0.1	0.0	-0.2	0.0	0.0	0.0
12 Construction	10.0	9.6	9.1	1.5	1.5	0.5	0.5	0.4	-0.1	-0.1
13 Wholesale and retail trade	10.7	10.5	10.1	2.6	2.6	0.2	-4.0	-0.9	-1.2	-1.2
14 Transport	2.1	2.1	2.0	0.6	0.6	0.3	1.8	0.5	0.2	0.2
15 Communication, finance, insurance, real estate and business services	14.5	14.0	13.5	4.5	4.5	1.0	-6.4	0.5	-0.5	-0.5
16 Government	0.5	0.5	0.4	0.1	0.1	0.0	-0.2	-0.1	-0.1	-0.1
17 Other services	2.4	2.3	2.2	1.2	1.2	0.1	-2.6	-0.4	-0.4	-0.4
Total	**96.8**	**95.3**	**93.5**	**15.7**	**15.7**	**5.4**	**-29.2**	**-15.4**	**-22.3**	**-21.9**

Table A.1 (cont): Net Economic Impacts for Selected Manawatū River Catchment Industries, 2011-2031

	Action E				
	2011	2015	2020	2025	2030
	$\$_{2007}$m	$\$_{2007}$m	$\$_{2007}$m	$\$_{2007}$m	$\$_{2007}$m
Action A					
1 Other farming and servs to agr.	0.1	0.0	0.0	0.0	0.0
2 Livestock and cropping farming	0.0	0.0	0.0	0.0	0.0
3 Dairy cattle farming	0.0	0.0	0.0	0.0	0.0
4 Forestry and logging	0.1	0.0	0.0	0.0	0.0
5 Other primary industries	0.1	0.0	0.0	0.0	0.0
6 Meat and meat product manuf.	0.0	0.0	0.0	0.0	0.0
7 Dairy product manuf.	0.0	0.0	0.0	0.0	0.0
8 Other food and beverage manuf.	0.0	-0.1	-0.1	-0.1	-0.1
9 Other manuf.	2.0	-0.1	-0.1	-0.1	-0.1
10 Wood and paper manuf.	0.5	0.0	0.0	0.0	0.0
11 Utilities	0.1	0.0	0.0	0.0	0.0
12 Construction	11.6	0.0	0.0	0.0	0.0
13 Wholesale and retail trade	1.5	-0.7	-0.7	-0.7	-0.7
14 Transport	0.3	-0.1	-0.1	-0.1	-0.1
15 Communication, finance, insurance, real estate and business services	6.1	-1.2	-1.2	-1.2	-1.2
16 Government	1.0	2.2	1.8	1.5	1.3
17 Other services	0.3	-0.4	-0.4	-0.4	-0.4
Total	**23.7**	**-0.6**	**-1.0**	**-1.3**	**-1.5**