HOW TO RECONNECT LANDSCAPES AND LINK PEOPLE THROUGH NEIGHBOURHOOD CATCHMENTS?

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Abstract
Since European settlement in the Fitzroy Basin (c.1850), large-scale alterations of natural systems have occurred, including recent widespread vegetation clearing under the Brigalow Development Scheme (1962-1976). Land use impacts include changes in hydrology and landscape water balance, declining water quality, and increased threats to biodiversity. The landscape has been artificially sub divided producing fragmented ecosystems and a resource management. Concern for catchment, river and estuarine health and possible impacts on the Great Barrier Reef Marine Park has also been associated with these changes.

This paper describes a process using local catchments to generate ownership in undertaking integrated resource management, and reconnect fragmented ecosystems and landscapes. The approach is known as Neighbourhood Catchments. The Fitzroy Basin Association, the Natural Resource management body in the basin is using a Community Neighbourhood Catchment approach to devolve NAPSWQ and NHT funding to achieve on-ground changes to resource management. Two focus Neighbourhood Catchments quantify the impacts of adopting integrated resource management, particularly on soil erosion and water quality. A catchment model (EMSS) is used to specifically show that sediment loads are reduced within cropping neighbourhood catchments in the Comet sub-basin when adequate surface cover is retained on hill slopes. The challenge is to achieve similar resource management outcomes throughout the Fitzroy basin.

Additional Keywords: erosion, agricultural systems, landscapes.

Introduction

Following European settlement the management of the Australian landscape was transformed from low intensity use to predominantly extensive and intensive managed agricultural systems. The impact of imposing an essentially static agricultural system within an inherently variable and unreliable rainfall environment has been challenging and has resulted in inevitable resource and environmental impacts.

Contemporary resource management is defined by property boundaries, artificially sub dividing landscapes, streams, catchments and ecosystems. Sub dividing in such a way has deconstructed the Australian landscape and has led to fragmented ecosystems and resource management.

The Fitzroy basin is an example of large river basin (142000 km^2) that has faced and continues to face a range of development, resource management and environmental challenges. Land use has changed significantly over the past 40 years, with 4 million hectares of brigalow cleared between 1962 and 1976. By 1999 58% of the remnant vegetation in the Fitzroy had been significantly altered or cleared (Accad *et al.*, 2001). Concern for catchment, river and estuarine health and possible impacts on the Great Barrier Reef Marine Park has been associated with these changes.

The landholders within the Fitzroy catchment are faced with a diverse and complex range of resource management issues. Sediment (turbidity), pesticide and nutrient levels, toxic algal blooms and widespread occurrence of exotic weeds and threatened habitats and species, in particular flood plains and riparian areas have been identified as major stream health issues in the catchment (Jones, 2000; Fabbro *et al.*, 1996; Telfor, 1995; Henderson, 2000). It is estimated that 4 million tonnes of sediment is discharged annually from the Fitzroy River in the Great Barrier Reef lagoon off Keppel Bay in central Queensland.

Soil erosion rates and water quality have been recognised as environmental performance indicators at not only a paddock scale but for local and progressively larger scales. Since, suspended sediment concentrations in streams and lakes affect water use and ecosystem health. High concentrations of sediment reduce stream clarity, inhibit respiration and feeding stream biota, diminish light needed for plant photosynthesis, and require treatment for human use. The challenged for the Fitzroy community is to acknowledge and recognise the capacity to undertake development has plateaux, and that a new era has emerged where fragmented landscapes need to be reconnected not only to control erosion but also to achieve environmental sustainable resource management outcomes.

This paper describes a process that is being used in the Fitzroy by the Fitzroy Basin Association (FBA) to achieve these outcomes and is known as the Neighbourhood Catchment approach. Community Neighbourhood catchments have been established by the FBA in collaboration with landholders to address local resource management issues, and are used to integrate other related resource management issues. Focus neighbourhood catchments have been established to quantify the impact of adopting improved resource management, particularly on sediment movement and water quality. Importantly, information from focus neighbourhood catchments and legacy data sets are used in a catchment model to predict the long-term adoption of the neighbourhood catchment approach to soil erosion and at progressively larger catchment scales.

Materials and Methods

The Neighbourhood Catchment approach proposes that local sub-catchments are an appropriate scale to engage individual landholders and reconnect fragmented landscapes. These catchments can subsequently be used as building blocks to further connect larger areas in the Fitzroy.

A Neighbourhood Catchment consists of a group of landholders located in a common catchment (typically about 300 km^2). Hence the term ‘Neighbourhood’ refers to the relationship between people and refers to the scale that is sufficiently small to promote ownership not only in their property but also in their surrounding environment. There are actual previous examples where a neighbourly approach has been used to achieve similar types of objectives. Noticeably, where soil conservation planning has involved the construction of contour banks and the management of storm runoff required negotiation among a number of landholders to achieve an acceptable catchment design. Another example is where extensive strip cropping layouts were designed on floodplains areas, particularly on the Darling Downs in Queensland (Figure 1). These examples of a neighbourhood approach are almost exclusively to control soil erosion, and highlight the strong stewardship ethic that exists within the agricultural sector. The Neighbourhood Catchments concept builds on this stewardship ethic and goes further to whole of landscape resource management including integrating vegetation, riparian, biodiversity and sustainable farming systems that require a cooperative and neighbourly approach.

Figure 1. Property contour bank and strip cropping layouts that require collaboration between a number of properties.

Community Neighbourhood Catchments

The FBA have adopted the Neighbourhood Catchment methodology to deliver devolved Natural Heritage Trust (NHT) and National Action Plan for Salinity and Water Quality (NAPSWQ) funding to achieve change in land, vegetation and biodiversity management. Catchments formed through the devolved grant process are termed Community Neighbourhood Catchments. Approximately 500 landholders have participated in 72 projects. By using the neighbourhood catchments approach the FBA and local Landcare and NRM groups were able to form a number of geographically defined catchment groups. Upon formation, these groups identified natural resource management issues that were important to their catchment. For example, Clematis Creek Neighbourhood Catchment landholders were concerned about weeds and declining water quality. Likewise, Belcong Creek Neighbourhood Catchment was concerned about the increasing problem of parthenium. Whereas, the Hedlow Creek Neighbourhood Catchment group were more concerned with the impact of dryland salinity. In all three cases action was taken through a "Neighbourhood Catchment Action Program" using incentive funding for weed control, riparian fencing and the installation of off-stream watering points. This work then had flow on benefits for other natural resource management issues, including water quality and biodiversity in both grazing and cropping industries. Although there are past examples of collaborative approaches to control soil erosion these collaborations have not been quantified at a landscape, local catchment or basin scales.

Focus Neighbourhood Catchments

Two focus neighbourhood catchments have been established to help quantify the impact of neighbourly actions, particularly on sediment erosion and water quality. Gordonstone (260 km^2) and Spottswood Creek (270 km^2) have been instrumented in upland ephemeral catchments with water quality equipment in biogeographical regions, as defined by Thackway *et al.* (1995). Gordonstone Creek is located in the Basalt Downs sub region and Spottswood Creek is located in the Dawson River Downs (Figure 2). Pollutant transport is monitored in the focus neighbourhood catchments using a nested methodology measuring sediment, nutrient and pesticide loads at scales from 15 ha up to the neighbourhood catchment scale (30 000 ha). The focus catchments are currently researching the impact of cropping and grazing practices on water quality from a paddock to a basin scale. In the Gordonstone catchment cropping is the major land use (59% of area), where as in Spottswood it is grazing (81%), with 25 properties in each catchment. GIS is used to produce land use maps (1:25000) and monitor current and future land management practices in each catchment.

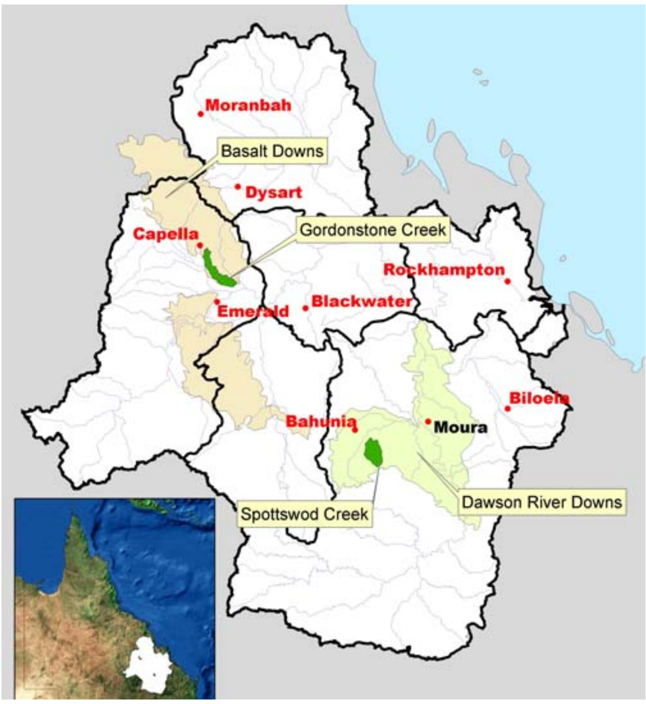

Figure 2. Location of the focus neighbourhood catchments. Gordonstone Creek (Basalt Downs landscape), and Spottswood Creek (Dawson River Downs landscape).

Catchment modeling

Legacy paddock scale erosion data (Carroll *et al.*, 1997) and focus neighbourhood catchment data are used to predict sediment export rates for five basaltic down upland catchments in the Comet sun-basin using the Environmental Management Support System (EMSS) model. EMSS estimates daily runoff and pollutant loads, including total suspended solids (TSS), total nitrogen (TN) and total phosphorus (TP). EMSS consists of three separate modeling components: a runoff and pollutant delivery model (Colobus), a stream routing model (Marmoset) and a storage model (Mandrill) (Vertessy *et al.,* 2001). The Colobus model is used to produce land management scenarios to determine total runoff and total suspend sediment loads. SIMHYD predicts daily runoff and subsurface runoff components, the pollutant loads are calculated from event mean concentrations (EMC) and base flow dry weather concentrations (DWC) of TSS, TN, and TP for different land uses. Underlying the EMSS are various data layers including land use, daily rainfall, daily potential evapotranspiration, and a 250 m DEM grid.

A 32-year period (1970-2002) is used to compare sediment loads from the 5 cropping neighbourhood catchments (Table 1) where 4 stubble residue scenarios are compared; <10%, 25%, 50%, >60% cover. The relative differences between treatments where determined from Carroll *et al.* (1997) tillage data. The relative change in sediment generation rates between the different cover conditions is based on a percentage change from current cropping generation rate (1450 mg L^{-1}), determined from focus Neighborhood Catchments, and ambient water quality data. For the 10% and 25% cover it is estimated sediment generation rate increased by 100% and 60% respectively. Whereas, it is estimated that sediment generation rate decreased by 15% when cover was >60%.

Table 1. Catchment and cropping area for 5 neighbourhood catchments in the Comet sub-basin.

	Area (km^2)	Cropping (km^2)	Cropping (%)
Catchment 1	2556	611	23.9
Catchment 2	802	233	29.1
Catchment 3	1393	178	12.8
Catchment 4	1246	131	10.5
Catchment 5	845	369	43.6

Results and Discussion

Carroll *et al.* (2001) in a long-term soil erosion study (1982-93) in central Queensland showed there is an exponential decline in soil erosion with increased surface stubble cover. Zero tillage retained the greatest stubble cover, producing the smallest ($P < 0.05$) average annual runoff and soil loss (Table 2). This information and the focus Neighbourhood Catchment data allowed EMSS predictions of land management impacts to be made over larger spatial and temporal scales.

Table 2. Effect of tillage and previous crop stubble on annual mean runoff and soil loss (1984 - 90). Treatments followed by the same letter subscript are not significantly different at P = 0.05. s.e.m is standard error of the mean.

	Runoff		Soil loss	
	(mm)	s.e.m	(t/ha)	s.e.m
Tillage				
Zero	19.1 a	2.44	1.42 a	0.444
Reduced	26.4 b	2.81	1.92 a	0.454
Conventional	33.3 b	2.81	4.01 b	0.454
Previous Crop Stubble				
Wheat	19.1 a	2.54	1.34 a	0.441
Sorghum	26.7 b	2.61	2.95 b	0.449
Sunflower	33.2 b	3.03	3.04 b	0.481

In the 5 neighbourhood catchments, EMSS predicted that up to 75,000 t yr^{-1} of TSS was generated over the 32 years period where there was consistently low surface cover (<10%) (Figure 3). In contrast TSS was halved if >60% stubble cover was maintained in the catchment over the same period. The greatest reduction in sediment yield occurred when stubble cover was >25%, with only a small change between 50% and >60% cover. The EMSS modeling shows that the 5 neighbourhood catchments generated very different total suspended sediment loads, with catchment 3 with steeper slopes generating the greatest and catchment 2 and 5 the least sediment. Importantly, this information allows the FBA to prioritize catchments for funding, extension, and management actions to achieve the greatest reduction in sediment from cropping areas in the Comet sub-basin. The EMSS illustrates that a best management practices undertaken in a neighbourhood catchment can significantly reduce sediment loads, illustrating that management action targets can be achieved at a local catchment scale.

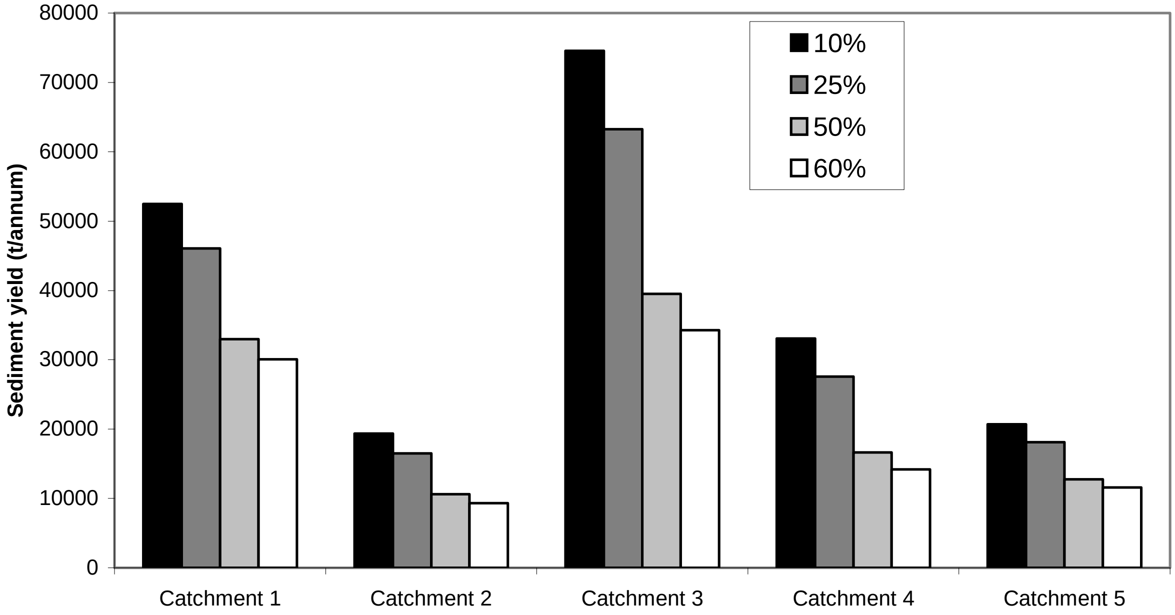

Figure 3. EMSS predicted total sediment yield determined from 5 cropping neighbourhood catchments under 4 cover conditions (<10%, 25%, 50% and >60% cover), 1970 to 2002.

In this example, the EMSS model specifically shows the potential of reducing sediment loads if adequate surface cover levels are consistently retained within a neighbourhood catchment scale. The neighbourhood catchment approach allows landholders to reassess their land management practices and continually improve their system of farming, and aims to integrate resource management at a property and catchment scale.

Landholders are familiar with integrating their activities on their properties across different enterprises, and likewise require resource management to be delivered in a similar integrated way. Developing practical ways in which natural resource and production management can be integrated is a crucial, yet largely missing aspect of successful Integrated Catchment Management. The Neighbourhood Catchments approach provides an opportunity to reconnect riparian areas, forest vegetation to ensure that the productive capacity of the land is maintained, while preserving native plants and animals, and the negative impacts of land clearing are limited

Conclusions

The neighbourhood catchment approach builds on the strong stewardship and landholder cooperation that exists within the rural community. It goes further than the historical linkages that existed between landholders that collaborated to undertake soil erosion control layouts and to consider other natural resource management issues, such as surface management, weed control, vegetation, biodiversity, and riparian management to achieve a similar overall neighbourhood and landscape outcomes. The EMSS modeling has shown that improvement in sediment loads can be achieved by the neighbourhood catchment approach. The challenge is to achieve similar outcomes in other resource management issues in the Fitzroy basin.

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