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A Comparison of Agricultural and Urban influences on Water Quality in South West WA

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Abstract

In Western Australia, a number of coastal rivers and estuaries have suffered from eutrophication since the 1960's. Often the focus of the threat to water quality in these areas has been agriculture because of its extensive nature and widespread use of highly soluble fertilisers.

Over recent years a focus on nutrient inputs, outputs and nutrient balance in a number of projects provides an opportunity to compare the relative nutrient threats from the agricultural and urban sectors, placed in the context of increasing urbanisation and development. These disparate data sets also allow a comparison of nutrient inputs in each sector in the form of fertiliser and non-fertiliser sources, and show how these translate into whole of catchment nutrient inputs, transformations and exports to waterways. These sets of data also provide some insight into the adoption of management practices in each sector, and the relative threats to water quality from each sector on the basis of its location in a catchment.

Introduction

Water quality deterioration and algal blooms in Western Australia (WA) have been attributed to nutrient and sediment transport from large-scale land clearing for agricultural and urban development. These developments are maintained by regular inputs of nutrients from fertilizers and feed in general to support agronomic requirements in agriculture and aesthetic aspects of urban landscapes

Catchments are unique and complex, encompassing a variety of land uses, landscape characteristics, soils, climate and vegetation. These and other factors conspire to predispose some parts of landscapes more to nutrient and sediment source areas than others. By identifying these critical source areas (Gburek et al., 2000), future management plans can be targeted to hotspots to minimise offsite impacts and maximise the cost effectiveness of remedial actions. Amongst many factors, nutrient input is important.

In an effort to reduce the discharge of Nitrogen (N) and Phosphorus (P) to waterways of the Peel Harvey, Swan-Canning and the Vasse-Geographe catchments, a range of projects were funded within the Coastal Catchment Initiative (CCI) to support the development of a Water Quality Improvement Plan (WQIP). These projects offered an opportunity to acquire datasets and develop models that allow the relative water quality impacts of different land use sectors to be compared.

Projects undertaken with an agricultural focus captured data from farm-gate nutrient budgets to assess farm nutrient inputs (fertiliser and feed), nutrient use efficiency (NUE) and surplus, and to compare the differences in efficiency and surplus within and between various enterprises. Not only can this data and approach provide agricultural landholders with valuable insight into their business performance and peer evaluation, it can be used as the basis for comparison to similar data from the urban sector. This survey-based approach was applied to the urban sector to facilitate that comparison (Kitsios and Kelsey, 2008).

Methods

Rural Farm Gate Nutrient Balance

In the Peel-Harvey, Vasse Geographe and Ellenbrook catchments over 370 landholders were interviewed to establish farm gate nutrient balances for different enterprises in each catchment. This process involved establishing inputs and outputs of a range of materials and products for each farm interviewed. Book values of nutrient contents were then applied to these materials to derive the mass of nutrient flows into, out of, and retained within each farm and landuse.

Urban Nutrient Input Survey

Seventeen suburbs in the Perth, Peel-Harvey and Geographe Bay areas received a questionnaire, and a total of 1,260 residents responded (Kitsios and Kelsey, 2008). The surveyed suburbs were determined on the basis of location, dwelling type, dwelling age and lot size. Respondents entered information which included lot size, areas of lawn and garden, number and type of pets, fertiliser regimes and disposal of garden and pet waste. Fertiliser regimes were specified by fertiliser type, application amount, frequency and seasonality. From the survey and other research (nutrient content and bulk density of each fertiliser) seasonal and annual TN and TP inputs could be determined for each respondent. In addition, based on the methods of Gerritse *et al.* (1992) and respondent information, domestic pet inputs (dogs and cats) could be determined, to indicate the proportion of pet waste disposed of 'on property'.

Comparing Agricultural and Urban Water Quality Influences

Agricultural and urban data was compared in a number of ways, firstly through input rates of P and N, and secondly through models that provide insight into the relative influences different landuses (Keipert et al, 2007; Weaver et al., 2005). The models used a risk based approach (Heathwaite et al., 2003) and combine source factors, transfer factors, and delivery factors to estimate the relative risk of different landuses. These relative risks were expressed either as estimated total nutrient load to water bodies or as unit area losses from each landuse. Total nutrient loads identify those landuses that represent a disproportionate water quality threat whilst unit area losses help to identify current and emerging threats from landuses with propensity to expand.

Results and Discussion

Input rates

Table 1: Median input rates of P and N to different landuses in the Peel Harvey, Vasse Geographe and Ellenbrook catchments.

Landuse	Median P input (kg ha $^{-1}$)	Median N input (kg ha $^{-1}$)
Annual Horticulture	205	150
Beef feedlot	19	112
Cattle for Beef	9.7	73
Cattle for Dairy	22.7	139
Horses	10.8	63.8
Mixed Grazing	7.2	74.8
Piggery	144	629
Poultry Eggs	74	727
Sheep Feedlot	7.9	66.6
Urban	43	138

Median N and P inputs for different landuses are shown in Table 1. Nutrient inputs increased with increasing intensity of use. The lowest input rates tended to be extensive landuses such as grazing enterprises (Cattle for Beef, Horses and Mixed Grazing). Even though it could be considered an extensive use, urban input rates were far in excess of extensive use rates, and not dissimilar to intensive use rates (Table 1).

Total Nutrient Loads

Modelled P load contributions and relative risk of P loss to the Peel Harvey estuary from different landuses are shown in Table 2. These modeled loads account for the combined effects of landuse area, inherent and management risk factors as well as the location and co-location of these landuses and risks in space. A relative risk > 1 indicates a disproportionate contribution based on these factors. Cattle grazing accounts for 50% of the area and produces 64% of the total load, and is the greatest contributor, however its relative risk is less than urban and peri urban which account for 8% of the area but contribute an estimated 20% of the total load. Relative risk is influenced by location and the high relative risk from urban is partly because urban areas are close to the estuary (or point of impact) with little opportunity for assimilation of nutrients. It is also important to note that these coastal areas are experiencing an unprecedented growth in urbanisation, and that the relative contributions and risks in Table 2 were determined using published urban nutrient input values significantly less than those now being reported by Kitsios and Kelsey (2008).

Table 2: Area, contributions and relative risk of P loss to the Peel Harvey Estuary from different landuses

Landuse	(% area)	Estuary P Load (%)	Relative Risk (Load/Area)
Remnant Vegetation	25	0.1	0.00
Cattle for Beef	42	51	1.21
Cattle for Dairy	8	13	1.63
Horses	3	2.8	0.93
Horticulture	2	1.8	0.90
Urban	3	11.7	3.90
Peri Urban	5	8.2	1.64

Unit area loads

Modelled estimates of annual P flows, storage, and transformation for cattle for beef and urban in the Peel Harvey catchment are shown in the Sankey diagram (Figure 1). Around 12.5% of P inputs into urban areas is realised as a load to the Peel Harvey estuary, whilst 5.9% of P inputs from cattle for beef grazing is realised as a P load. These differences are due mainly to the proximity of the landuses to the Peel Harvey estuary, P input rates, and the landscapes that these landuses occupy. Using revised urban input figures reported by Kitsios and Kelsey (2008), this would translate into an eightfold difference between the current cattle for beef unit area load of 0.7 kg P ha^{-1} and the revised urban unit area load.

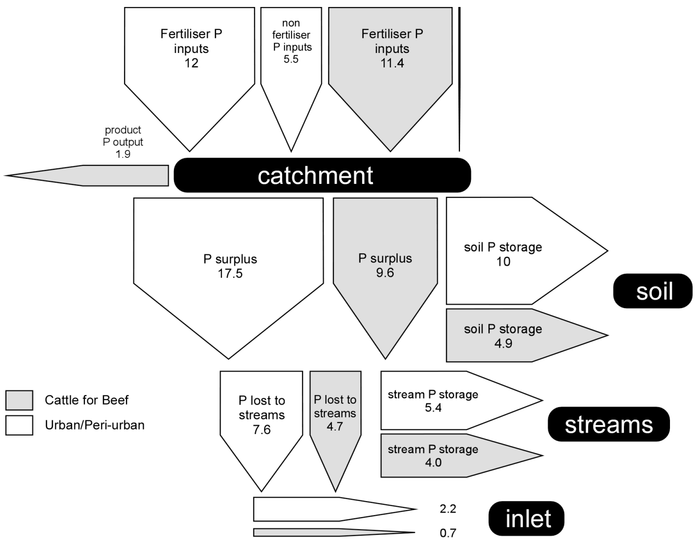

Figure 1: Sankey diagram of the Peel-Harvey P flows and stores for cattle for beef and urban land use sectors. Width of each bar and values represents the relative contribution (kg P ha^{-1}) associated with each land use sector and transport pathway.

Conclusions

Cattle grazing is the most extensive landuse and the greatest contributor to P loads in the Peel Harvey catchment. However, the urban sector has much greater input rates, and is a major and emerging player in relation to its relative risk of contributing to poor water quality. More recent data (Kitsios and Kelsey, 2008) suggests that the urban risk requires further consideration.

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