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Upscaling understanding of nitrogen dynamics associated with overland flow in a semi-arid environment

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An experiment was designed to further the empirical understanding of the effects of scale on fluxes of water and dissolved nitrogen from hillslopes in semi-arid shrubland. It was hypothesised that the behaviour of dissolved nitrogen is related to the scale of the contributing hillslope/catchment area and dynamics of the overland flow as has been demonstrated to be the case for soil erosion. Data from four hillslope scales (ca. 21 – 300m^2) and one sub-catchment (ca. 1500m^2), collected over two monsoon seasons, support this hypothesis and demonstrate that the key controls of average dissolved nitrogen yields are flow discharge and plot scale. The slope of the best-fit line describing the relationship between flow discharge and TDN yields decreases with increasing scale, from 0.0183 at 21.01m^2, 0.0092 at 56.84 m^2, 0.0059 at 115.94m^2, 0.0024 at 302.19m^2 to 0.0004 at 1500m^2. An implication of these findings is that care must be taken when upscaling results describing nutrient behaviour from small, plot experiments, as this behaviour appears to be scale dependent. For example, average yields of total dissolved nitrogen (TDN) in overland flow increase to a maximum with increasing plot area until an area of 50 m^2 is reached, and decline with increasing plot size thereafter. Thus, studies that rely upon fixed plot scales may misrepresent catchment- or landscape-scale fluxes as they do not describe the changing relationship between overland flow and nutrient fluxes with increasing spatial scale. Further

investigations into intra-event behaviour illustrate that nitrogen losses from natural rainfall/runoff events are supply-limited as over the course of the events monitored, decreasing concentrations illustrate a pattern of nutrient exhaustion. When events are compared at the same sites through the monsoon season, however, the anticipated seasonal exhaustion effect is not present. This work provides an empirical basis to up-scale the understanding of dissolved nitrogen behaviour from small hillslope plots to catchment scales in degraded semi-arid environments.