Physiographic controls over Southland's ground and surface water chemistry – methods

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1 Environment Southland

The Concept

Water chemistry is variable in both space and time. This variability occurs despite similar or identical land use practices (figure 1), often due to varying hydrological, geological, edaphic and biochemical factors.

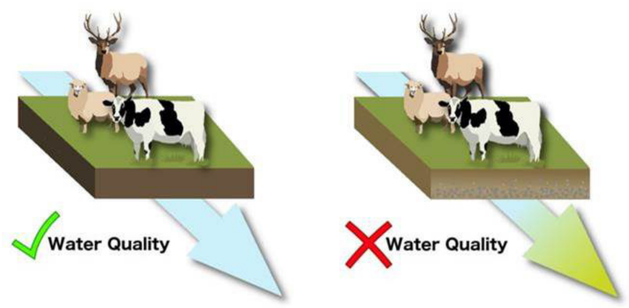


Figure 1: Demonstration of differing water quality outcomes despite the same land use.

A conceptual model was developed to explain this chemical variation. Using hydrochemical data, the key drivers of water chemistry were identified. Subsequently this allowed for estimation of the key controls over water chemistry across the region (figure 2).

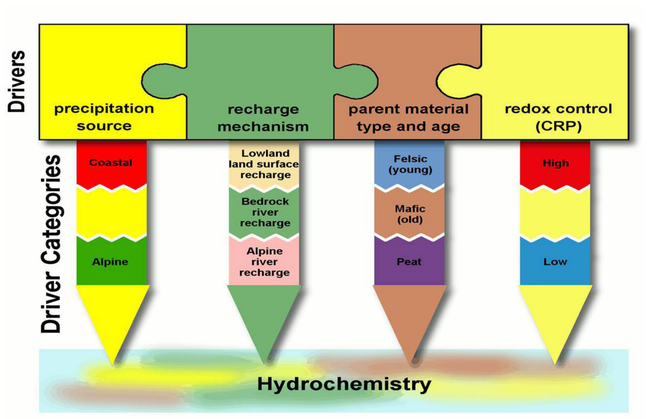


Figure 1: Schematic depicting the general physiographic approach.

An application of this conceptual model is to use an objective rules based mapping method to simplify these unique driver assemblages and delineate the region into nine physiographic units (figure 3).

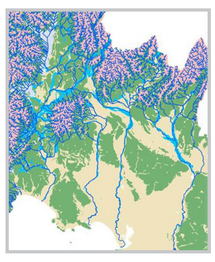
This process provides a better understanding of the specific controls over water quality within each of the units, allowing land use within these different units to be managed more appropriately.

Identifying key drivers

This approach involved the use of local and international literature; understanding of regional climate; geological and hydrological setting; and the analysis of an extensive regional hydrochemical dataset of 26,615 samples (detailed in Daughney et al., 2015). The use of major ion facies, redox assignments, saturation indices, isotopic assessments and multivariate statistics including cluster analysis, allowed for grouping of chemically similar samples and, through an iterative process, the identification of four key drivers of water chemistry in Southland. These drivers were predominantly mapped using attributes from existing frameworks (see below).

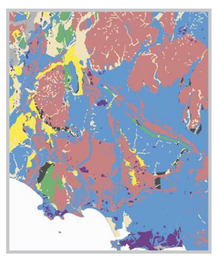
Recharge mechanism

This describes the method by which water at a certain locality is recharged. The categories include: alpine river recharge, bedrock river recharge, land surface recharge and areas of soil zone bypass.



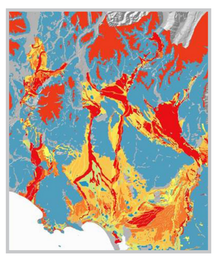
Geomorphic age and substrate composition

This describes critical characteristics in relation to weathering processes. Landform age and soil/aquifer compositions (felsic – mafic) are described.



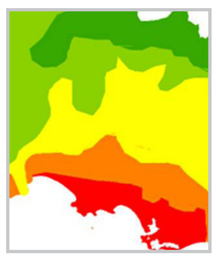
Combined reduction potential

Soil and aquifer reduction potential is critical in determining water quality and chemistry. Regionally this can be assessed using available soil and geological information.



Precipitation

Precipitation chemistry varies greatly across Southland and is predominantly controlled by altitude and distance from the coast. This driver was mapped using gradients in chemical data rather than an existing framework.

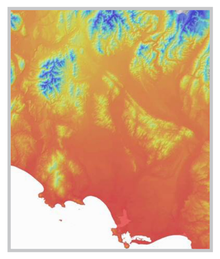


Delineating simplified units

For planning purposes simplified units were developed that were more specific to water quality outcomes (N,P, Sediment, E.coli). The mapping utilised existing information about soils, geology, topography and hydrology to delineate the region into areas with similar inherent properties that influence water quality outcomes. Specific mapping rules were developed using only the input layers shown below to give a consistent and objective method. The key drivers were used to inform this process by identifying and characterising the processes controlling variability and hence the basis for delineation.

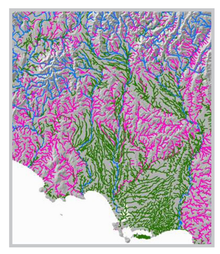
Topography

A regional 8m DEM was used to define topography for mapping rules. Locally this DEM was updated to include LIDAR and GPS spot measurements.



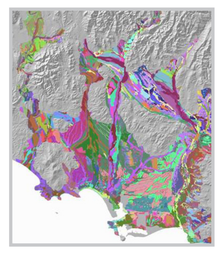
River environment classification (REC)

REC classification was used to map rivers and streams and identify the stream origin (REC, 2010).



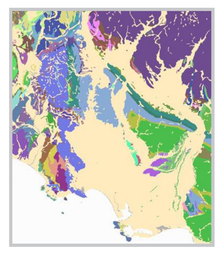
Regional geology

The QMap series of 1:250,000 geological maps were used to provide information on geology and aquifers (Turnbull, 2000; Turnbull & Allibone, 2003; Turnbull et al., 2010).



Regional soils map

The 1:50,000 Topoclimate South soils database was combined with the Wallace County and LRI maps to provide information on soil type, hydrology, distribution and chemistry. (Topoclimate South, 2001; O'Byrne, 1986).



References

Daughney, C., Rissmann, C; Friedel, M.; Morgenstern, U.; Hodson, R.; van der Raaij; R; Rodway, E.; Martindale, H.; Pearson, L.; Townsend, D.; Kees, L.; Moreau, M.; Millar, R., (in prep); Hydrochemistry of the Southland Region. GNS Science Report 2015/24.

O'Byrne, T. N., 1986. Soils of part Wallace County. South Island, New Zealand. NZ Soil Bureau.

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Turnbull I.M., 2000: Geology of the Wakatipu area. Lower Hutt, Institute of Geological & Nuclear Sciences Ltd. Institute of Geological & Nuclear Sciences 1:250 000 Geological Map 18. 1 sheet & 72 p.

Turnbull, I.M., Allibone, A.H., comp. 2003: Geology of the Murihiku area. Institute of Geological & Nuclear Sciences 1:250 000 Geological Map 20. 1 sheet & 74 p. Lower Hutt, Institute of Geological & Nuclear Sciences Ltd

Turnbull I.M., Allibone A.H., Jongens R., (comp.) 2010: Geology of the Fiordland Area. Institute of Geological and Nuclear Sciences 1:250,000 geological map 17.

The physiographic units

The map

Developing the mapping rules using the understanding gained during the conceptual model development allows for the region to be classified into nine physiographic units in an objective and consistent way (figure 3).

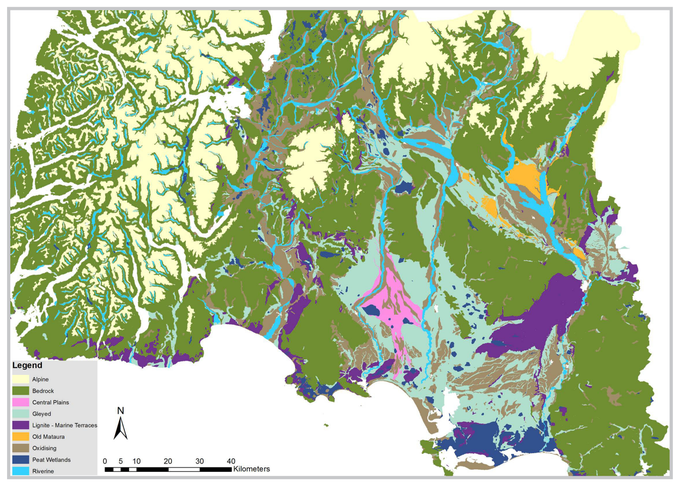

Figure 3: Map of Southland's Physiographic Units.

Understanding water quality

The physiographic method gives an improved understanding of the factors affecting water quality within each unit and this information can be used in a variety of ways:

- To inform the community about the varying controls over water quality across Southland on their property/in their catchment.
- Develop specific contaminant mitigation strategies for each unit, tailoring these to the water quality controls within that unit.
- Inform policy to allow effective and efficient management of Southland's freshwater.

Where to?

- Detailed technical sheets for each unit, an accompanying user guide and the physiographic science reports are now available.
- The physiographics only consider the inherent properties of the landscape and do not take into account effects of land use. Can this be incorporated?
- Can we start to consider how interactions between the physiographic units influence water quality outcomes at a catchment and sub-catchment scale?