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Heterogeneity in catchment properties: a case study of Grey and Buller catchments, New Zealand

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Abstract. The scaling behaviour of landscape properties, including both morphological and landscape patchiness, is examined using monofractal and multifractal analysis. The study is confined to two neighbouring meso-scale catchments on the west coast of the South Island of New Zealand. The catchments offer a diverse but largely undisturbed landscape with population and development impacts being extremely low. Bulk landscape properties of the catchments (and their sub-basins) are examined and show that scaling of stream networks follow Hack's empirical rule, with exponents ~0.6. It is also found that the longitudinal and transverse scaling exponents of stream networks equate to $v_l \approx 0.6$ and $v_w \approx 0.4$, indicative of self-affine scaling. Catchment shapes also show self-affine behaviour. Further, scaling of landscape patches show multifractal behaviour and the analysis of these variables yields the characteristic parabolic curves known as multifractal spectra. A novel analytical approach is adopted by using catchments as hydrological cells at various sizes, ranging from first to sixth order, as the unit of measure. This approach is presented as an alternative to the box-counting method as it may be much more representative of hydro-ecological processes at catchment scales. Multifractal spectra are generated for each landscape property and spectral parameters such as the range in α (Holder exponent) values and maximum dimension at α_0, (also known as the capacity dimension D_{cap}), are obtained. Other fractal dimensions (information D_{inf} and correlation D_{cor}) are also calculated and compared. The dimensions are connected by the inequality $D_{cap} \geq D_{inf} \geq D_{cor}$. Such a relationship strongly suggests that the landscape patches are heterogeneous in nature and that their scaling behaviour can be described as multifractal. The quantitative parameters obtained from the spectra may provide the basis for improved parameterisation of ecological and hydrological models.

Keywords: fractal, multifractal, scaling, landscape, patchiness

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