THE MATRIX OF GOOD MANAGEMENT: TOWARDS AN UNDERSTANDING OF FARM SYSTEMS, GOOD MANAGEMENT PRACTICE, AND NUTRIENT LOSSES IN CANTERBURY

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Abstract

The Matrix of Good Management (MGM) project is a collaborative initiative between Environment Canterbury, three Crown Research Institutes (CRIs; AgResearch, Plant & Food Research and Landcare Research), six primary sector organisations (DairyNZ, Beef + Lamb New Zealand, Deer Industry New Zealand (DINZ), NZPork, Horticulture NZ and the Foundation for Arable Research (FAR)), and is overseen by a cross-sector governance stakeholder group.

The project has taken a collaborative co-design approach to quantifying the typical nitrate nitrogen (N) and phosphorus (P) losses that are expected to occur from the range of farming systems, soils and climates across Canterbury when managed to industry-agreed good-management practice (GMP). At catchment scale this will improve estimates of cumulative nutrient losses from agriculture and at farm scale it will provide nutrient loss benchmarks for farmers.

This paper provides an update to the introductory paper presented at the 27th FLRC Workshop in 2014. In particular it summarises progress with:

- Collection and analysis of real farm data aimed at characterising the main farm systems in operation in Canterbury;
- Definition of GMP through iterative and consultative approaches within and across the six primary sectors involved;
- Translation of these narrative descriptions of GMP into inputs that can be used to model N and P losses using OVERSEER®;
- Creation of clusters of soils and climates to provide appropriate resolution for the range of possible uses of the matrix.

The first iteration of the 'Matrix of Good Management' (MGM) is expected by August 2015.

Introduction

The National Policy Statement for Freshwater Management 2014 (Anon., 2015a) sets out how regional councils are to go about setting objectives, policies and rules about fresh-water in their regional plans. In particular, it requires councils and their community to:

- Establish freshwater management units across their regions;
- Identify the values (for example irrigation, mahinga kai, swimming, etc.) that the community holds for the water in those areas;
- Gather water quality and quantity information on the water bodies to assess their current state;
- Decide the water quality objective for each value the community has chosen based on the economic, social, cultural and environmental impact to that community;
- The final step is for the community to assess how, and over what time frames, those goals are to be met.

Regional councils should also note the recommendations of the Land and Water Forum (Anon., 2012) that emphasise the use of agricultural good management practices (GMP) in setting and managing within limits, and that GMP should be the minimum standard for the primary sector. It follows that there is an urgent need to develop widely agreed definitions of GMP, to understand the nutrient losses that are expected to occur from farms operating at GMP, and to support the primary sectors in implementing GMP.

For any particular farming system managed under GMP, there will be a range of potential nutrient losses depending on soil type and climatic conditions. Within the MGM project, we aim to quantify the typical nitrate nitrogen (N) and phosphorus (P) losses that are expected to occur from the range of farming systems, soils and climates across Canterbury when managed to industry-agreed GMP.

This information will be invaluable at the catchment scale for estimating cumulative nutrient losses that arise from the patchwork of farming systems present, and at the farm scale for providing nutrient loss benchmarks for individual farmers. Moreover, it is essential underpinning data to support well-considered community deliberations regarding freshwater values and the associated targets and time frames that are set for improving quality. Without understanding the contribution of GMPs to catchment loads, and therefore to water quality outcomes, it is difficult to transparently set and manage to limits and for primary industries to understand their contribution to meeting freshwater quality targets.

The MGM project is focused on farming in Canterbury but provides a template for generating essential information to address the New Zealand-wide challenge of intensifying land uses and protecting freshwater quality. If the MGM approach is successful and endorsed by communities and industry in Canterbury, then the suite of industry-agreed, nationally-applicable GMPs will be available for other councils to use. Where appropriate, using the MGM approach to estimating the footprint of GMP in other regions could result in significant savings in cost and time. An additional, national benefit anticipated from the project is that two research work streams, focused on wintering systems and intensive cropping systems, will provide information that can be used for improvements to the OVERSEER® model.

Methodology for characterising farming systems in Canterbury

The first stage of the MGM project was to establish realistic descriptions of the range of current farm systems and management practices for agricultural land uses in Canterbury. The collection of information from commercial farms for use in the MGM project was considered essential to accurately characterise the range of practices that are actually occurring in the region. The steps to collecting these data were:

1. Each industry-good body designed methodologies, reflecting the different scales, structures and resources of the industries, for collecting the required information including an appropriate sampling strategy;
2. The types of data required for each primary sector involved were agreed between the industry-good bodies, CRIs and Environment Canterbury;
3. Collection methodologies were compared across sectors and their adequacy in representing the range of current management practices was established and agreed;
4. Data were collected by each industry-good body, with support from the relevant CRI where applicable.

All industries, except pork and dairy, collected farm management information through conducting on-farm visits. Information for dairy farms was collected via Fonterra suppliers' Dairy Diary and predictive nutrient budgets (OVERSEER® files held by Ravensdown Fertiliser Cooperative). Information for outdoor pig farms was collected via a mail survey and follow-up by telephone interviews where necessary.

Information collected for dairy, beef, sheep, and deer farms related to the management practices and systems used over the 2012–13 year. For outdoor pig farms, information about typical on-farm management practices was collected. For horticultural and arable farms, typical rotation information based on multiple years of data, as well as actual paddock histories were collected for 2–14 year periods. To ensure that appropriate information was collected from all farms, each industry used agreed data templates. Many of the farms in the region were a mixture of enterprises, which made it difficult to categorise those farms and increased the time needed to identify and collect the relevant information.

There were some significant challenges in the data collection phase resulting from the complexity of the farm systems involved, the dynamic nature of the farming operations, and the type and magnitude of information required. A key lesson learned was not to underestimate the difficulty of capturing the required type of information from farmers. Much of it was not the type of data that farmers have readily available, or are in the habit of recording in detail. In addition, some of the information needed was commercially sensitive or private and strict confidentiality agreements were necessary. These challenges were overcome through discussion and methodology development among the project partners, iterative data collection and verification with the participating farmers, and the investment of many hours of work by both the project team and farming community.

Full details regarding the data collection methodology and results will be published on the project website (http://ecan.govt.nz/get-involved/mgmproject/Pages/Default.aspx). A summary of the data collected on current farming systems in Canterbury is given in Table 1.

Table 1. Summarised characteristics of the main farming systems in Canterbury in the early 21st century.

	Type and number of farms surveyed					
	Dairy (n=492)	**Beef & sheep (n=30)**	**Deer (n=13)**	**Outdoor pigs (n=16)**	**Horticulture (n=19)**	**Arable (n=9)**
Range of farm size (ha)*	92–240	51–10,799		10–480	8–3000	80–320
Stocking rate /ha	2.7–3.7 cows/ha	9.8 SU/ha		1.5–29 (mean 13.5)	n/a	n/a
Range of fertiliser N inputs kg N/ha/yr	0–375 (mean 208)	0–78 (mean 22)		0 on pig block	0–322^ (mean 88)	
Range of fertiliser P inputs kg P/ha/yr	0–88 (mean 31)	0–38 (mean 12)		0 on pig block	0–280^ (mean 19)	
Range of modelled N losses kg N/ha[+]	10–168 (mean 31)	3–24 (mean 10)	8–29 (mean 13)	Not modelled[#]	2–35 (mean 14)	4–17 (mean 10)
Range of modelled P losses kg P/ha[+]	<0.1–9.5** (mean 1.1)	0.1–1.3 (mean 0.4)	0.1–1.7 (mean 0.6)	Not modelled	0–0.8 (mean 0.2)	0.1–0.7 (mean 0.3)

**For dairy, the median farm area in each of Canterbury Water Management Strategy (CWMS) zones was calculated and the range of these medians is given here. The CWMS zones were chosen simply to provide a geographic breakdown of Canterbury. For beef and sheep, deer, outdoor pigs and horticultural enterprises, this is the range of total farm size. For arable enterprises, this is the range of total crop block sizes.*

^ Range of application rates derived from mean application rates for each individual crop, (based on ten most commonly occurring crops). Mean derived from all application rates to all of the ten most commonly occurring crops.

+Modelled by OVERSEER® for five of the industries as it is currently not possible to model losses from outdoor pig production using OVERSEER®. For dairy, beef and sheep and deer, the range of losses is based on one year of data. For horticultural enterprises, the range of losses is based on a whole rotation on a block. For arable enterprises, the range of losses is based on the mean across all crop blocks on a farm.

#Preliminary mass balance estimates indicate that an outdoor pig unit with an average stocking rate may leach in the region of 42 kg N/ha (Ian Barugh Pers. Comm.*, 2014).*

***For some parameters, the ranges shown include extreme outlier values. The associated mean values help to put these atypical results in context but, regrettably, space does not permit inclusion of distribution curves for each parameter.*

As well as often being complex enterprises, farms are spatially and temporally dynamic systems. For this study, we aimed to simplify them to enable construction of representative farm systems that could be used to populate the matrix. This simplification was a necessary, pragmatic step to enable modelling of nutrient loss across the region. Consequently, it is possible that there will be aspects of the actual farm systems present in Canterbury that these constructed systems will not fully reflect. This represents a source of uncertainty in the modelled results that will be explored further in future MGM reports.

Defining Good Management Practice

The second stage of the MGM project was to define GMP for each primary sector represented in the project. To provide a consistent framework for this, the MGM partners agreed on the following overarching principles:

- GMPs should be defined by the relevant primary sector in close consultation with farmers and should be supported by the Boards of each industry-good body;
- GMPs should balance environmental and financial sustainability and must not adversely affect other sustainability criteria such as animal welfare;
- GMPs should be nationally applicable while recognising that their application in practice would be dependent on the specific context; for example, land use, soil type, and climate;
- GMPs, when compared across sectors, should be generally equivalent in terms of the effort required to implement them.

To help differentiate GMP from other types of practice, for example, current practice, best management practice, or mitigation measures, and to establish a shared 'touchstone' for assessing the qualities of GMP across the primary sectors involved, the project partners adopted a working definition of GMP: *"What can be reasonably expected from farmers undertaking 'tidy farming'"*. This was found to be a useful starting point for GMP discussions with farmers across the range of primary sectors involved in the project.

Each primary sector tailored its approach to defining its industry-agreed GMP but common themes included: collating existing strategies, holding industry workshops, and collecting farmer feedback.

For the dairy industry, collating existing strategies (e.g. Sustainable Dairy: Water accord; DairyNZ, 2015) resulted in a list of qualitative GMP descriptions that was used in an extensive programme of workshops and questionnaires involving a Dairy Industry Advisory Group with representatives from across the dairy industry (e.g. milk processors, fertiliser industry), farmers and rural professionals from across Canterbury. Alongside GMPs to be used for MGM purposes, best management practices were identified. These latter practices may be required when, for example, the sub-regional limit-setting process requires improvements beyond GMP. A revised list of GMPs is currently being distributed widely among industry representatives and leading farmers to test national applicability and to achieve wide support for implementing the GMPs.

DairyNZ has incorporated the GMPs in the Sustainable Milk Plan template that has been signed off by Environment Canterbury. Implementation of the GMPs is likely to take a significant effort by the industries. The results of the farmer feedback from the dairy industry show clearly that the majority of the GMPs are not in place on all farms; for the various GMPs the percentage of farms having the GMP in place ranged from 42% to 95%. Implementation of some GMPs will require a considerable effort to set up necessary infrastructure, for example, for waste management, or for sufficient expert support to develop and implement the Sustainable Milk Plans, which includes nutrient management plans.

The beef and sheep sector based the first draft of GMPs on the existing information in the Land and Environment Planning toolkit from Beef + Lamb NZ (2015). The GMPs were tested and refined with input from farmers and consultants in targeted meetings.

The deer industry also developed a first list of GMPs based on existing material held by DINZ, notably the DINZ Landcare manual. Targeted meetings and consultations with farmers and industry representatives were held to further refine the list.

For the arable and horticultural industries, existing GMP frameworks such as NZGAP were used as a starting point for discussion with groups of growers and advisors. These had already been subject to considerable development and industry consultation over recent years. Other sources of draft GMPs, such as Waikato's good practice menus, were also drawn on. Through an iterative process of discussion, revision and further discussion with groups of horticultural[1] and arable farmers, a list of draft GMPs was developed for both sectors. These were then compared and, due to the similarity between the lists developed for each sector, it was agreed to combine the lists into a single set of GMPs covering both horticulture and arable farming.

The farming of sows outdoors generally occurs on freely draining soils with rainfall less than 800 mm/yr and in areas with a ready access to straw for bedding. In New Zealand, these conditions are found in the Canterbury Region. NZPork estimates that at least 40% of the New Zealand sow herd is farmed outdoors, with all its outdoor operations situated in Canterbury. In two public meetings of outdoor pig farmers in Canterbury run by NZ Pork in March and November 2013, the MGM project was introduced and the task of defining GMPs laid out. An extensive survey of outdoor pig farms was undertaken covering 80% of the outdoor farms. This provided a valuable resource highlighting the range in the size of farms as well as the systems and practices undertaken on outdoor pig farms.

Following the meeting in March the industry formed an 'outdoor pig farm working group'. This group consisted of eight outdoor pig farmers and two NZPork staff and the NZPork CEO and was supported by MGM staff. The working group had the objective of formulating a suite of GMPs that would be brought back to the wider industry for approval and subsequent testing. Relevant GMP material from other industries and Regional Councils (for example Waikato's good practice menus) was collated along with any pertinent material from outdoor pig production overseas and indoor pig production from New Zealand. The outdoor pig working group met for a series of five half-day sessions either as a whole or in part to formulate GMP for outdoor pigs that covered the several types of outdoor pig production systems identified in the survey. The suite of GMPs was built up, tested and refined over time and the final draft was presented back to, and agreed by, the wider industry at a public meeting in late 2013.

Once draft GMPs had been drawn up for each sector, these were compared across industries. There were many GMPs in common and it was evident that all the primary sectors involved shared the same framework for good nutrient management on farm, i.e.:

- Develop an understanding of nutrient loss pathways on the property;
- Assess risks to water quality;
- Manage appropriately;
- Record actions;
- Review regularly.

[1] The MGM project covers field vegetable production including onions and potatoes but does not extend to tree fruit or berry production.

It was therefore agreed by the industry representatives that the GMPs should be amalgamated where possible into a single, generic set with supporting, industry-specific, interpretative details. For ease of access, these were grouped under the following headings:

- **Whole farm**, including farm planning, record keeping and auditing;
- **Land**, including cultivation, ground cover, sediment and faecal coliforms;
- **Plants,** including nutrient management, irrigation and water use;
- **Animals**, including feed, farm effluent and waste water management and intensive winter grazing;
- **Other**, mainly waste management.

These draft GMPs are currently subject to final review by each industry-good body and are expected to be finalised and published during 2015.

Modelling Good Management Practice
Once GMPs had been defined in narrative terms, and the intent of the GMP was understood, it was then necessary to review these in the context of using OVERSEER®[2] to model expected nutrient losses from the farm systems identified within Canterbury when managed according to GMP. To do this, all the GMPs were categorised as follows:

1. Already assumed within OVERSEER®;
2. Not assumed within OVERSEER® but can be represented within the model;
3. Not assumed within OVERSEER® and not yet able to be represented within the model;
4. Not assumed within OVERSEER® and not amenable to modelling.

For all GMPs, the contaminants that the identified practice aims to manage were identified. Where scientific knowledge or research did not support the industries' anticipated outcome of the GMP, these practices were subjected to further discussion with the sector leading to refinement or exclusion from the lists of GMP.

For Category 1 GMPs, it was sufficient to simply document the nature of what has been assumed in OVERSEER®.

For the Category 2 GMPs, modelling rules and/or 'proxies' (modelling interpretations) for the GMPs were developed in a series of workshops with industry representatives, farmers and the scientists involved. These proxies are an attempt to capture the impact (as modelled by OVERSEER®) of implementing a specific GMP in terms of nutrient loss from the farm. For some Category 2 GMPs, it was necessary to seek further guidance from farmers and growers and/or expert nutrient management advisors to identify the correct proxies. For example, in arable cropping rotations where different tillage practices may be used at different points in the rotation, it was necessary to agree with the sector on the relative frequency of use of the different methods of cultivation. Hence, neither the modelling rules nor the proxies are

[2] OVERSEER® was chosen because it works at the whole-farm scale, is widely used in New Zealand, is freely available and was accepted by the industry representatives on the MGM project as the best tool available to assess nutrient losses for the purposes of the project (Williams *et al.*, 2013).

prescriptive in terms of what a farmer must do to fulfil the GMP but instead try to reflect the intent of the GMP for modelling purposes.

For Category 3 GMPs where current research is ongoing that may soon be reflected in OVERSEER® this was noted and where possible comment made on how the GMP might be modelled once included.

Category 4 GMPs were split into two groups. The first are those that do not fall in the domain of land use and water quality, such as disposal of waste plastic. For these GMPs, no further comment was made. For other Category 4 GMPs that are relevant to land use and water quality, such as keeping accurate farm records, it is not possible to model these GMPs directly. For these GMPs any likely impacts were noted but not modelled.

The modelling rules and proxies developed apply to Canterbury only. If other regional councils wanted to apply the MGM approach to their region, these would need to be tested and perhaps amended for the new region.

In this project, once the necessary modelling assumptions had been agreed, modelling of N and P losses could commence. A range of sheep/beef/deer farms managed under agreed GMPs were modelled using a linear program (Rendel *et al.*, 2013) to ensure that the farm systems were biologically feasible. A range of inputs (for example pasture growth rate profiles, stock classes on farm) and constraints (for example area of forage cropping) to the linear program were varied to ensure that the farm systems created for the matrix extend beyond the range revealed by the farm systems survey. The farm system outputs from the linear program will be used in OVERSEER® to calculate nutrient losses from farm enterprises and blocks to form the elements of the matrix. A similar process will be followed for the milking platform of dairy farms.

For the outdoor pig farms, modelling in OVERSEER® is not currently possible. A Sustainable Farming Fund project to develop an outdoor pig production module within OVERSEER® is underway and will be completed in 2015. Preliminary mass balance modelling had been undertaken by NZPork to estimate rough order losses from their farm systems (Ian Barugh. *Pers Comm*. 2014).

For arable and horticultural farms, an extensive range of OVERSEER® models that represented realistic cropping rotations were created based on actual farm information collected in the survey. Agreed GMPs were applied to these models to generate nutrient losses under these scenarios. Although a stratified survey approach was used to ensure information for all of the major crop types was collected (the resulting modelled dataset contained a large diversity of crops, frequency of crop occurrences and rotational crop combinations across a large number of blocks), further testing will be undertaken to determine if a greater range of inputs will be needed to cover all the relevant soil and climate combinations in the matrix.

Clustering of soils and climates

There is a large range of soils and climates in Canterbury. These must be grouped, or clustered, into a manageable number of categories that reflect important biophysical differences to make them tractable for the matrix. We have used two approaches to help decide what the categories should be: statistics and expert knowledge.

To understand the impacts of climate on N leaching, we used APSIM (Holzworth *et al.*, 2014) to model N losses from pasture (a simulated urine patch) and from a wheat crop, across three different soil types, dryland and irrigated, for each of the 1491 virtual climate stations in the region (Anon., 2015b) over 30 years. This generated a large amount of data that was analysed statistically to produce clusters or climate groups. The purpose of the analysis was to categorise the climate characteristics into groups that had similar impacts on nitrate leaching, irrespective of actual climate differences.

Ten climate categories are proposed (Figure 1). The analysis uses a grid-based interpolation of the virtual climate station network grid, resulting in areas with square edges - which have been smoothed. This smoothing process also results in the merging of very small areas with a different adjacent climate category.

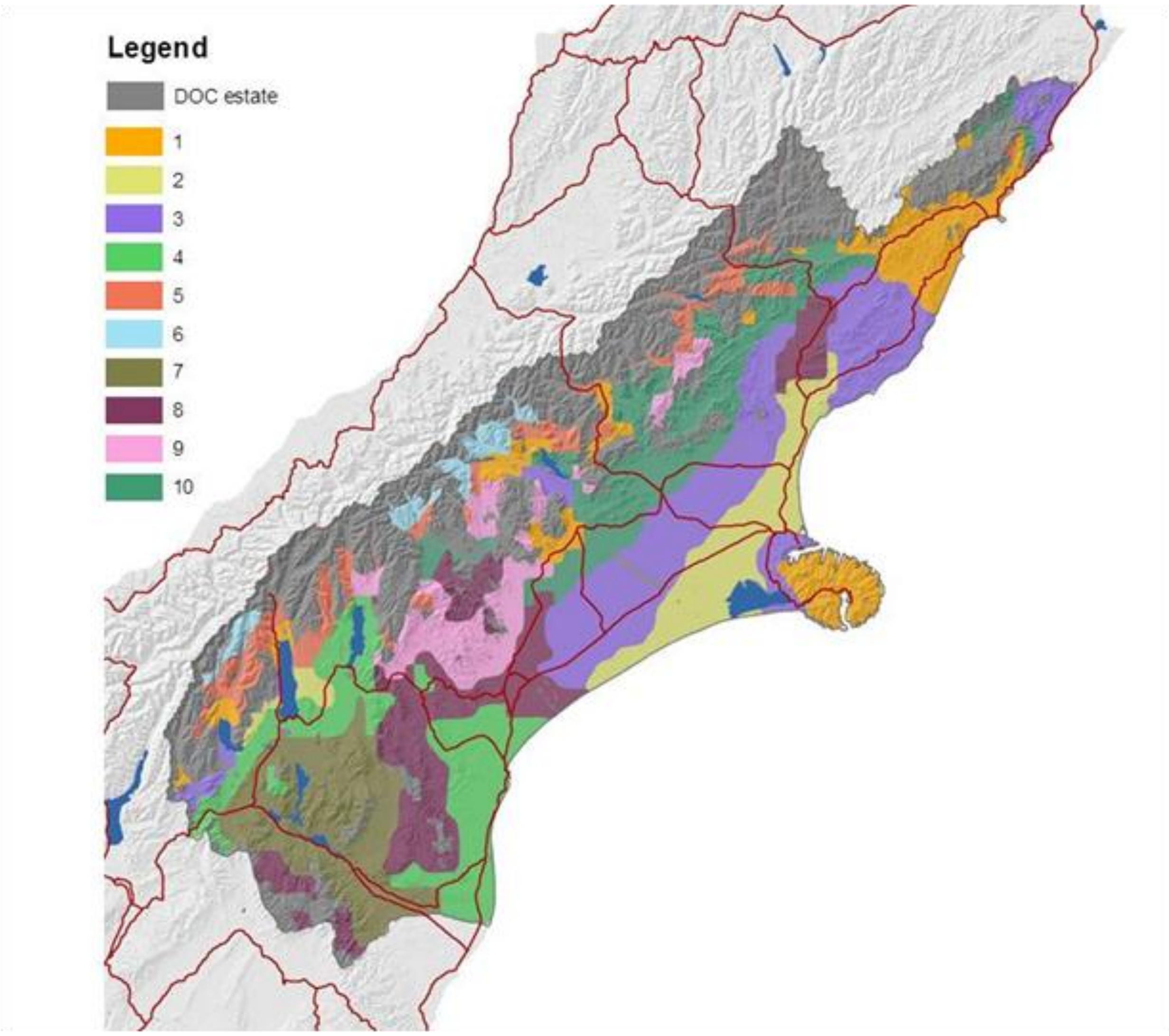

Figure 1. Map of proposed climate categories.

The climate categories are made up of several different climate factors. Table 2 shows how each of the climate categories is characterised with respect to the climate variables and Table 3 gives the colour codes for these variables.

Table 2. Climate variables in each of the ten climate groups (colour indicates median value and text indicates the range where 50% of the values lie).

Climate category	Rainfall (mm/yr)	PET (mm/yr)	Temp-erature (°C)	Annual range in average monthly temp-erature (°C)	Radiation (MJ per m^2 per day)	Elevation (m above sea level)
1	1006–1262	670–861	9.8–11.3	9.5–11	13.3–13.9	295–619
2	626–677	858–932	11.7–12	10.6–10.9	13.4–13.7	18–92
3	719–811	810–902	11.1–11.7	10.3–11.1	13.3–13.8	113–262
4	576–663	729–832	9–10.7	10.6–13.1	13.2–14.3	81–655
5	1565–1854	462–610	6.3–8.9	11.1–12.9	13–13.7	791–1461
6	2734–3890	384–545	6.1–8.4	10.3–12.3	12.3–13.2	821–1673
7	496–548	685–835	8.5–10.1	12.2–13.6	13.8–14.4	398–797
8	688–836	612–799	8–10.7	10.9–11.8	13.1–13.7	232–822
9	982–1192	479–672	7.3–9.4	10.9–11.5	13–13.3	510–1165
10	930–1036	656–766	9.5–10.7	11–11.4	13–13.4	329–641

Table 3. Key to colour coding of climate variables in Table 2.

Median annual rainfall (mm/yr)	Median annual PET (mm/yr)	Median annual temp-erature (°C)	Median annual range in average monthly temperature (°C)	Median daily radiation (MJ per m^2 per day)	Median elevation (m above sea level)
>1000	>800	> 11	>11	>14	>750
750–1000	600–800	8–11	10–11	13–14	250–750
<750	<600	<8	< 10	<13	<250 m

For the soils, the region was split into plains/downs and hills. Some previous work undertaken by pedologist Trevor Webb (Landcare Research) categorised the soils on the plains on the basis of profile available water (PAW). These categories were reviewed and refined using both expert and statistical approaches. To understand the impact of soils on N leaching, N losses were modelled from a forage crop across all the different S-map (Anon., 2015c) soil types, dryland and irrigated, for five rainfall classes in the region over 30 years using OVERSEER®. This generated a large amount of data that was analysed statistically. As with the climate cluster analysis, the purpose was to categorise the soils into groups with similar behaviour with respect to N leaching. The resulting statistical classification supported the use of PAW to separate the soil categories. However, in some circumstances, the modelling results did not reflect some other soil properties believed to have a significant influence on soil drainage. The expert review identified several new categories for the plains and identified a need to separate out the soils with fragipans. Figure 2 shows the soil categories for the plains and downs (fragipans excluded). Note the mole drain category is not shown on the map as there is no centrally-held spatial information available. The proposed expert categories for fragipans and hill country are shown in Figure 3.

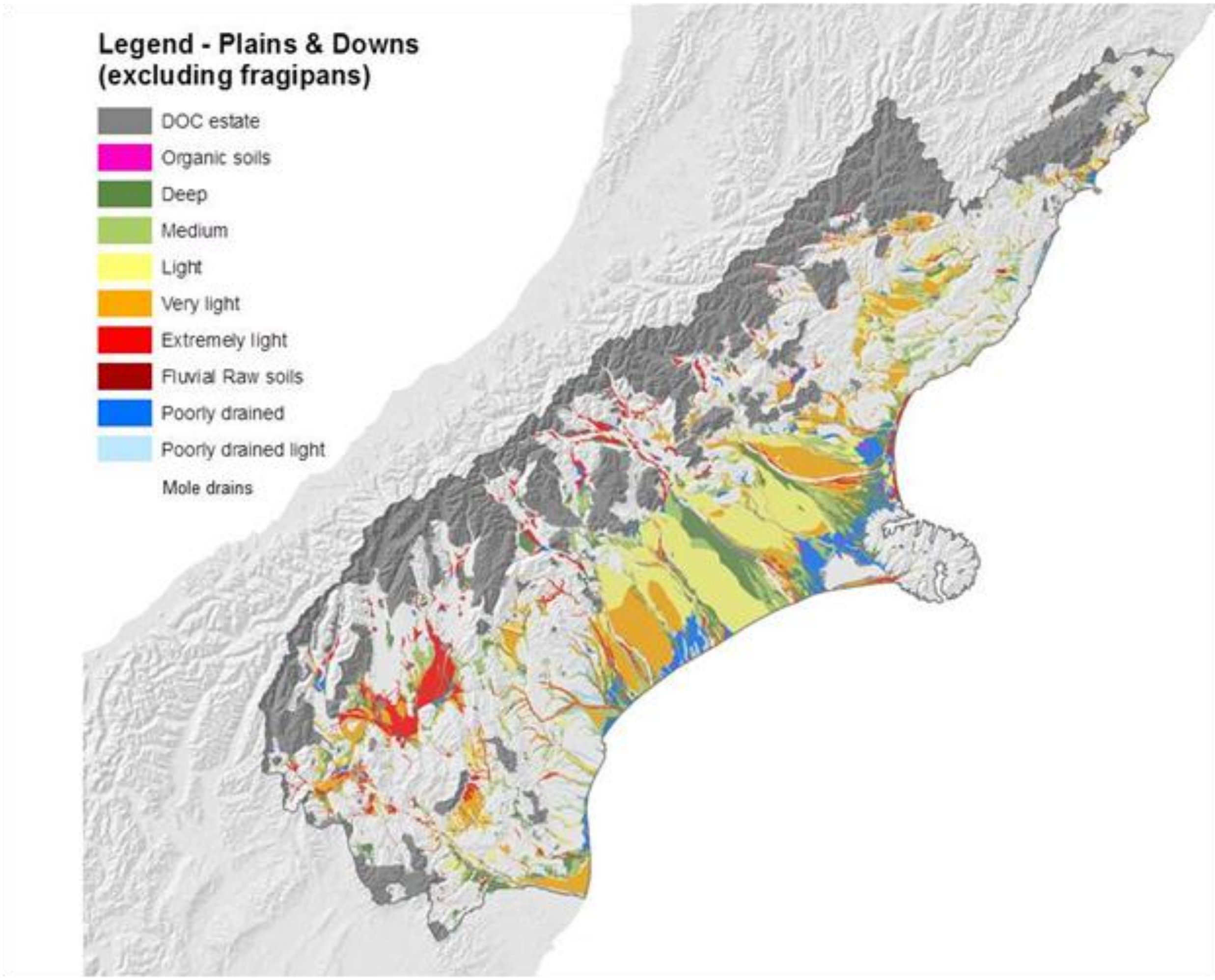

Figure 2. Map of proposed soil categories for the plains and downs soils (excluding the soils with fragipans).

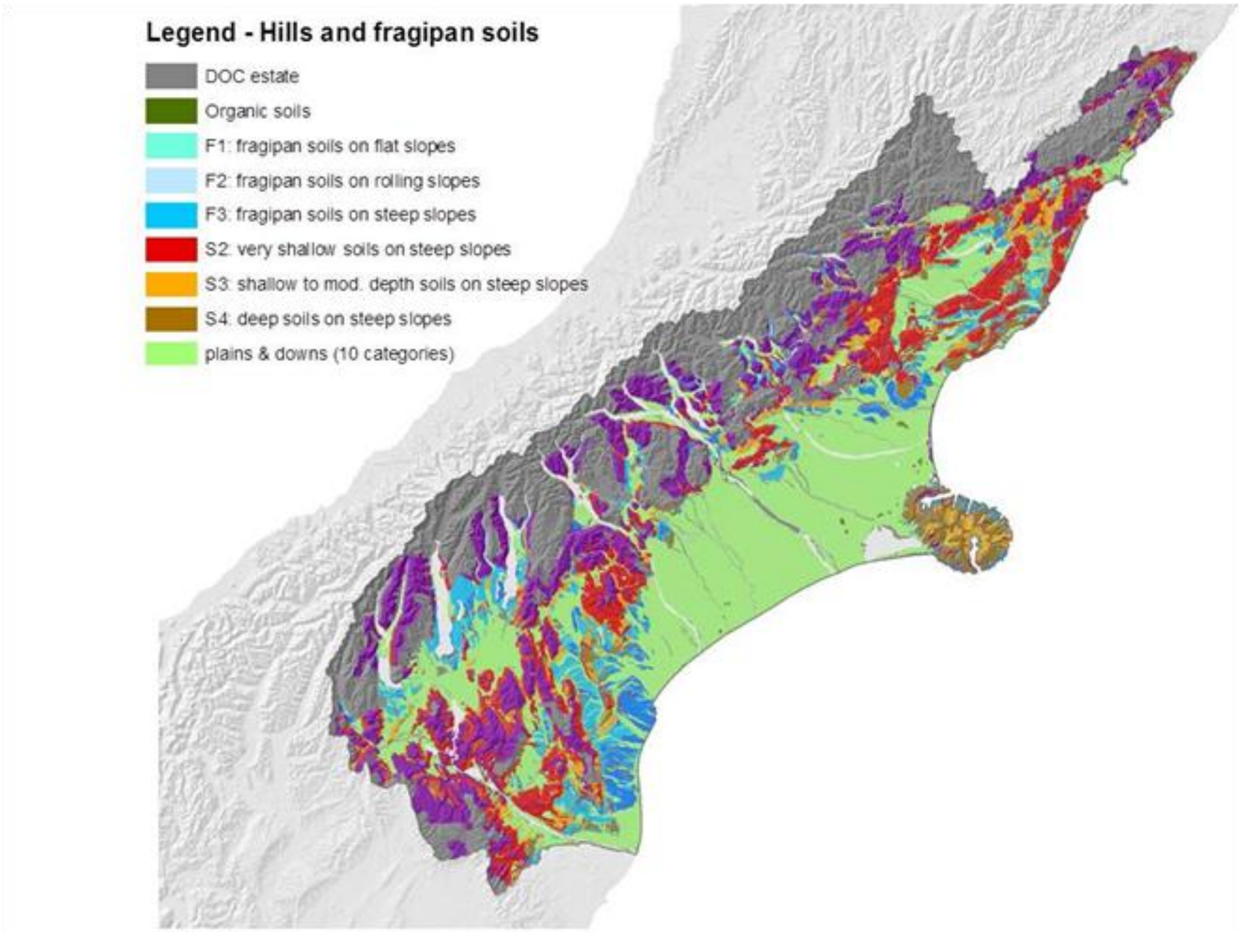

Figure 3. Map of proposed soil categories for the soils with fragipans and on the hills. NB: S1 category (very steep slopes), purple shading, is missing from the legend.

An expert approach to soil categorisation allowed making usable categories where there is incomplete data (for example, areas where there is no S-map coverage), or where the ability to model is not quite as advanced as available expert knowledge (for example, behaviour of fragipan soils). Also, it allowed for creation of categories where there is less need for fine categorisation (for example, where variations in leaching loss are likely to be very small and where further intensification is unlikely).

The climate and soil categories are currently being reviewed by agricultural experts and tested as to their resolution, i.e. to test whether or not the range of nutrient losses within each category is sufficiently narrow before being finalised. A more complete explanation of the methodologies, results and testing of the climate and soil clustering will be included in the technical reports that will be available from the project website: (http://ecan.govt.nz/get-involved/mgmproject/Pages/Default.aspx).

Implementing GMP in the Canterbury Land & Water Regional Plan

Under the proposed Canterbury Land & Water Regional Plan (Anon., 2015d), farmers are expected to manage nutrient losses from their properties. As a minimum requirement, it is expected that all land-owners will be operating at GMP.

The challenge facing Environment Canterbury is to devise a way of incorporating the results of the MGM project into the regional plan. The regional council has set up two working groups to develop plan provisions: an internal working group comprising senior staff from across the organisation, and an external Policy Working Group made up of representatives from primary sector organisations, farmers, Ngai Tahu, New Zealand Fish & Game, and government agencies.

Both groups have been meeting regularly and have reached broad agreement on the policy approach. The drafting of the plan provisions is expected to be completed by April. Subject to Council approval, staff will undertake Resource Management Act 1st Schedule consultation with the aim of notifying a plan change by September this year.

Conclusion

The MGM project reaches beyond a conventional consultation between industry, the research community and regional government: it has been co-designed, and is being collectively delivered, with input from all partners. Operating in a complex and traditionally somewhat adversarial environment, it is drawing on the expertise and goodwill of a diverse range of parties to tackle a complex and important technical question: what is the N and P footprint of Canterbury farming under GMP?

To date, we have characterised current farming practice across a range of primary sectors in the region, consulted widely to establish agreed definitions of GMP, developed a set of assumptions to translate narrative GMP descriptions into inputs for OVERSEER® modelling, and set out an approach to categorising Canterbury's diverse soils and climates.

The next phase of the MGM will focus on generating the data needed to populate the matrix with N and P footprint estimates. In parallel, but outside of this technical project, Environment Canterbury will continue to work with industry partners to incorporate the matrix in its Land and Water Regional Plan.

The approach taken in this project could provide a template for generating N and P footprints for farming in other regions across New Zealand.

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