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# OVERSEER® Nutrient Budget modelling in the Manuherikia Catchment

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# OVERSEER® Nutrient Budget modelling in the Manuherikia Catchment

## Golder Associates

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# 1. Introduction

The Manuherikia catchment is located in Central Otago. The headwaters of the Manuherikia River are in the far north west of the Central Otago region, with the West Branch draining the eastern side of the St. Bathans Range, and the East Branch draining the western flanks of the Hawkdun Range. The river continues southwest through the wide Manuherikia Valley to its confluence with the Clutha River at Alexandra.

A feasibility study is currently underway in the Manuherikia catchment with the aim of providing options for water storage and distribution for irrigation within the catchment, while ensuring Central Otago's economic and environmental interests are addressed.

A key component of ensuring environmental interests are addressed is an understanding of current and potential nutrient losses from the Manuherikia catchment. To determine nutrient losses from the catchment OVERSEER® Nutrient Budget Model *(Overseer)* will be used. *Overseer* is an agricultural management tool which assists farmers in examining nutrient use and movement within a farm. *Overseer* calculates and estimates the nutrient flows in a farming system and can be used to identify where efficiencies in managing nutrients can be made as well as the potential risk of environmental impacts from losses through run-off, leaching, and greenhouse gas emissions.

The aim of this report is to outline previous *Overseer* modelling that has occurred within the Manuherikia catchment.

# 2. *Overseer* Modelling

## 2.1 Introduction

*Overseer* allows nutrient budgets to be created for a large range of farm systems in New Zealand, from dairy farms to cropping and some horticultural operations. More information on *Overseer* can be obtained from www.overseer.org.nz. *Overseer* can be used to assess nutrient losses from farm systems and catchment scale losses. *Overseer* can be used to determine catchment scale losses to the bottom of the root zone (60 cm pasture and 150 cm in cropping systems). However, to understand nutrient losses to groundwater, additional models are required that can determine nutrient transport through the vadose zone i.e. Trim or CLUES.

Within the Manuherikia catchment it is likely that individual nutrient budgets may have been carried out on farming enterprises. Currently within the Otago region, the only farming enterprise that requires an *Overseer* nutrient budget is dairy farming. Dairy

farms are required to display an *Overseer* nutrient budget in their dairy sheds to ensure that shed inspections are passed. The majority of these *Overseer* nutrient budgets will have been prepared for the dairy farmer by their fertiliser representative.

The Otago Regional Council is currently going through a plan change process where nutrient limits will be set throughout the region. The proposed plan change 6A (Water Quality) specifically refers to *Overseer* as the nutrient budgeting model that will be used to determine nutrient losses from a farm system. It is therefore likely, that the use of *Overseer* in all farm systems within the Otago region will increase significantly.

An Otago region N leaching risk map was prepared by AgResearch for the Otago Regional Council, with the aim to provide information to better understand the influences of inherent soil and climate properties and their interaction with different land-use within the Otago region on N leaching. The process of developing the Otago region N leaching map is explained below.

## 2.2 Otago Regional Council N leaching maps

AgResearch produced two maps focussing on N leaching losses for the Otago region. The first map utilised only the animal urine patch N sub-model within *Overseer* and the second map utilised the whole N model within *Overseer* (animal urine patch model + background N model). To further explain, within *Overseer,* N leaching is calculated by two processes; background N leaching losses and N leaching from animal urine patches. Background N leaching losses incorporate the effects of fertiliser use, effluent application and soil N cycling. The animal urine patch N model within *Overseer* is based on two components; 1) the amount of excreta (urine) N added and 2) the proportion of N leached each month. In most pastoral farms, leaching from the animal urine patch is the dominant source of N leaching.

N leaching losses are estimated monthly and reported annually within *Overseer*. Excreta (urine) N added is largely determined by management practices such as stock type and numbers, stock diet and timing of stock on pasture. The proportion of N leached each month is largely determined by site characteristics such as climate and soil properties that determine the drainage potential of that soil. The reasons for creating the two maps are explained below:

**Map 1: Inherent N leaching risk from urine N inputs**

The aim of this map is to show the risk of N leaching specific to the urine N patch model within *Overseer.* A standardised input of urine N was assumed (100 kg N/ha), which meant that the proportion of N leached each month was just a function of the physical characteristics of the Otago region. No

management effect i.e. different land use types, stock numbers and management practices are taken into consideration. The only management effect which has taken into consideration was the addition of the GIS irrigation layer, due to the effect of irrigation on drainage. The purpose of this map was to highlight the areas of the region that are most at risk (sensitive) of N leaching regardless of existing or future management practices.

**Map 2: Estimate of N leaching under existing land-use**

The aim of this map was to combine all relevant factors, including soil properties, rainfall/drainage, stock numbers and type, existing land-use and management practices to produce a map of estimated N leaching for existing land-use. This map therefore utilised the background and urine patch N leaching models within *Overseer*.

The process to develop the maps, involved three key steps; *Overseer* files, GIS data and the development of a Dynamic library link (DLL) (Figure 1).

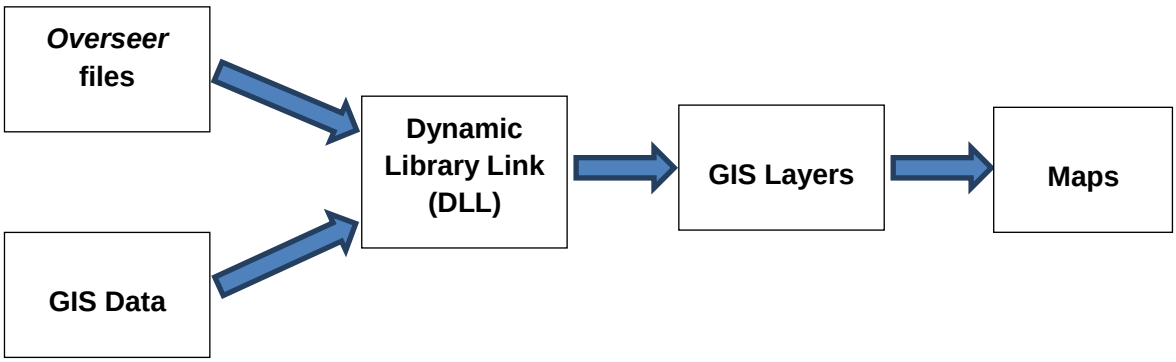


**Figure 1: Overview of the process undertaken to develop the maps**

A number of *Overseer* files were created using *Overseer* 5.5.1 to reflect the dominant land uses in Otago. *Overseer* 5.5.1 is the development model for the publically available model. The dominant land uses chosen were based on Agribase data. The Agribase data was supplied in October 2013. However, individual records may be older (as participating in Agribase is voluntary). The *Overseer* files created are listed in Appendix 1. Multiple *Overseer* files were created for a number of farm systems (i.e. sheep, mixed sheep and beef and beef). The reason for this was these farm systems occur across large areas of the Otago region and one *Overseer* file would not adequately describe the different management practices that might occur on these farms and allocation of different farm systems could be derived based on land use capability (LUC) classes and rainfall.

A large amount of the information required for the *Overseer* files was defined through the GIS layers or hard-coded in the DLL. Appendix 2 outlines the source of information

used to create the *Overseer* files. The main information required in the establishment of the base *Overseer* files was an understanding of likely stock numbers and management practices to support these farm systems.

GIS layers used included Agribase, GrowOtago (soil and climate information), LUC, slope and an irrigation layer supplied by the Otago Regional Council. A number of the GIS layers were reclassified to reduce the size of the databases and processing times. The DLL used information from the *Overseer* files created, input data form GIS layers and a series of rules, such as the effluent block on dairy farms cover 20% of the total farm area. The DLL produced outputs of N loss, P loss and urine N leaching risk index, that were stored on a database table, which was used to build the maps.

The two maps produced are shown in Figure 2 and 3. The inherent N leaching risk map (Figure 2) indicates that for the Manuherikia catchment the inherent risk of N leaching is low to moderate, this would likely be due to the climate of this region and the associated amount of expected drainage. The map showing estimates of N leaching under existing land use (Figure 3) indicates that the Manuherikia catchment current leaching losses are also in the low to moderate range.

A number of limitations exist based on how the maps were developed and the quality of the information used; it is therefore crucial that these maps are only used for their original purpose of providing background information to better understand the influence of soil and climate features combined with land-use on N leaching risk. It is also important that the large scale of the map is taken into consideration. The current maps are definitely not applicable at a farm scale or even most catchment scales as the level of input data is not specific enough. A number of steps could be undertaken to improve the quality of the maps, particularly for catchment scale modelling, where a much greater level of data resolution is essential.

Areas where improvements should be made if catchment scale modelling is required:

1. Allocation of farm systems across a region. Agribase is currently used and significant gaps exist in the data set, partly due to how data collection occurs (voluntary).
2. Farm system information within the *Overseer* files. Currently this is very generic and only a limited number of *Overseer* files were created to represent the farm systems within the Otago region.
3. Stock numbers. Improvements in the way stocking numbers are estimated and incorporated into the maps.
4. Irrigation entry into *Overseer*. Irrigation entered into *Overseer* is based on “best practice” and this will be greatly overestimating the efficiency of these systems (therefore underestimating leaching). Currently within the *Overseer* files irrigation is entered as method only, and no values are placed under rates

applied. Using method only (leaving rates blank), means *Overseer* calculates the amount of irrigation water applied based on daily water balances and replacing the estimated soil water deficit. The calculated amounts are usually considerably less than actual rates applied on a long-term basis.

5. Soil information. GrowOtago is currently used and moving to S-Map when it becomes available for the Otago region will improve the quality of soil information. Only a limited range of soil properties were available within GrowOtago. A wider range of soil properties, in particularly better definition of areas with shallow stony soils, would improve estimates of N leaching.
6. Climate information. GrowOtago climate information is currently used, moving to the Virtual Climate Station data should provide more accurate climate information, but this will greatly slow processing times.
7. To date there is a lack of research documenting N leaching losses from high (>1500 mm) and low (<600 mm) rainfall zones. This means that information is extrapolated out to these regions based on scientific principles. Further research in high and low rainfall zones would provide more information to calibrate and/or evaluate *Overseer*.

Improvements to the quality of land-use, and management data are necessary before the map could be used to look at leaching risks within specific catchments.

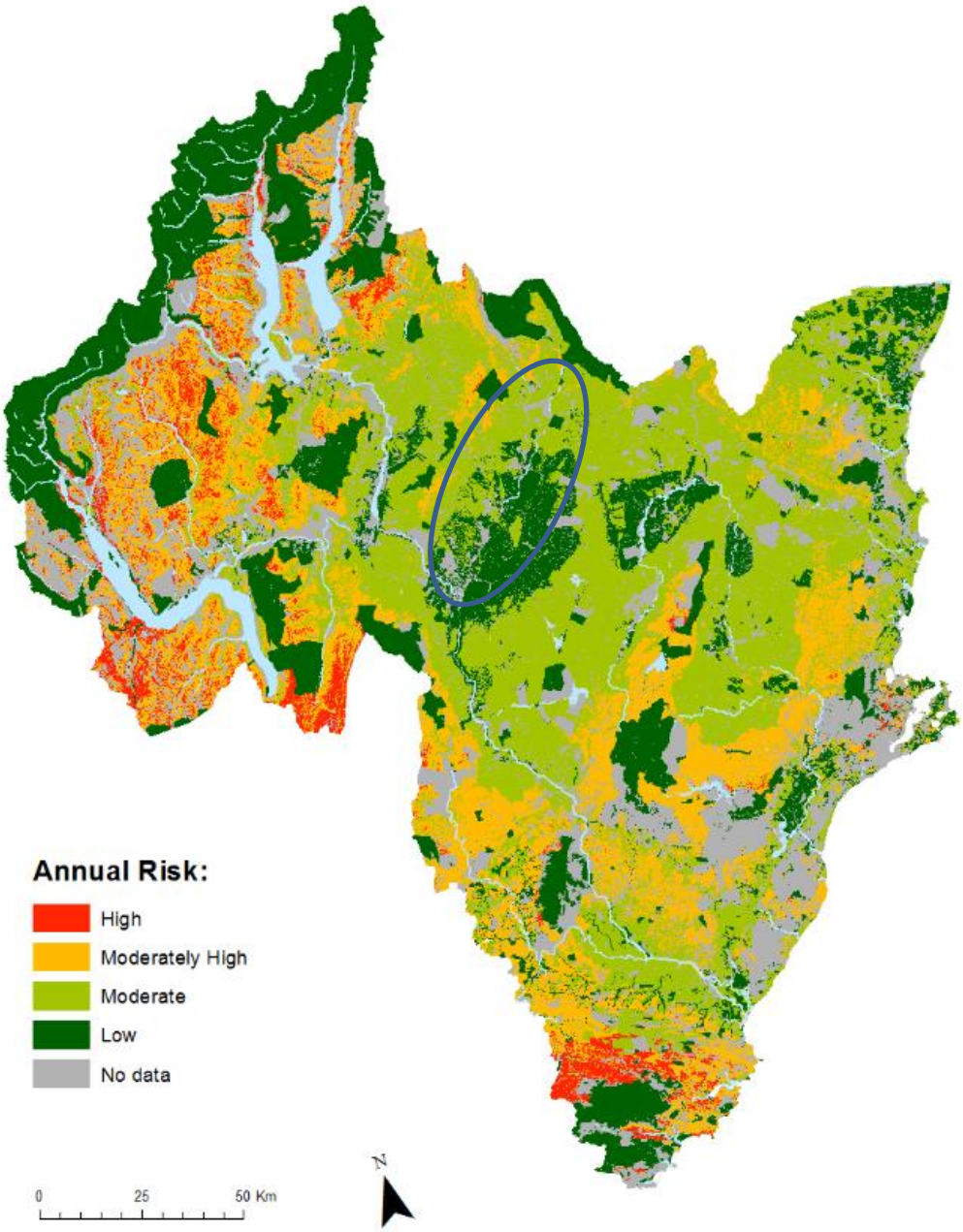


**Figure 2: Inherent N leaching risk from urine N inputs. The blue circle approximately highlights the Manuherikia Catchment.**

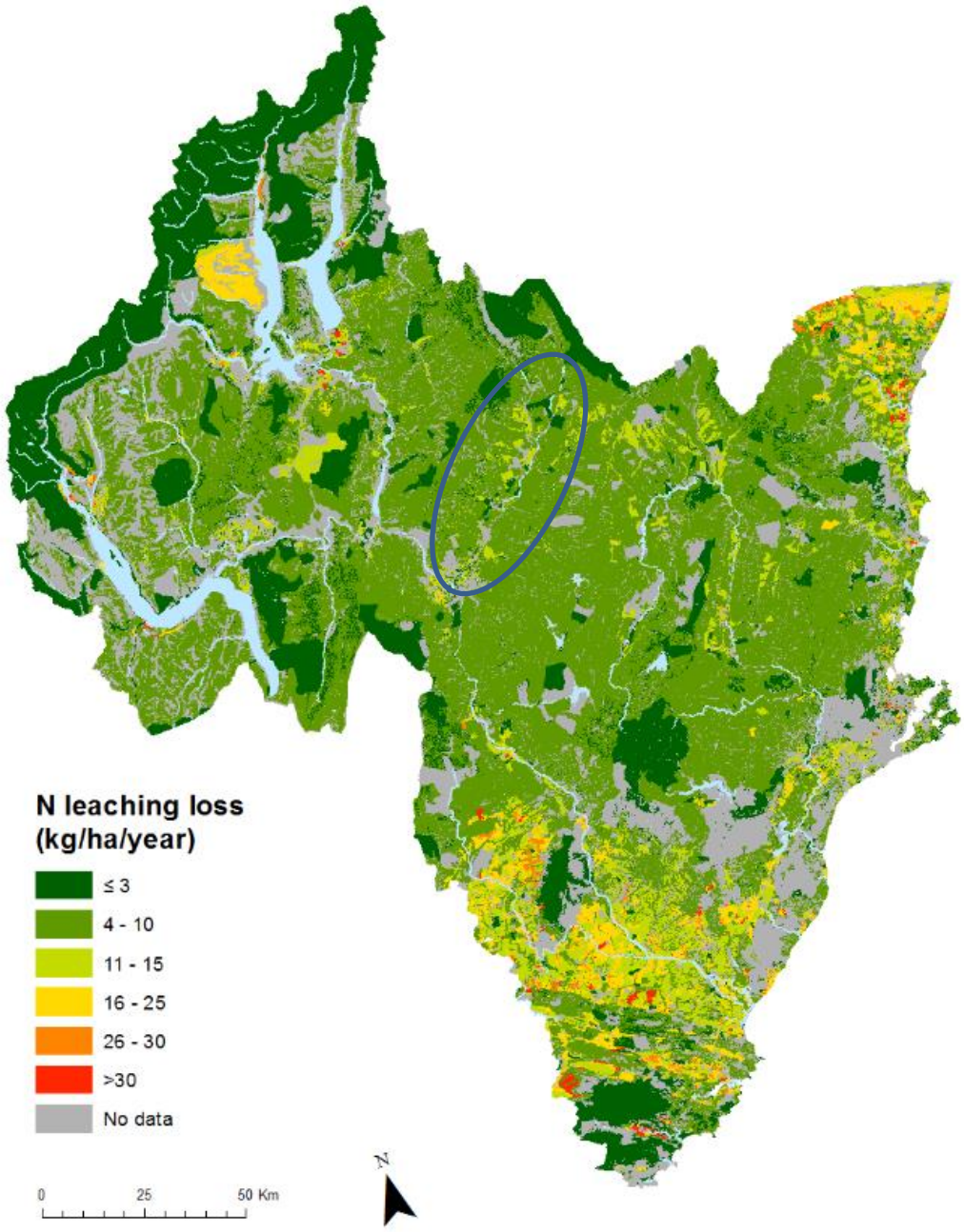


**Figure 3: Estimate of N leaching under existing land use. The blue circle approximately highlights the Manuherikia Catchment.**

# 3. Conclusions

To the best of our knowledge *Overseer* modelling within the Manuherikia catchment has been limited to individual farm *Overseer* nutrient budgets and the development of the Otago N leaching risk maps. A limitation of this report is no current individual farm nutrient budgets that have been carried out in the Manuherikia catchment have been reported here. The Otago N leaching maps provide a broad indication of potential N leaching risk within the Manuherikia catchment. The maps indicate that the inherent risk of N leaching and current N leaching risk is low to moderate, however information sources would need to be significantly improved and ground-truthing would be required before catchment scale interpretation would be possible.

# 4. Appendices

**Appendix 1: Description of the *Overseer* files created**

| Farm Type | LUC* Class (GIS Layer) | Rainfall (mm) (GIS Layer) | Farm descriptions |
|---|---|---|---|
| Sheep | 1 to 3 | < 800 | Breeding and finishing operation |
| Sheep | 1 to 3 | 801 – 1300 | Breeding and finishing operation |
| Sheep | 1 to 3 | >1301 | Breeding and finishing operation |
| Sheep | 4 | < 800 | Breeding and finishing operation |
| Sheep | 4 | 801 – 1300 | Breeding and finishing operation |
| Sheep | 4 | >1301 | Breeding and finishing operation |
| Sheep | 5 to 6 | - | Breeding and finishing operation |
| Sheep | 7 to 8 | - | Breeding and finishing operation |
| Irrigated sheep | 1 to 3 | - | Breeding and finishing operation with irrigation |
| Beef | 1 to 3 | < 800 | Breeding and finishing operation |
| Beef | 1 to 3 | 801 – 1300 | Breeding and finishing operation |
| Beef | 1 to 3 | >1301 | Breeding and finishing operation |
| Irrigated beef | 1 to 3 | - | Breeding and finishing operation with irrigation |
| Mixed sheep and beef | 1 to 3 | - | Breeding and finishing operation |
| Mixed sheep and beef | 4 | < 800 | Breeding and finishing operation |
| Mixed sheep and beef | 4 | 801 – 1300 | Breeding and finishing operation |
| Mixed sheep and beef | 4 | >1301 | Breeding and finishing operation |
| Mixed sheep and beef | 5 to 6 | <800 | Hill country, breeding operation |
| Mixed sheep and beef | 5 to 6 | >800 | Hill country, breeding operation |
| Mixed sheep and beef | 7 to 8 | - | Extensive operation |
| Irrigated mixed sheep and beef | 1 to 3 | - | Breeding and finishing operation with irrigation |
| Dairy farm | - | - | 2.99 cows/ha dryland |

| | | | |
|---|---|---|---|
| Irrigated dairy farm | - | - | 3.7 cows/ha irrigated dairy farm |
| Dairy support | - | - | Support block for dairy crops with fodder block |
| Arable cropping | - | - | Arable cropping farm, predominantly barley |
| Deer farm | - | - | Deer breeding and finishing farm |
| Fruit growing orchard | - | - | Peach** production orchard |
| Horticultural farm | - | - | Potato farm |
| Viticulture farm | - | - | Wine production |

**Appendix 2: Source of information required to create *Overseer* files**

| **Main *Overseer* Inputs** | **Source** | **Step information implemented in** |
|---|---|---|
| Farm area | Agribase GIS layer | GIS |
| Stock numbers | Industry information for the Otago region | GIS & *Overseer* |
| Stock production | Industry information (DairyNZ, Beef and Lamb, FAR etc.) | *Overseer* |
| Distance from the coast | GIS layer | GIS |
| Topography | Land Use Classes GIS layer | GIS |
| Climate information | GrowOtago | GIS |
| Soil information | GrowOtago | GIS |
| Soil tests | *Overseer* defaults | *Overseer* |
| Soil drainage | GrowOtago | DLL |
| Fertiliser | Industry information | *Overseer* |
| Crop information | Industry information + Local knowledge | *Overseer* |
| Irrigation information | Irrigation GIS layer for ORC | GIS & *Overseer* |
| Pasture type | Industry information + Local knowledge | *Overseer* |
| Supplements | Industry information + Local knowledge | *Overseer* |
| Effluent management | Industry information + Local knowledge + DLL | GIS & *Overseer* |