Sensible Farming on Sensitive and Steep Land – A Catchment Management Approach in Tauranga Harbour

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Abstract

Sedimentation of Tauranga Harbour was identified as the top environment issue in a 2006 environmental report. Research has indicated that 63.7% of the sediment yield from the 98 641 hectares of contributing catchments of the southern harbour was from pasture that covers only 34.7% of the catchment area. Bay of Plenty Regional Council has developed and implemented a catchment management framework to work alongside farmers and the rural community to address the issue. The approach involved firstly gaining accurate data, including modelling sediment movement and accurately "ground-truthing" 2190 km of waterways in 28 sub-catchments. It included data analysis for Land Use Capability (LUC), erosion risk, land cover, existing protection status of land, as well as developing an effective communications plan to engage landowners. A perception survey was also undertaken to determine what farmers understood of their environmental responsibility and what the drivers for change were. Council now has a much better understanding of land cover, current land use, the community concerns and their knowledge of issues in Tauranga Harbour. This has enabled a more focused catchment management approach and better use of funds to support riparian protection and land use change.

Keywords: Catchment, sedimentation, riparian, erosion

Introduction

This paper summarises recent research undertaken in the Tauranga Harbour and how Bay of Plenty Regional Council (Council) is using the data to improve sustainable land use practices in the catchment. Tauranga Harbour is a significant cultural, social, ecological and economic asset to the Bay of Plenty region. It is the largest estuarine inlet in the region, being impounded by a barrier island (Matakana Island) and two barrier tombolos, Mount Maunganui to the south and Bowentown to the north (Briggs *et al*. 1996). The harbour is shallow and covers an area of 20 100 ha with two-thirds of its area being intertidal (Park 2003). The harbour catchment covers an area of 123 234 ha, with 50 783 ha developed for horticultural and agricultural use, spread over 28 sub-catchments that drain into the harbour from the Kaimai-Mamaku Ranges.

The Tauranga Harbour Integrated Management Strategy (Lawrie 2006) identified sedimentation from these catchments to the harbour as the largest environmental management issue for the western Bay of Plenty region. Other management issues identified in the strategy included the loss of seafood and recreational access, flooding, erosion of stream banks and hillsides, loss of ecological habitats and poor water quality. The community was also concerned with the prolific growth of mangroves on the harbour margins. The Port of Tauranga Ltd mentioned the increased need to maintain channel depth due to accumulation of fine sediment. Ecological concerns were noted by Park (2003) and Hume *et al.* (2010) on the loss of habitat caused by infilling and increasing mud levels in estuaries and sheltered tidal flats.

Sediment source data from Surman (1999) did not specifically quantify the fate of sediment in the Tauranga Harbour catchment. Bay of Plenty Regional Council commissioned the National Institute of Water and Atmospheric Research Ltd (NIWA) to assess and model sediment sources and movements in the southern half of the harbour. Consequently, Council staff carried out a catchment survey to assess the extent of intervention required to reduce sediment and other contaminants to the harbour. A landowner perceptions survey was commissioned by Council and conducted by Versus Research Limited. Finally a case study was commissioned by Council and undertaken by P A Handford and Associates to determine the financial feasibility of land use change on steep country.

The results of these studies were used to provide guidance for Council land management policy and decision-making for the western Bay of Plenty to address sedimentation concerns.

Sediment modelling

The NIWA sediment study began in April 2007 and was completed in 2010. The study area included the southern harbour extending from Matahui Point in the north to Rangataua Bay in the south (Figure 1). The aim of the study was to develop models that could be used to assess the relative contributions of various sediment sources, assess the characteristics of significant

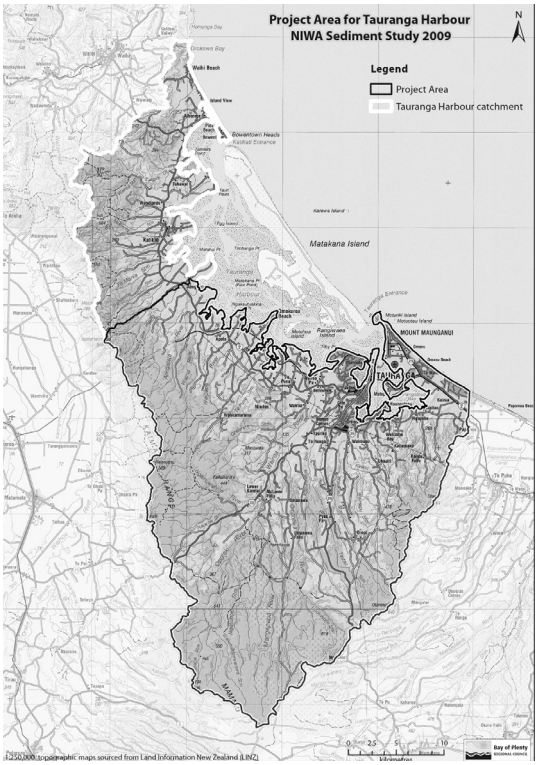

Figure 1 Tauranga Harbour sediment study project area

sediment sources, and investigate the dispersal and deposition of the catchment sediments in Tauranga Harbour. Four models were used to access sediment source and sediment movement within the harbour.

The Groundwater Loading Effects of Agricultural Management System (GLEAMS) catchment model (Mullan *et al*. 2009) was used to predict daily sediment runoff from the catchments of the southern harbour, comparing sediment sources under existing and various future scenarios, and assessing sediment characteristics from significant sources. The DHI Flexible Mesh hydrodynamic and sediment (DHI FM) and the Simulating Waves Near Shore (SWAN) wave models (Gorman & Pritchard 2009) were used to predict sediment dispersal and deposition at an event scale. The Urban Stormwater Contaminants (USC-3) sedimentation model (Green 2009) was used to make predictions, at decadal time scales, of sedimentation, bed-sediment composition and linkages between sources and sinks.

Hume *et al.* (2010) validated the models by measuring stream exports, mapping the harbour bed and measuring tides, waves and sedimentation rates in the harbour. Council resources at the time precluded the inclusion of a streambank erosion assessment. Representation of streambank erosion in a model requires very detailed boundary conditions describing the state of the stream banks in the catchment and how likely they would be to fail from place to place.

The contribution of land cover to the total sediment load depends on the yield and the extent of the land cover plus the soils, slopes and climate for the area that cover occurs upon (Elliot *et al*. 2009). The results (Table 1) indicate that pasture has the largest contribution (63.7%) and covers 33.5% of the project area catchment. Bush, scrub and native forest has the next highest contribution (27.8%) and covers 44.2% of the catchment. Exotic forest (open and closed canopy, afforestation and harvested forest) covers 10.2% of the catchment and contributed 4.8% of the sediment load. Orchards and cropland made a small contribution (0.3%) and cover 5% of the catchment. Uncontrolled earthworks can yield up to 43 t/ha/yr (Hume *et al*. 2009), and controlled earthworks have a comparable yield to pasture, however the area of earthworks is small (0.2%). Based on digitised earthworks areas in 2007/8 that showed 88% of sites had modern sediment controls in place, urban earthworks contributed 0.5% of the sediment load.

Table 1 Project area sediment yield and load from various land covers for the current climate and distribution. These values are before sediment deposition in the stream network. The yields are averaged over the range of slopes, soils and climate that occur for the land cover.

Land cover	Total load (t/yr)	Fraction of total load (%)	Total area (ha)	Fraction of total area (%)	Yield (t/ha/yr)
Pasture	119 696	63.7	33 262	33.7	3.6
Bush, scrub and native forest	52 291	27.8	43 595	44.2	1.2
Exotic forest	9079	4.8	10 098	10.2	0.9
Other bare earth	3227	1.7	121	0.1	26.66
Urban and roads	2162	1.1	6416	6.5	0.34
Urban earthworks	992	0.5	186	0.2	5.33
Orchards and cropland	579	0.3	4963	5.0	0.12
Total	**188026**	**99.9**	**98641**	**99.9**	**38.15**

The total sediment load from all land covers is 188 026 t/yr (Table 1). This is considered low compared to other large North Island estuaries such as Auckland, the Firth of Thames and Pauatahanui inlet (Hancock *et al.* 2009). Sediments loads were elevated along the fringes of large estuaries such as Welcome Bay and in sheltered zones where flushing is obstructed by causeways. Due to the effects of wind, tide and current, sediments from some catchments were transported and deposited in neighbouring sub-estuaries or directly to the open sea. For example, the Wairoa River sub-catchment produces the largest contribution of 42.4% of the total sediment load, however 95% of the fine sediment from the Wairoa River, (49 630 tonnes/yr), discharges to the open ocean through the Mount Maunganui harbour entrance.

The Tauranga Harbour Sediment Review (MacGibbon *et al*. 2011) was commissioned by Council to provide specific remediation options to reduce sedimentation. The recommendations included urban earthworks control, land retirement, forestry establishment, forestry controls and riparian planting. Where practicable, flood water inundation of natural flood plains to slow flood water velocity and allow sediment to disperse and deposit onto land was also highly recommended.

To assess the financial feasibility of land use change on steep land, Council commissioned PA Handford & Associates to undertake a farm case study of forestry options compared with grazing (Pratt 2013). The study showed that by applying an internal rate of return to include inflation and annual returns from livestock, investing in forestry was a profitable option (Table 4).

Catchment Ground Truthing Survey

The NIWA Tauranga Harbour Sediment Study indicated most of the sediment load from the catchment comes from pasture on hill country. Using the New Zealand Land Resource Inventory (Landcare Research n.d. a), this correlates to Land Use Capability (LUC) classes 6, 7 and 8, which include land with a slope >26 degrees (Lynn *et al.* 2009).

These Land Use Capability classifications were overlaid with the New Zealand Land Cover Database (Landcare Research n.d. b) to determine the area of steep land in pasture and exotic forestry (Table 2). Exotic forestry has potential for high sediment yields during high intensity rainfall events immediately before and after harvesting operations (Phillips *et al*. 2005). Property boundaries were added and the resulting data identified zones with potential to produce high sediment yields.

To prioritise work, properties that had existing management plans in place were filtered out, e.g., land protection covenants, agency management plans or statutory protection such as reserves or other planning protection mechanisms. This left *ca.*1000 properties of interest, upon which a physical survey to ascertain current management status and potential for land use change was conducted.

The survey was conducted on 436 priority farms covering a total of 40 000 hectares (32.4% of the catchment area). These priority farms were identified by combining data for LUC, vegetation cover and existing protection areas to define high erosion risk zones.

Data captured during the survey included: current management of steep land; spatial extent of remnant native bush on private land; length of unfenced waterways; length of active stream bank erosion; and extent of any other erosion features. Potential areas for soil conservation measures such as converting pasture to trees, land retirement, and open tree conservation planting were mapped (see Table 3). Active stream bank erosion was mapped along 8.6 km of stream margins throughout the catchment. This data provided a reliable snapshot of the current land use in the Tauranga Harbour catchment, and highlighted areas eligible for Council support.

Table 2 Land Use Capability classes by area for dominant land cover type in the total Tauranga Harbour catchment

LUC Class	Pasture (ha)	Orchard and Croplands (ha)	Exotic Forest (ha)
1	0	0	0
2	2267.89	1552.16	80.02
3	7406.04	3105.82	1067.96
4	8463.11	2219.75	4441.21
5	567.85	42.69	37.31
6	18 809.22	1516.2	5493
7	3260.47	165.72	1639.05
8	766.03	48.45	1483.24
Total	**41 540.61**	**8650.79**	**14 241.79**

Perception Survey

To determine the most appropriate way to work with different landowners, Council commissioned a quantitative research report (Versus Research Limited 2011). Specific measures included land owners' awareness and understanding of sedimentation in Tauranga Harbour and their awareness of regulations, initiatives and assistance options. Motivators and barriers for change were sought, as were preferences for communication with the Council.

A sample of 404 land owners within the catchment area was surveyed by telephone between 20 June and 7 July 2011.

The results of the survey showed different levels of awareness of environmental issues affecting Tauranga Harbour. Farm run-off, mangroves and weeds were found to be primary concerns. The main factors that triggered these environmental problems were noted as unsustainable farm practices, lack of council support and low awareness of environmental issues. A few property owners (19%) were unsure of what contributed towards these problems. A high number (69%) agreed that land use practices had a substantial influence on adjacent waterways, however, only 52% agreed that what they did on their own land had a direct impact on waterways.

Property owners considered that the Bay of Plenty Regional Council (82%) and local district councils (78%) to be primarily responsible for the maintenance of waterways.

Uptake of environmental or land management initiatives was low, and only 14% of property owners said they had an environmental or land management plan in place. However, those property owners who had implemented an environmental or land management plan found it helpful (44%) or very helpful (33%).

Property owners were neither seeking nor receiving substantial external assistance as only 10% of the property owners mentioned they received external assistance with any environmental improvements they made on their property. In addition, 72% of landowners surveyed were aware of Council support options for activities to improve sustainable land use.

Discussion

Gathering data through sediment modelling, ground truth surveying, a review of sediment reduction options and a landowner perceptions survey has provided Council with a reasonably clear understanding of current land use, landowners awareness of environmental issues, and options to address the issue. The NIWA Tauranga Harbour Sediment Study suggests the main source of sediment is from developed steep land that has pasture cover. It is however acknowledged that assessing the relative contribution of stream bank erosion towards sedimentation of Tauranga Harbour is required to provide a complete picture.

The ground survey by land management staff indicated 240 km of streams needed fencing to completely exclude stock from 2190 km of streams in the catchment. In addition, nearly 32 000 hectares of land required a change in management practice to significantly reduce sediment yields. The results of the perception survey (Versus Research Ltd 2011) indicated there is a certain amount of apathy towards implementing sustainable land management practices in the Tauranga Harbour catchment. There are probably many reasons for this but perhaps an important one is that 48% of those surveyed did not agree that what they did on their land had an impact on waterways. This might indicate a lack of understanding of the effects, positive or negative, of land use.

Table 3 Sustainable land management opportunities using data captured from a ground survey of Tauranga Harbour catchment in 2011

Opportunity	Hectares	Kilometres
Remnant native bush to protect	336	
Wetlands and seeps to protect	98	
Soil conservation measures required	31876	
Riparian fencing for stock exclusion required		580
Active stream bank erosion		8.6

Table 4 Livestock and forestry returns on steep land (>26° slope)

	Livestock (7 stock units)	Forestry (includes fencing $1,293/ha)
Investment ($/ha)	$700	$4528
Average annual profit per hectare over 30 years	$18	$762
Internal rate of return (excluding land value)	1.90%	6.60%

Development of Catchment Action Plans (CAPs) for each of the sub-catchment work areas has been completed with targets allocated for riparian and biodiversity protection. Incentive tools have been developed to support rules under the Resource Management Act (1991) to address sedimentation and other sustainable land use issues.

In response to the perception survey, Council launched a "Future Proof Your Land" campaign designed to deliver a clear message that landowners are responsible for environmental outcomes on their land and that there is support to assist with this. The campaign included information packages covering erosion control, pollution prevention, pest control, natural habitat preservation and soil health.

The current priority for Council's Sustainable Land Management programme is to encourage soil conservation practices and land use change (including forestry) on pastoral land and within riparian margins. Farms identified with a higher risk of erosion will be targeted as a high priority as a step toward improving the sustainability of pastoral land use. In 2012, Council has assisted 47 landowners in the Tauranga Harbour Catchment to fence off 23 km of streams and retire or change land use across 178 hectares.

The transformation of marginal lowland pasture near the coast into wetlands specifically for sediment and nutrient control is being actively encouraged. Further scientific research to assess the relative contribution of sediment from stream bank erosion is planned. This will complete the sediment study and assist with outcome monitoring of riparian protection work.

Some key actions for the Councils 2013/2014 Annual Plan include:

1. The operational budget of the Sustainable Land Use Programme in the 2013/2014 financial year has been increased to $700 000 to support landowners with protection work in the Tauranga Harbour catchments; and to trial a coastal wetland restoration project.
2. Initiate a project to determine the relative contribution of river and stream bank erosion to harbour sedimentation; and to develop a quantitative measure of effectiveness for sediment control interventions.

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