agresearch
Farming, Food and Health. First™
Te Ahuwhenua, Te Kai me te Whai Ora. Tuatahi

Manawatu Catchment Water Quality Workshop - 3 September 2010

horizons
regional council

February 2011

Envirolink project HZLC76

Prepared for:

Horizons Regional Council
Palmerston North

February 2011
Report No. 2011/EXT/1158
ISBN978-1-877556-74-6
Envirolink project: 913-HZLC76

Prepared by:

Alec Mackay[1], Brent Clothier[2], Grant Douglas[1], Jon Roygard[3] Maree Clark[3], Roger Parfitt[4]

[1]AgResearch Grasslands Palmerston North,

[2]Plant and Food Research,

[3]Horizons Regional Council

[4]Landcare Research

Table of Contents

Executive Summary

The findings of a one-day workshop, funded by an Envirolink medium advice grant: Manawatu River water Quality (Medium Advice Grant 913-HZLC76), attended by a experts from across a range of scientific disciplines are the first step to developing an integrated research approach to determining the loads of sediment, phosphorus and nitrogen entering the Manawatu Catchment and to assist in identifying opportunities to reduce these contaminants at a range of flows to meet water quality targets.

The workshop was successful in advancing the development of an integrated research approach to determining the loads of contaminants entering the Manawatu Catchment and the opportunities to reduce these in the context of water quality targets, at a range of flows. It was also success in raising awareness among researchers of what other programmes, including in house Regional Council and Crown Research Institutes projects, were funded and or underway.

Outputs from the workshop included a list of current and proposed science activities with a Manawatu Catchment focus, a list of the current knowledge gaps, comment on the extent to which they are being addressed by the current science programmes, along with a list of future science and associated investments and initiatives.

Suggestions on the content of the briefing document being prepared for the members of the Manawatu River Leaders' Forum were also made. These outputs will be used to inform a series of brainstorming sessions within Horizons Regional Council to further inform the River Leader Forum process on a potential set of actions and goals that could be used to affect short- and medium- changes to the Manawatu River and a set of targets to monitor progress towards the 2020 Manawatu River Accord goal.

In places some notes have been added post-workshop to improve clarity, and to provide additional thoughts and scientific developments and plans

1. Introduction

There is a recognized need by the public and a range of agencies to significantly improve the water quality of the Manawatu Catchment. This requires the development and implementation of appropriate strategies as soon as possible. Identification of the relative contributions of contaminants and opportunities to reduce these contributions in areas of poor water quality is a key step to making informed decisions in relation to improving water quality in relation to water quality targets. Such information will clearly benefit decision makers as they balance the environmental outcomes with the other requirements of Regional Councils.

Horizons Regional Council is the agency responsible for managing the water resources of the Manawatu Catchment. The recent publicity on the water quality in this catchment has arisen through the Regional Council's own science and that of other agencies working with Horizons to understand the water quality issues in the Catchment. In recent months, several council programmes and initiatives to address water quality in the Manawatu Catchment have reached significant milestones. The Regional Council has coordinated a Manawatu River Leaders' Forum, who have signed an accord and agreed to work together to improve water quality in the Manawatu River. Horizons Regional Council's Sustainable Land Use Initiative (SLUI), which addresses hill country erosion including the effects on water quality, has completed its third year. Additionally, the SLUI programme has received further funding from Central Government for the next four years.

The decisions on One Plan have been released and these set out the Regional Council's objectives, policies, rules and non-regulatory methods for water quantity and quality including provisions around management of contributions to water quality from intensive agriculture and point source discharges. The One Plan adopted a water management framework that includes spatially defined water management zones, values and numerical water quality targets to provide for the values. The One Plan also defined numerical minimum flows and allocation limits for each water management zone in the region. The One Plan decisions are still subject to an appeal process. A further Regional Council initiative has been the substantial upgrade of its monitoring network and methodologies over the past three or so years.

Many Research Institutes have recently received funding for new science programmes that involve science relevant to the Manawatu Catchment. These include several multi-agency programmes funded during the recent FRST round of funding of freshwater research projects, a number of these have connections with Horizons Regional Council. These programmes will contribute to our collective understanding of river catchments and their management. Several of these projects have proposed case studies in the Manawatu Catchment, adding to a number of ongoing research initiatives already underway in the Catchment.

With the collective knowledge among scientists working for Research Institutes and Horizons Regional Council in the area of water quality, and related research, a 1-day workshop was held on Friday 3 September 2010 in the Boardroom of Horizons Regional Council, Palmerston North. The workshop was made possible through funding from Envirolink (Medium Advice Grant 913-HZLC76), applied for by Horizons Regional Council with AgResearch as Research Organisation, and supplementary support from the Sustainable Land Use Research Initiative (SLURI).

The workshop involved invited experts and aimed to gain an overall understanding of previous and current activities and initiatives of relevance to the Manawatu Catchment, and new programme content and research plans. Armed with this background information the aim of the day was to initiate the development of an integrated research approach to determining the loads of contaminants (sediment, phosphorus and nitrogen) entering the Manawatu Catchment and the opportunities to reduce these in the context of water quality targets, at a range of flows.

Specifically the objectives of the workshop were to establish methodologies and work programmes to:

- Advance the development of methods for completion of phosphorus and nitrogen budgets and sediment load analysis for the Manawatu River Catchment, aggregated from the water management zones or other spatial delineation of the catchment;
- Identify approaches for quantification of contaminant loadings from major point and non-point sources at a range of flows, including separation of the relative contributions from the individual point sources and non-point sources; and
- Identify and prioritise actions and practices that can reduce the loadings.

The contracted output was a proceeding of the workshop, including proposed research programmes and methodologies to undertake the analyses required. To facilitate achievement of the objectives, current methodologies that have been applied in some parts of the Manawatu Catchment were advanced as a starting point (see further detail

below). It was considered whether to extend these to the broader Manawatu Catchment or propose alternative methodologies.

2. Background

There are several completed projects addressing water quality in the Manawatu Catchment, ranging from those identifying sources of contaminants to those calculating contaminant loads. Projects funded by Envirolink to date include:

1. Work in a project (408-HZLC41); Parfitt et al. (2007) which involved several CRI's, calculated the phosphorus balance for the upper Manawatu Catchment, including how this would change through the introduction of best management practice. This methodology was presented at the workshop, offering a starting point from which to develop an agreed methodology to calculate phosphorus balances for the Manawatu Catchment.

2. The work of two projects (243-HZL25 (Mackay 2007) & 243-HZLC26 (Douglas et al. 2008)) generated standard data collection methods and methods for calculating outcomes from soil conservation works. With over 300 Whole Farm Plans now completed, Horizons Regional Council is looking to incorporate the detailed information from these into research models and also into integrated catchment management models.

3. The Catchment Land Use for Environmental Sustainability (CLUES) models nitrogen and phosphorus loads in waterways, can be linked to land use and land use changes, and also provides data on economic implications. Has been used to model N loadings in the Manawatu catchment. It was noted by the authors of CLUES and Regional Council scientists that improvements to the modelling could be made for application to the Manawatu by the inclusion of additional river quality monitoring data points, not available during the initial construction of CLUES. This includes better characterisation of point source contributions (larger datasets are now available for this) and use of more localised information for contributions from non-point sources. Since that time further new information is available from Horizons Regional Council's as a consequence of the upgraded State of Environment monitoring programme that has been underway for more than three years.

Several previously completed research projects undertaken by Horizons Regional Council provide also provide value background information on which to progress a catchment scale calculations. For example,

1. Roygard and McArthur (2008) established a methodology to calculate loads in sub catchments of the Manawatu Catchment to determine relative contributions of N and P across a range of flow categories and compared these to water quality targets at the various flow categories. This methodology was presented at the workshop as a potential starting point for calculating the relative contributions from non-point and point sources in each reach of the Manawatu Catchment The information from this analysis is now available following the completion of three years of Horizons' combined State of Environment and discharge monitoring.

2. The work by Clothier et al. (2007) utilised the non-point source calculations from Roygard and McArthur (2008) and determined the relative contributions of various land uses e.g. native cover, forestry, sheep and/or beef farming and dairy to water quality outcomes. The information from Clothier et al. (2007) and the use of the CLUES model presented at the workshop, offer a starting point from which to develop an agreed methodology to calculate relative contributions to N loadings from various non-point sources for the Manawatu Catchment.

3. Schierlitz et al. (2006) completed an estimate of the long-term average annual sediment loads in the Manawatu Catchment. This study also included a scenario-based testing of management of hill country erosion and the changes in sediment loads that were possible. A PhD thesis that followed refined this work further to provide estimates of the losses from various sub catchments in the Manawatu (Schierlitz, 2008). The information from Schierlitz et al. (2006) and Schierlitz (2008) presented at the workshop offers a starting point from which to develop an agreed methodology to calculate relative contributions of sediment sources for the Manawatu Catchment.

4. Parfitt et al. (2007) (Envirolink project 408-HZLC41) used elements of the methodologies from Schierlitz et al. (2006), Roygard and McArthur (2008) and Clothier et al. (2007) as a part of a new methodology to solve the phosphorus balance for the upper Manawatu Catchment.

Several of the projects above have introduced new science to understanding the contributions of various contaminants to the Manawatu Catchment. The current project aims to build on these projects to apply methodologies at a common scale in the Manawatu Catchment.

3. List of current and proposed science activities with a Manawatu Catchment focus

The following is a brief summary of current or proposed science activities, personal and Institutions involved projects in the Manawatu Catchment.

3.1 FRST programmes and related studies and initiatives

- Clean water productive land proposed work in the Manawatu Catchment (Sediment and P) - Richard McDowell (AgRes.) John Dymond (LCR)
- Management of cumulative effects of stressors on Aquatic Ecosystems(water quality) - Roger Young (NIWA)
- Framework for interoperable models" and "Applying CLUES in the Manawatu Catchment" Sandy Elliot (NIWA)
    - Sandy Elliot at NIWA is reparameterizing CLUES with Horizons Regional Council's data and data from three other Regional Councils.
- Sustainable Land Use Research Initiative Soil physical integrity and soil natural capital. Ian McIvor / Brent Clothier (PFR)
- Isotopes as indicators of land to water nitrogen transfer Troy Baisden (GNS)
- Aquatic Rehabilitation through attenuation John Quinn (NIWA)

3.2 Envirolink projects and projects funded directly by Horizons

- Nitrogen and Phosphorus limitation, water quality targets, non point source/point source split, newly available information - Jon Roygard (HRC)
- Non-point source split of Nitrogen in the Upper Manawatu Brent Clothier (PFR)
- Non point source split of DRP through to Sediment P in the Upper Manawatu - Roger Parfitt (LCR)
- Application of CLUES TO THE Manawatu Sandy Elliot (NIWA)
- Calculation of relative contributions of N and P from point and non-point sources: Jon Roygard (HRC)

- The Sustainable Land Use Initiative and the use of whole farm plans for soil conservation. Grant Cooper (HRC)
- Linking whole farm plans to catchment outcomes Alec Mackay (AgRes.)
- Linking whole farm management plans to catchment outcomes using SEDNET- John Dymond (LCR)
- Relative contributions of sediment sources to Manawatu Catchment using SEDNET- John Dymond (LCR) and Schierlitz (LCR)

4. Summary of likely content of the briefing document being prepared for members of the Manawatu River Leaders' Forum

The discussion on the likely briefing documents being prepared for members of the Manawatu River Leaders Forum identified the following items

- Establish an historical context to the current situation
- Provide an inventory of the current state of the Manawatu River: values e.g. contact recreation; physical-chemical parameters; aquatic ecosystem health; trends in water quality and aquatic health etc.
- Provide a commentary on the "doing nothing" too address water quality scenario.
- Identify the contaminants (P, N, sediment) and the sources of these contaminants to the present state and likely future trends
- Establish what will be required to fix the River
- Identify what actions can be taken and what will the outcomes will be from these activities by tackling the following questions
    - Where does the current scientific knowledge suggest it is possible to get the best value for money?
    - What are the ongoing science programs to inform future decisions?
    - What science gaps are not currently being addressed?

5. Current knowledge gaps and the extent to which they are being addressed by the current science programmes

Many of the current knowledge gaps are being addressed in part in the current suite of science programme listed in section three, but gaps still remain. In this section the gaps are first listed and then a priority list on the assumption additional research funding was found to tackle the highest priority gaps.

5.1 General knowledge gaps

These are in no priority order

- Need for small scale monitoring of all contaminants at farm and sub-catchment scales to demonstrate outcomes and links to actions.
- Targeted synoptic monitoring and link to temporal investigation.
- Better understanding of the storm event peak flow relationships.
- Relationship between the critical Source area size and size of the storm event.
- Effectiveness and benefits of Best Management Practice (BMP) for P and N mitigation during low flows.
- Ground water and surface water connectivity in the Manawatu River
- Lack of individual farm scale information (nutrient budgets, stocking rates etc.).
- Closing gaps between catchment scale models and small scale.
- Cyanobacteria and some work to understand it.

5.2 Sediment

- Lack of a clear understanding of erosion over time and space.
- Influence of cover in reducing sediment yield to water.
- What is relevant contribution of different processes involved in generating sediment (e.g. fresh erosion material, material in the valley floor, stream bank erosion, reworking sediment in the channel)?
- Catchment models only look at fine sediment, what happens with larger material (sand, fine gravels, coarse gravels, etc)?
- Modeling clarity during base flow conditions?
    - Horizons Regional Council is trialing turbidity as a predictor for this water quality attribute.
- What factors affect clarity and do these factors change with different flow conditions?
- Role of riparian planting in reducing sediment entry and stream bank erosion?

5.3 Nitrogen

- Relationship between nitrogen and phosphorus loads and concentrations.
    - Horizons Regional Council has some work that clarifies these relationships (Roygard and McArthur, 2008).
    - The Clean water-productive land programme could have nutrient work focused in the Manawatu Catchment.

- Speciation of dissolved fraction from Overseer?
- Time lags through the catchment.
    - A proposal is being prepared by Dr's Ranvir Singh and Dave Horne at Massey University for a joint Horizons Regional Council and Massey University PhD study looking at water ageing and time lags
- Interested in nitrate, NH_4-N, monthly N distributions, mitigation and seasonal changes.
    - Horizons Regional Council is conducting work in this area with daily sampling of the Manawatu River at the Teachers College site, including targeted hourly samples during some high flow events.
- Attenuation in relationship between to distance downstream
    - Addressed in part Isotopes as indicators of land to water nitrogen transfer Troy Baisden (GNS)
    - John Quinn (NIWA) indicated that some of his attenuation research will use the available Manawatu water quality datasets.
- Lag between N in the root zone and N in the river.
- What are the main flow paths i.e. drainage, tiles, preferential flow, streams?
- Lack of data sets for validation of N leaching under high rainfall
- Contribution from mineralization of organic N in sediment in channel?

5.4 Phosphorus

- Sediment risk models in Overseer.
- Subsurface buffer and attenuation? In tile and mole systems?.
- Faecal material. If sediment and P are removed through mitigation do faecals also decrease?

5.5 If you had another million dollars, where would it be spent?

- Temporal aspects of sediment, nitrogen, phosphorus and faecal matter.
- Nitrogen attenuation pathways from root zone to river.
- Small farm scale Best Management Practice demonstrations and monitoring.
- More data on the on-farm mitigations and specific efficacy in Horizons Regional Council Region.
- Tools for farmers and benefits.
    - Linked to advice and best practice equals well informed.
- Relating benefit to community of on-farm management practices.
- Model catchment to a Rolls Royce ICM standard

- Difference between scales, paddock, farm, sub-catchment, catchment.
- What mitigations will make a difference?
- Soil water connection to surface and ground water.
- Refined models for scenarios that include interactions between outcomes.
- Reduce the errors and uncertainties associated with monitoring and modelling.
- Estuarine and coastal effects of Manawatu River.
- CLUES including nitrate. Reparameterizing CLUES with additional Horizons Regional Council's data and three other Regional Councils.
- Linkage between nutrient loading and concentration.
- Connection between hill country erosion processes, techniques available for quantify soil erosion, and sediment yields in the river.
- Improved spatial discrete datasets, including soils, land use, farm specific nutrient budgets and mitigation practices, stream networks, climate, etc.

6. Summary and next step

The workshop made possible through funding from Envirolink (Medium Advice Grant 913-HZLC76) and involving 16 invited experts set out to establish an overall picture of previous and current research activities and initiatives of relevance to the Manawatu Catchment, and new research programme content and plans.

The workshop was successful in advancing the development of an integrated research approach to determining the loads of contaminants (sediment, phosphorus and nitrogen) entering the Manawatu Catchment and the opportunities to reduce these in the context of water quality targets, at a range of flows. It was also success in raising awareness among researchers of what other programmes, including in house Regional Council and Crown Research Institutes projects, were funded and or underway

Outputs of the workshop included a list of current and proposed science activities with a Manawatu Catchment focus and a list of the current knowledge gaps and the extent to which they are being addressed by current (e.g. Isotopes as indicators of land to water nitrogen transfer) or new science (e.g. Clean water productive land) and investments (e.g. Sandy Elliot at NIWA is reparameterizing CLUES with Horizons Regional Council's data and data from three other Regional Councils) and initiatives (e.g. proposed Massey University based PhD study looking at water ageing and time lags) by Horizons Regional Council.

A summary of the likely content of the briefing document being prepared for the members of the Manawatu River Leaders' Forum was also prepared. This covered establishment of an historical context to the current situation, inventory of the current state of the Manawatu River, a commentary on the "doing nothing" too address water quality scenario, identification of the contaminants and their sources, potential actions

through to where does the current scientific knowledge suggest it is possible to get the best value for money.

The outputs of the workshop will be used to inform a series of brainstorming sessions within Horizons Regional Council to further inform the River Leader Forum process on a potential set of actions and goals that could be used to affect short- and medium-changes to the Manawatu River and a set of targets to monitor progress towards the 2020

In places some notes have been added post-workshop to improve clarity, and to provide additional thoughts and scientific developments and plans.

7. References

Clothier B., Mackay A., Carran A., Gray R, Parfitt R., Francis G., Manning M., Duerer M., and Green S. 2007: Farm strategies for contaminant management. A report by SLURI, the Sustainable Land Use Research Initiative, for Horizons Regional Council.

Douglas G., Dymond J. and McIvor I. 2008. Monitoring and reporting of whole farm plans as a tool for affecting land use change. Prepared through Envirolink Fund (Contract No: 244HZLC26) for Horizons Regional Council by SLURI, the Sustainable Land Use Research Initiative.

Mackay A., 2007. Specifications of whole farm plans as a tool for affecting land use change to reduce risk to extreme climatic events. Horizons Regional Council. Envirolink medium advice grant 243-HZLC25).

Parfitt R., Dymond J., Ausseil A., Clothier B., Deurer M., Gillingham A., Gray R., Houlbrooke D., MacKay A. and McDowell R. 2007. Best Practice Phosphorus Losses from Agricultural Land. Prepared for Horizons Regional Council. *Landcare Research Contract Report No. LC0708/012*.

Roygard J. and McArthur K. 2008. A framework for managing non-point source and point source nutrient contributions to water quality. Technical report to support policy development. *Horizons Regional Council Report No. 2008/EXT/792*.

Schierlitz, C., Dymond J., and Shepherd J. 2006. Erosion/sedimentation in the Manawatu Catchment associated with scenarios of Whole Farm Plans, Landcare Research Contract Report: 0607/028, Report No. 2006/EXT/748

Schierlitz, C. 2008. New Zealand Empirical Erosion Model (NZeem®): Analysis, evaluation and Application in Climate Change Scenarios. PhD Thesis.

Appendix I

Workshop Programme
Location: Boardroom, Horizons Regional Council, Palmerston North

8:30 am Coffee

9:00 Welcome and Introductions – Brent Clothier (Chairman)

9:10 Where are we at? An update from Horizons Regional Council – Greg Carlyon and Jon Roygard

- Water quality state and trends in the Manawatu Catchment
- Brief overview of some of the science for the One Plan
- Overview of the One Plan and its provisions around water quality
- The Sustainable Land Use Initiative (SLUI)
- Monitoring networks
- The Manawatu River accord

9:40 "Clean water productive land" proposed work in the Manawatu Catchment - Rich McDowell/John Dymond

9:50 Management of cumulative effects of stressors on Aquatic Ecosystems - NIWA rep/Roger Young

10:00 "Framework for interoperable models" and "Applying CLUES in the Manawatu Catchment" - Sandy Elliot

10:10 SLURI theme 2 and 3: Ian McIvor (2)/ Brent Clothier(3)

10:20 "Isotopes as indicators of land to water nitrogen transfer" Alec Mackay on behalf of Troy Baisden

10:25 "Aquatic Rehabilitation" John Quinn

10:35 Coffee Break

10:55 Nutrients and sediment - what's already been done and where to next?
5 minute presentations on

- N & P limitation, water quality targets, non point source/point source split, newly available information - Jon Roygard
- Non point source split – Nitrogen - Brent Clothier
- Non point source split – Phosphorus - Roger Parfitt
- Use of CLUES - Sandy Elliot
- The Sustainable Land Use Initiative - Whole farm plans (what they contain and how they are implemented) - Grant Cooper
- Linking whole farm plans to catchment outcomes - Alec Mackay or Ian McIvor
- Linking management of whole farm plans to catchment outcomes - John Dymond

Discussion

12.00 Lunch

12.30 Developing an agreed 2010 statement

- on water quality and river ecosystem health in the Manawatu Catchment
- What the joint expertise of the research providers recommend as actions (and what these would achieve) and
- Broad outline of current research and monitoring initiatives and how these will help answer similar questions in the future

Discussion on the following questions

- What contribution can our science stakeholders make?

- If you had the opportunity to advise a panel of decision makers about an action plan for the Manawatu
  - What actions would you recommend?
  - What would these achieve?
  - On what timeframe would these be achieved?

- A number of recent regulatory controls have been introduced via the One Plan, these contain certain information requirements e.g. nutrient management plans, nutrient budgets etc. How can this information best be incorporated or used in modelling catchment outcomes?

- How can the implementation of the various controls best be modelled? E.g. Implementation of the stock exclusion rule?

- How can the information from the non-regulatory Sustainable Land Use Initiative, best be incorporated or used in modelling catchment outcomes? E.g. Information from the 72 whole farm plans already completed in the Manawatu catchment. These contain information on farm scale land use capability mapping, implementation plans, and increasingly a programme of works completed.

- How could Horizons and others improve monitoring of the Manawatu catchment?

- How can we better coordinate the science and monitoring effort in the Manawatu Catchment?

2:00 The way forward for modelling water quality outcomes for Sediment, Phosphorous and Nitrogen

- Introduction to session - Alec Mackay, followed by Discussion

3:15 Coffee Break

3:30 Revisit action plan, including defining action points and wrap up.

4:00 pm End of workshop

Appendix II

Workshop Participants

First name	Surname	Organisation
Alec	Mackay	AgResearch
Andrew	Manderson	AgResearch
Bob	Wilcock	NIWA
Brent	Clothier	Plant & Food Research
Brent	Watson	Horizons Regional Council
David	Horne	Massey University
David	Wheeler	AgResearch
Estelle	Dominati	Landcare Research
Greg	Carlyon	Horizons Regional Council
Grant	Cooper	Horizons Regional Council
Helen	Marr	Horizons Regional Council
Ian	McIvor	Plant & Food Research
John	Dymond	Landcare Research
John	Quinn	NIWA
Jon	Roygard	Horizons Regional Council
Les	Basher	Landcare Research
Logan	Brown	Horizons Regional Council
Maree	Clark	Horizons Regional Council
Peter	Taylor	Horizons Regional Council
Richard	McDowell	AgResearch
Rob	Davies-Colley	NIWA
Roger	Parfitt	Landcare Research
Roger	Young	Cawthron Institute
Sandy	Elliott	NIWA

Appendix III

Proposed work in the Manawatu within the FRST-funded 'Clean Water Productive Land' programme

The purpose of this work is two-fold:

1. Data collection/analysis component to provide information on critical source areas for sediment in the Manawatu, and to provide data to underpin the modelling. This work will be contained within Objective 1 of the programme.
2. Develop a catchment sediment model that contains a physical representation of all erosion processes, sediment storages, and transfers (SedNetNZ). The aim is to produce a model that will be useable at the local reach scale to predict the relative source contribution of sediment from farms (dependent upon farm plans etc.) and movement of that sediment from hill slope to streams and through the catchment. This work will be contained within Objective 2 of the programme and will ultimately provide an improved sediment model component of CLUES (replacing the current regression-based SPARROW model).

Need for the work – current models (NZeem (Dymond et al. 2010) and a simplified SedNet (Schierlitz et al. 2006) have both previously been applied in the Manawatu) make broad assumptions about the influence of land cover on erosion, sediment delivery ratios, and the connection between upstream hill slope erosion and downstream sedimentation. By developing a model with better erosion process representation, explicit linkage between hill slopes and channels, and simulation of catchment scale connectivity we will be better able to simulate the effects of changes in land management on upstream sediment loading and downstream response. It will also provide an improved means of simulating interactions between sediment and other contaminants (P, microbes).

We propose using the Manawatu as a case study for model development because it has major sediment issues, considerable existing data, and the likelihood of major land management change that can be used as a test bed for the model. We expect the work to provide Horizons with tools for better predicting the impact of land management change and demonstrating the effects of this change. The following work strands are envisaged:

(1) Code up SedNetNZ using PYTHON software. New algorithms for dealing with all erosion processes are needed and recompiling the programme in PYTHON will maximise flexibility in model development.

(2) Develop high resolution DEMs for representative areas of the main erosion terrains and use DEM terrain analysis to derive sediment delivery ratios for the different erosion processes.

(3) Use NZUSLE to derive surface erosion rates (likely to be small delivery term, but needed for interaction with P).

(4) Determine magnitude/frequency relationships of landslides for the main erosion terrains (sandstone, unconsolidated sandstone, mudstone, greywacke) and

vegetation types from historical aerial photographs. Derive slope–landslide probability density relationships using analysis of high resolution DEMs.

(5) Map gullies from aerial photographs and estimate long-term erosion rates from field measurement for representative areas. Use sequential high resolution DEM analysis of selected gullies to investigate gully area–denudation rate relationships.

(6) Map earth flows and estimate long-term erosion rates from field measurement for representative areas (are earth flows important in the Manawatu?).

(7) Measure bank erosion for representative reaches of the main tributaries using a combination of LiDAR and historical aerial photographs following De Rose and Basher (In Prep). Develop and calibrate stream power based empirical model for implementation in SedNet (see De Rose (in prep) Review of bank erosion models).

(8) Develop sediment discharge records of sub catchments in the Manawatu River from Horizons sediment and flow data – turbidity, suspended sediment concentration (SSC), and discharge (Q). In addition to the main river (Manawatu at Teachers College), all the main sub catchments currently have turbidimeters: Oroua, Pohangina, Mangahao, Mangatainoka, Tiraumea, Upper Manawatu at Hopelands. Need to combine the continuous measurement of turbidity with SSC to calibrate the turbidity data and derive a continuous record of SSC. Combine the continuous SSC and Q from water level recorders at the same sites to produce time series of sediment discharge from which suspended sediment yield (SSY) can be calculated. This needs to be done because the sediment concentration/discharge rating curves are notoriously looped in this catchment and using this approach provides a more accurate measure of sediment yield. Existing data needs to be examined to assess its quality and identify any possible data gaps that the CWPL programme might fill.

(9) Having a continuous time series of sediment discharge will allow us to derive storm event SSY-peak flow relationships (Hicks 1994, Hicks et al. 2000, Hicks and Basher 2008) and integrate with flow records to determine longer-term catchment sediment yields. The storm event SSY-peak flow relationships would provide us with a measure of the differences between sub catchments and could potentially provide a measure in the longer term of the effect of farm plan implementation effectiveness. We would expect the storm event SSY-peak flow relationships to change as land management changes take effect

(10) Validate the Manawatu SEDNET model using the sediment discharge records from (8) and sediment fingerprinting techniques based on radionuclides, compound specific isotopes and geochemistry (Rustomji et al. 2008). Sediment fingerprinting will also provide a means of confirming key contributing processes.

References

Dymond JR, Betts HD, Schierlitz CS 2010. An erosion model for evaluating land-use scenarios in New Zealand. Environmental Modelling and Software 25: 289-298.

Hicks DM 1994. Land-use effects on magnitude-frequency characteristics of storm sediment yields: some New Zealand examples. Variability in Stream Erosion and

Sediment Transport (Proceedings of the Canberra symposium, December 1994), IAHS Publication No.224: 395-402.

Hicks DM, Gomez B, Trustrum NA 2000. Erosion thresholds and suspended sediment yields, Waipaoa River Basin, New Zealand. Water Resources Research 36: 1129-1142.

Hicks DM, Basher LR 2008. The signature of an extreme erosion event on suspended sediment loads: Motueka River Catchment, South Island, New Zealand. Sediment Dynamics in Changing Environments (Proceedings of a symposium held in Christchurch, New Zealand, December 2008). IAHS Publication 325: 184-191.

Rustomji P, Caitcheon G, Hairsine P 2008. Combining a spatial model with geochemical tracers and river station data to construct a catchment sediment budget. Water Resources Research 44, W01422, doi:10.1.1029/2007WR006112.

Schierlittz C, Dymond J, Shepherd J 2006. Erosion/sedimentation in the Manawatu catchment associated with scenarios of Whole Farm Plans. Landcare Research contract report 0607/028.