Manaaki Whenua
Landcare Research

Erosion sources: quality attributes and sediment contributions

Simon Vale, Hugh Smith

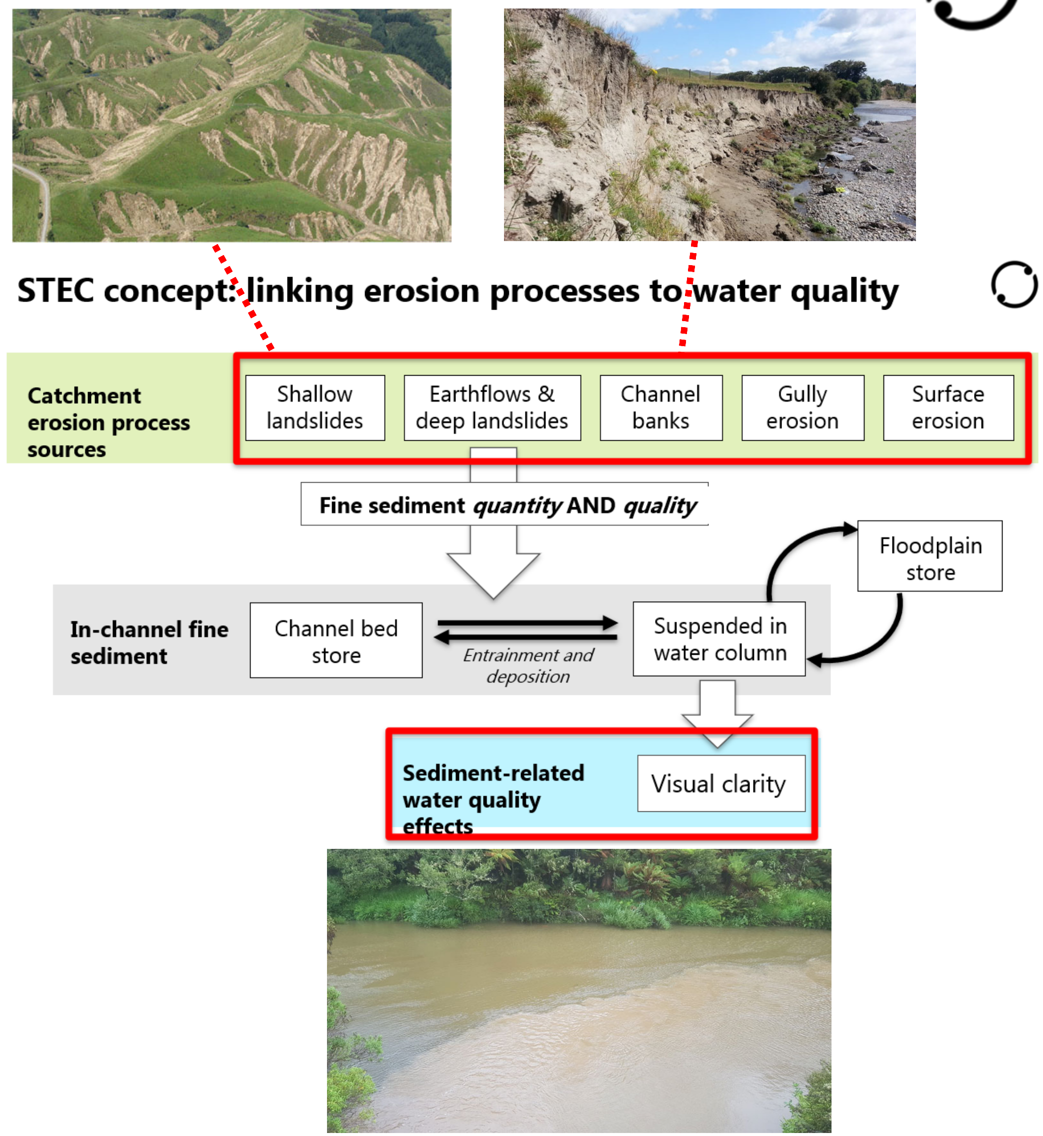
Overview

A) Erosion source quality

- Understand the influence of different erosion sources on **Sediment-Related Water Quality (SRWQ)** attributes
  - Visual clarity

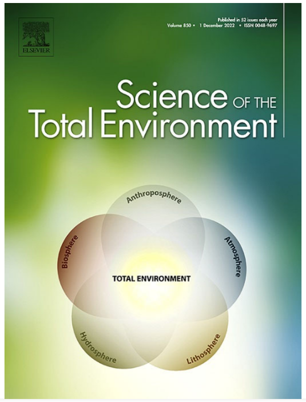
B) Sediment source fingerprinting

- Understand **intra-storm sediment contributions** in a nested catchment (Ōreti)
- Understand **sediment dynamics** and **source phasing** in an instrumented study catchment (Haunui research catchment)



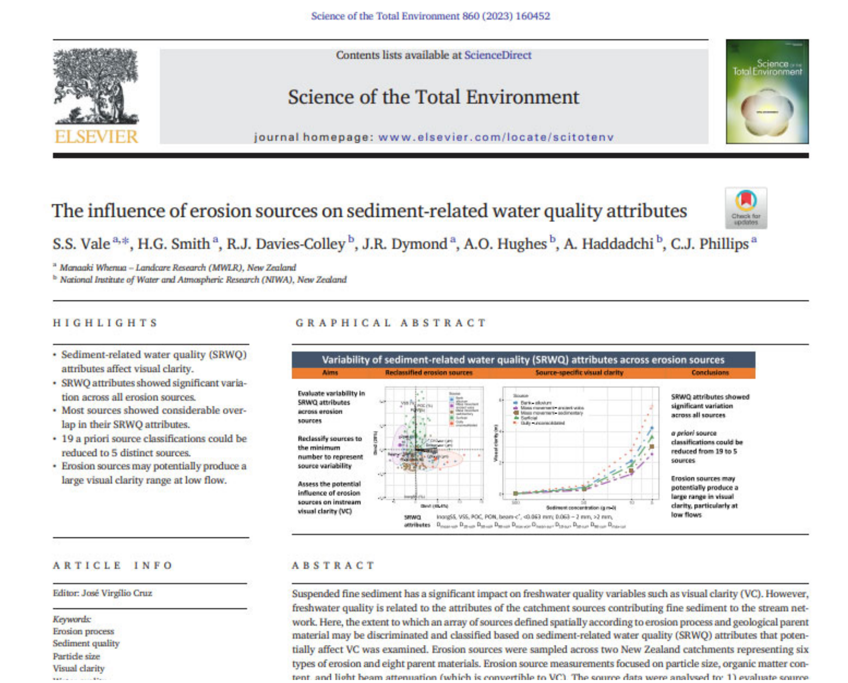
A) Erosion Source quality

Influence of erosion sources on sediment-related water quality (SRWQ) attributes



Aims and experiment design

1. Evaluate **variability in SRWQ attributes** across different erosion sources.
2. **Reclassify sources** to the minimum number needed **to adequately represent variation** in SRWQ attributes.
3. Assess the **potential influence** of **erosion sources** on instream visual clarity (VC).



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The influence of erosion sources on sediment-related water quality attributes

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HIGHLIGHTS

- Sediment-related water quality (SRWQ) attributes affect visual clarity.
- SRWQ attributes showed significant variation across all erosion sources.
- Most sources showed considerable overlap in their SRWQ attributes.
- 19 a priori source classifications could be reduced to 5 distinct sources.
- Erosion sources may potentially produce a large visual clarity range at low flow.

GRAPHICAL ABSTRACT

ARTICLE INFO

Editor: José Virgílio Cruz

Keywords:
Erosion process
Sediment quality
Particle size
Visual clarity

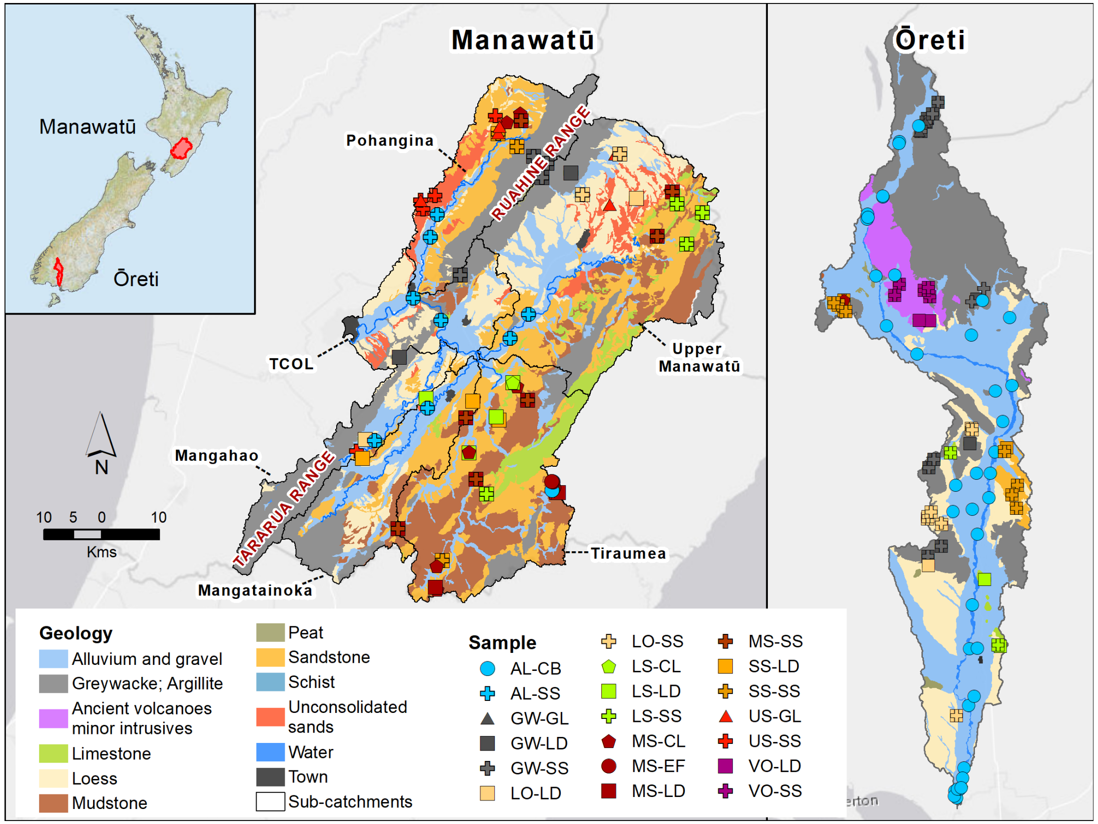
ABSTRACT

Suspended fine sediment has a significant impact on freshwater quality variables such as visual clarity (VC). However, freshwater quality is related to the attributes of the catchment sources contributing fine sediment to the stream network. Here, the extent to which an array of sources defined spatially according to erosion process and geological parent material may be discriminated and classified based on sediment-related water quality (SRWQ) attributes that potentially affect VC was examined. Erosion sources were sampled across two New Zealand catchments representing six types of erosion and eight parent materials. Erosion source measurements focused on particle size, organic matter content, and light beam attenuation (which is convertible to VC). The source data were analysed to: 1) evaluate source

Source sampling

Manawatū & Ōreti catchments

- Sources defined spatially according to **erosion process** and **geological parent material**



Source sampling

Manawatū & Ōreti catchments

- Sources defined spatially according to **erosion process** and **geological parent material**

Parent material	Erosion Process	Sample	Sample number		
			Manawatū	Ōreti	Total
Alluvium	Channel bank	Al-CB	9	10	19
Alluvium	Surficial	Al-SS	8	-	8
Ancient volcanics	Landslide	VO-LD	-	5	5
Ancient volcanics	Surficial	VO-SS	-	5	5
Greywacke	Landslide	GW-LD	6	5	11
Greywacke	Surficial	GW-SS	6	5	11
Greywacke	Gully	GW-GL	-	4	4
Limestone	Landslide	LS-LD	7	3	10
Limestone	Surficial	LS-SS	6	2	8
Loess	Landslide	LO-LD	5	3	8
Loess	Surficial	LO-SS	5	4	9
Mudstone	Landslide	MS-LD	9	-	9
Mudstone	Earthflow	MS-EF	5	-	5
Mudstone	Surficial	MS-SS	9	-	9
Mudstone	Cliff	MS-CL	10	-	10
Sandstone	Landslide	SS-LD	6	4	10
Sandstone	Surficial	SS-SS	7	4	11
Unconsolidated	Gully	US-GL	10	-	10
Unconsolidated	Surficial	US-SS	3	-	3
Total			**111**	**54**	**165**

Sediment related water quality (SRWQ) attributes

Particle size attributes

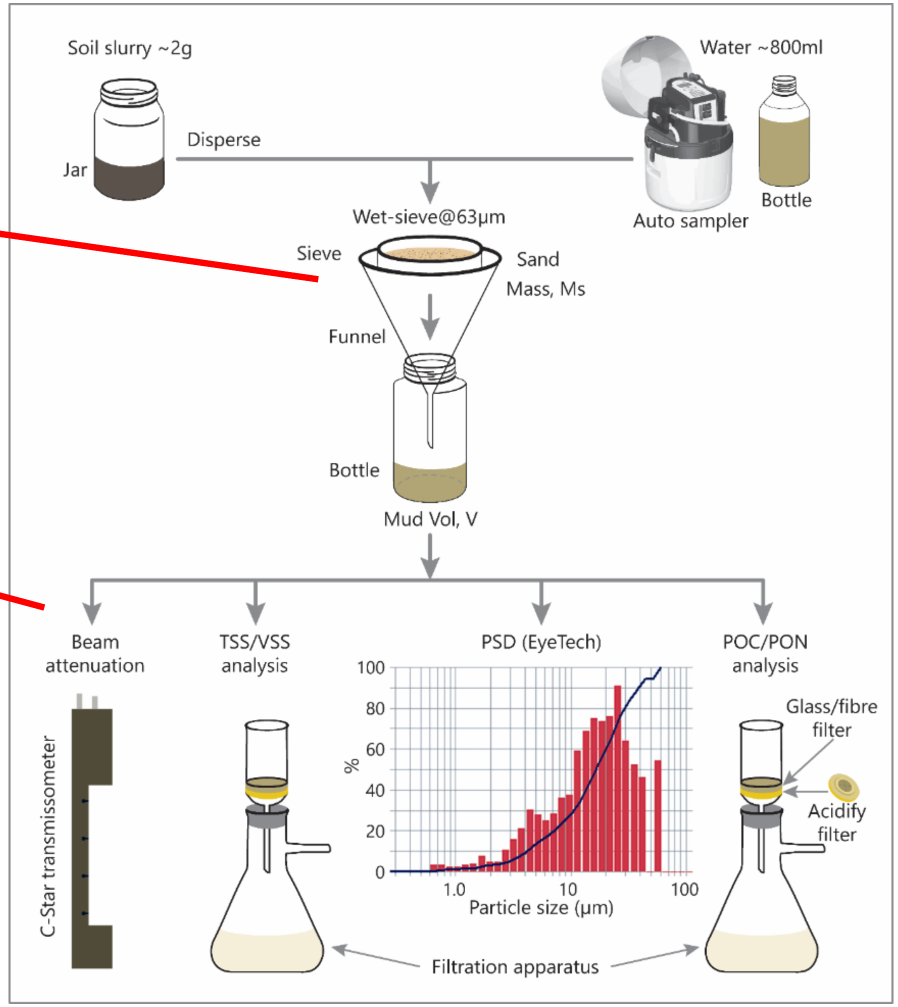
- <0.063mm, 0.063-2mm, >2mm

- **PSD** of <0.063mm
  - $D_{mean\text{-}sur}$, $D_{10\text{-}sur}$, $D_{50\text{-}sur}$, $D_{90\text{-}sur}$, $D_{max\text{-}sur}$
  - $D_{mean\text{-}vol}$, $D_{10\text{-}vol}$, $D_{50\text{-}vol}$, $D_{90\text{-}vol}$, $D_{max\text{-}vol}$

Organic matter attributes

- VSS (%), InorgSS (%), PON (%), POC (%)

Light beam attenuation coefficient
Beam-c /beam-c* (m2/g)



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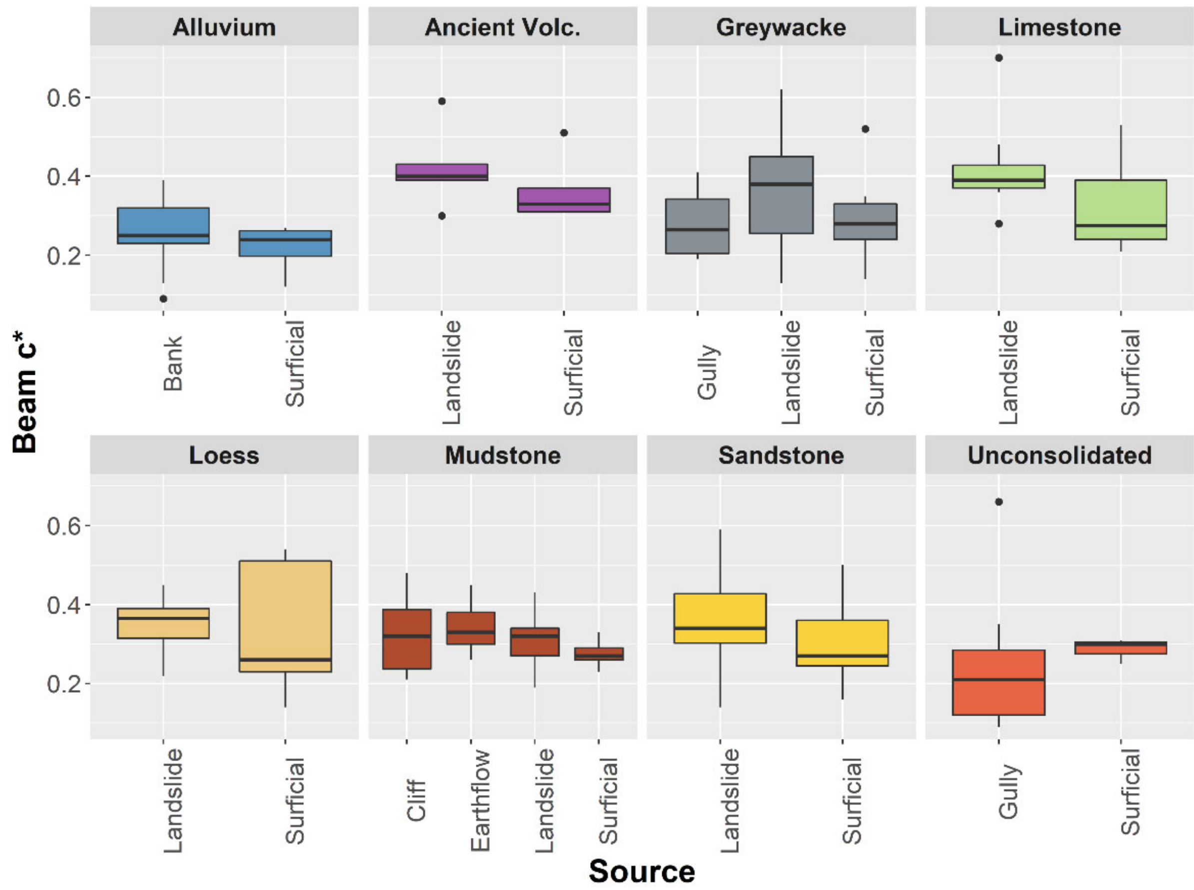
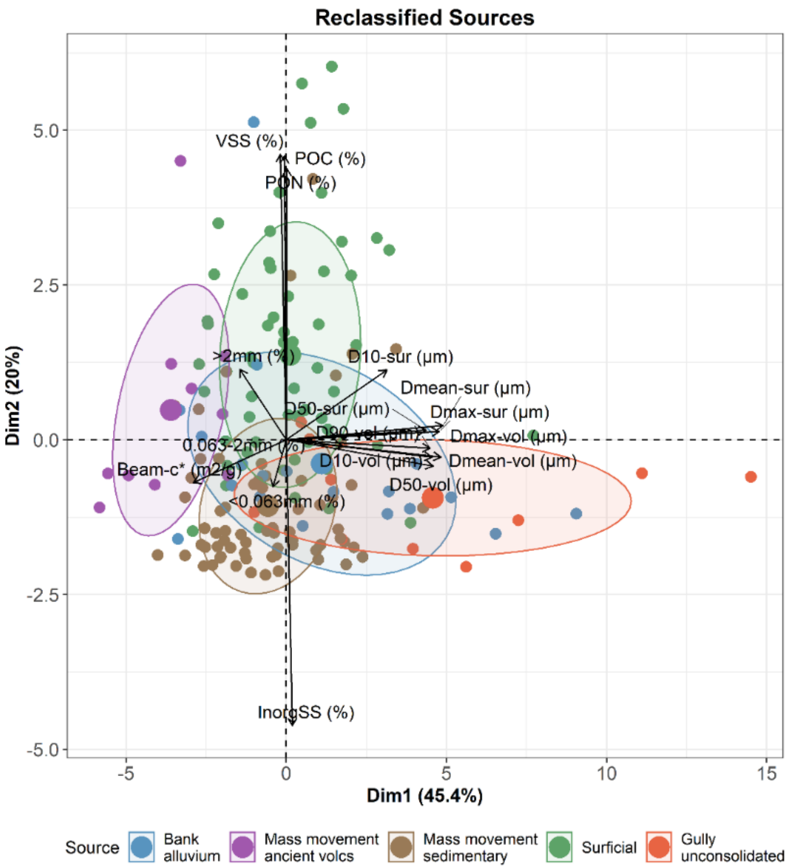


Source reclassification



Reclassified Source: OOB = 26.1%

Source (n)		Predicted class: Bank – alluvium	Mass movement – ancient volcs.	Mass movement – sedimentary	Surficial	Gully – unconsolidated	Class error
Bank – alluvium	(20)	42	5	32	11	11	58%
Mass movement – ancient volcs.	(10)	-	70	20	10	-	30%
Mass movement – sedimentary	(66)	2	2	77	18	2	23%
Surficial	(60)	-	-	15	85	-	15%
Gully – unconsolidated	(11)	40	-	10	-	50	50%

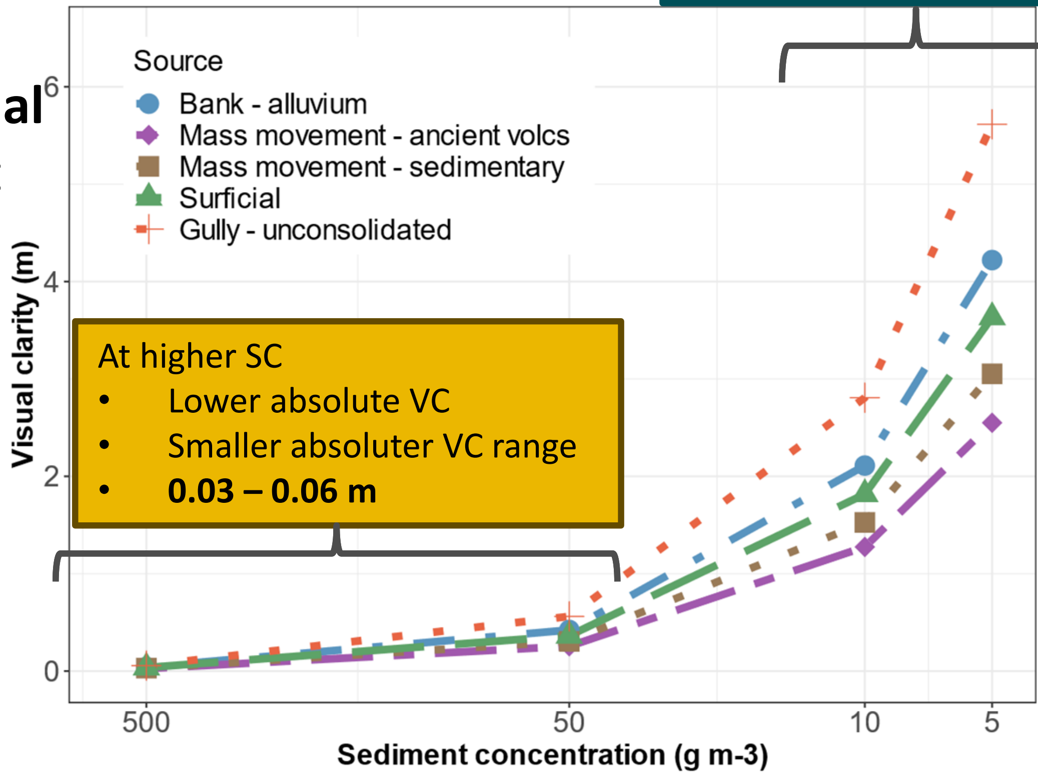
The *a priori* source classifications could be reduced from 19 to 5 distinct sources to adequately represent attribute variability although some overlap and misclassification remained.

Source-specific VC variation

How might **different erosion sources influence instream visual clarity** over a range of sediment concentrations

Different erosion sources may produce a large range in theoretical VC values

At lower SC
- Higher absolute VC
- Larger absolute VC range
- **2.6 – 5.6 m**



At higher SC
- Lower absolute VC
- Smaller absoluter VC range
- **0.03 – 0.06 m**

Source-specific VC variation

May have implications for:

- Environmental monitoring and reporting
  - e.g., suspended fine sediment attribute targets (NPS-FM)
  - Median visual clarity

Table 8 – Suspended fine sediment

Value (and component)	Ecosystem health (Water quality)			
Freshwater body type	Rivers			
Attribute unit	Visual clarity (metres)			
Attribute band and description	**Numeric attribute state by suspended sediment class**			
	Median			
	1	2	3	4
A Minimal impact of suspended sediment on instream biota. Ecological communities are similar to those observed in natural reference conditions.	≥1.78	≥0.93	≥2.95	≥1.38
B Low to moderate impact of suspended sediment on instream biota. Abundance of sensitive fish species may be reduced.	<1.78 and ≥1.55	<0.93 and ≥0.76	<2.95 and ≥2.57	<1.38 and ≥1.17
C Moderate to high impact of suspended sediment on instream biota. Sensitive fish species may be lost.	<1.55 and >1.34	<0.76 and >0.61	<2.57 and >2.22	<1.17 and >0.98
National bottom line	**1.34**	**0.61**	**2.22**	**0.98**
D High impact of suspended sediment on instream biota. Ecological communities are significantly altered and sensitive fish and macroinvertebrate species are lost or at high risk of being lost.	<1.34	<0.61	<2.22	<0.98

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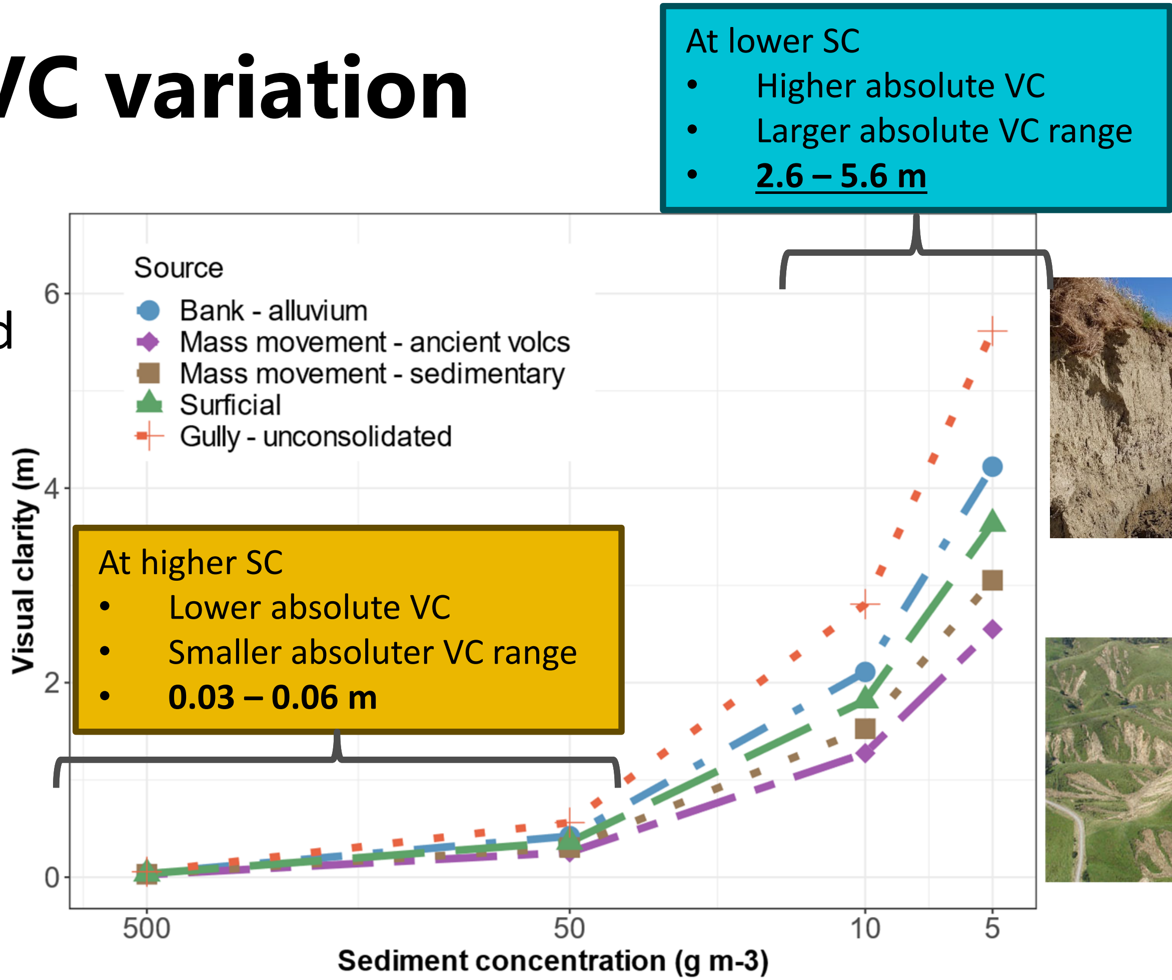
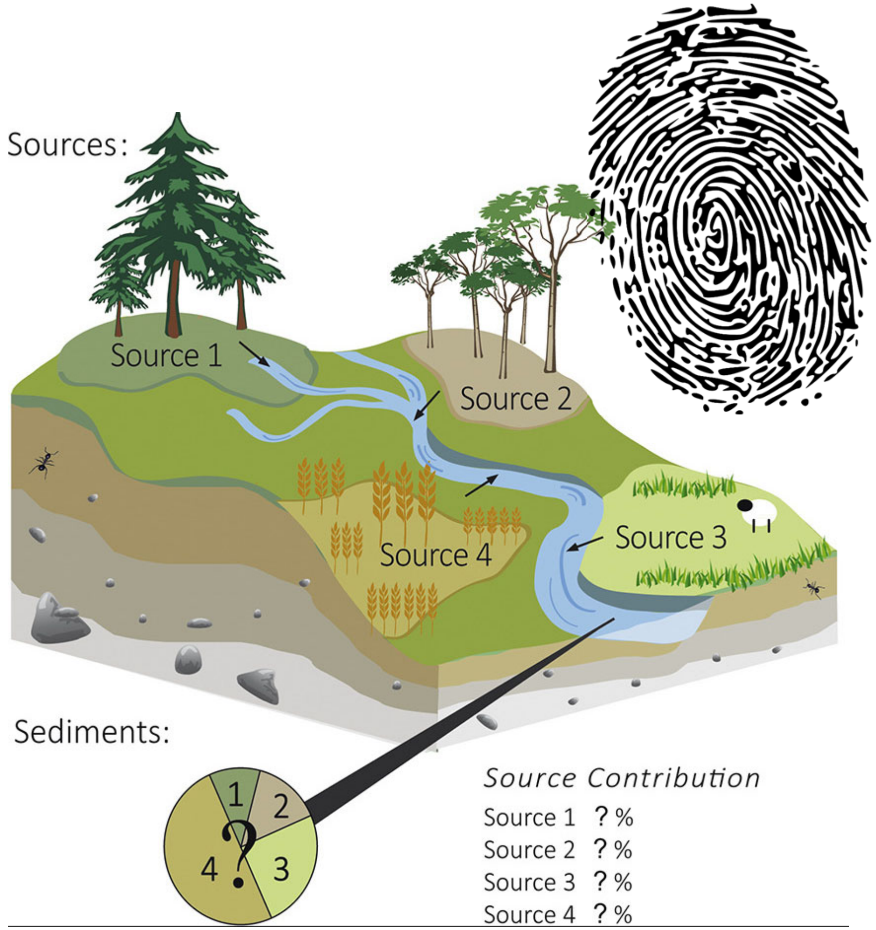


B) Source contributions from sediment fingerprinting

Aims and experiment design

1. **Ōreti:** quantify sediment source contributions during significant flow events using geochemical sediment fingerprinting

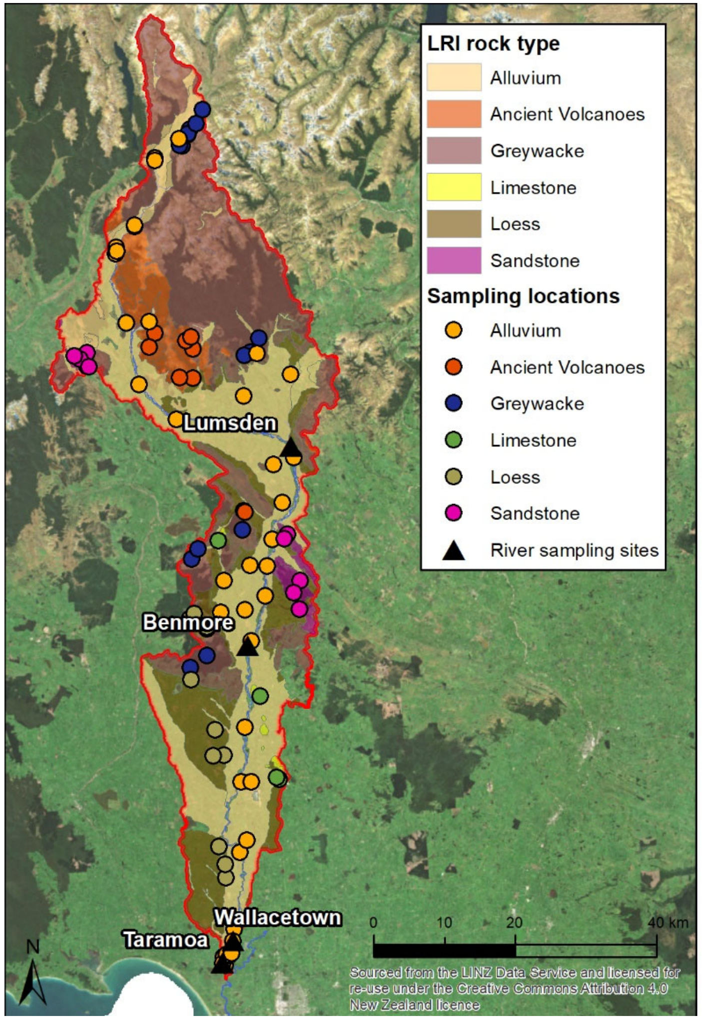
2. **Haunui (Upper Tiraumea):** sediment dynamics in a small catchment - contrast seasonal (monthly) contributions with high flow events



Source: Gaspar et al., 2019

Ōreti catchment source sampling

- Total n source samples = **104**



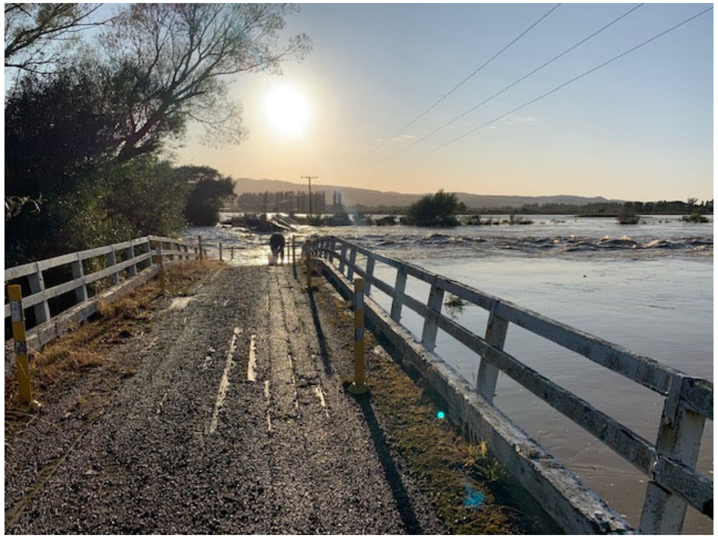
Ōreti storm event sampling

3 Storm events - 4 stations

1. **February 2020 flood event**
    - Major flood event
    - Peaked over >1000 cumecs
    - Significant flooding across the region

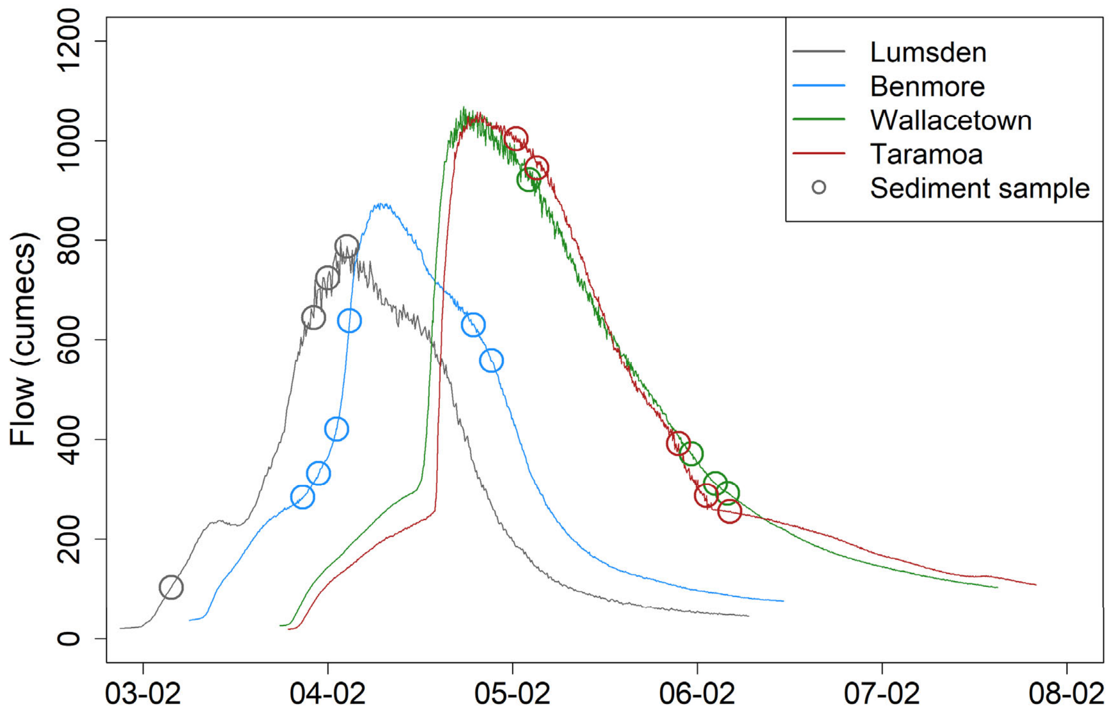
2. **September 2020 flood event**
    - Peaked at ~150 cumecs

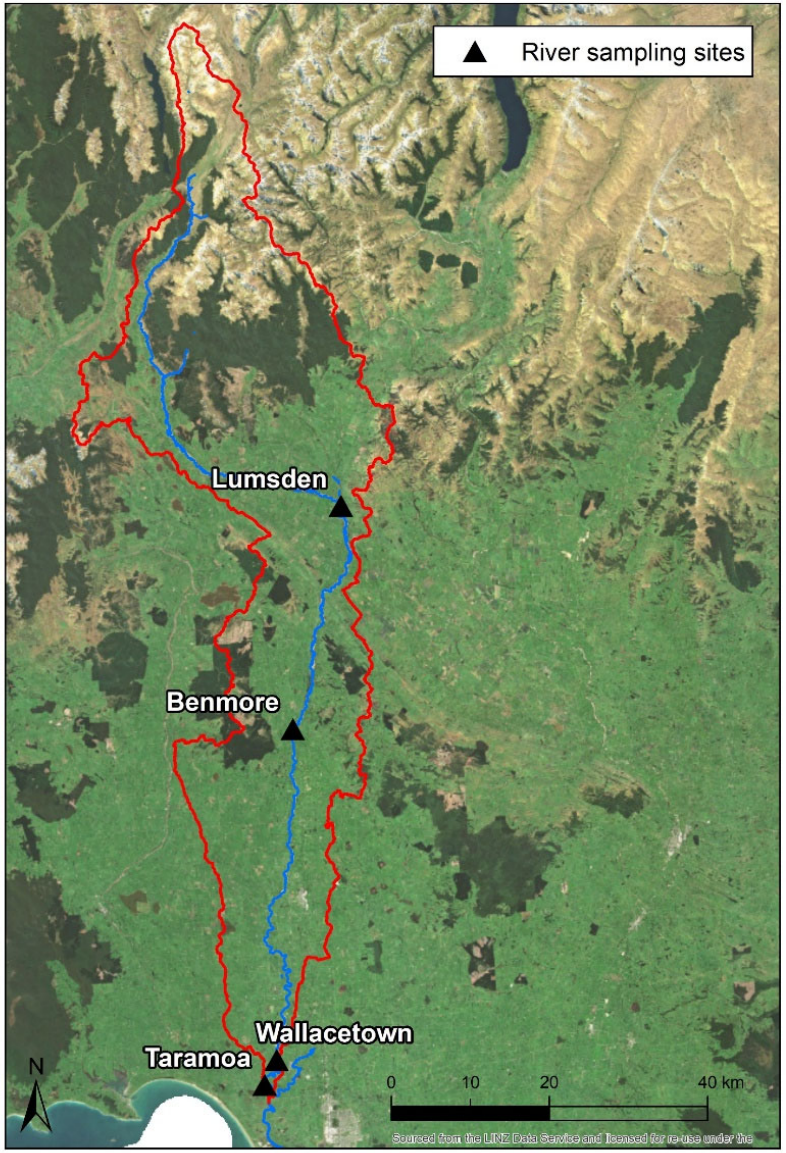
3. **July 2022 flood event**
    - Smaller event <140 cumecs
    - Different rain distribution pattern compared with previous events



Ōreti storm event sampling

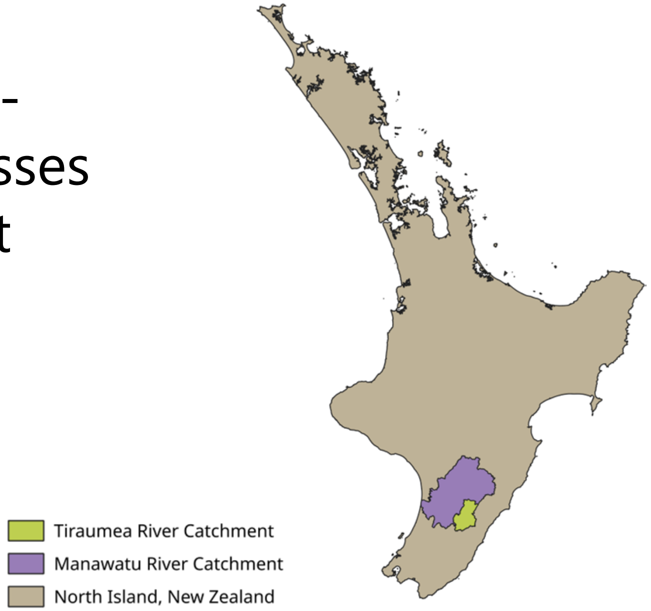
- Nested event sampling – 4 stations
- Collected bulk 20 L grab samples
- Phased hydrograph sampling for multiple sites





Haunui research catchment

Aim: better link land-based erosion processes to instream sediment load & quality



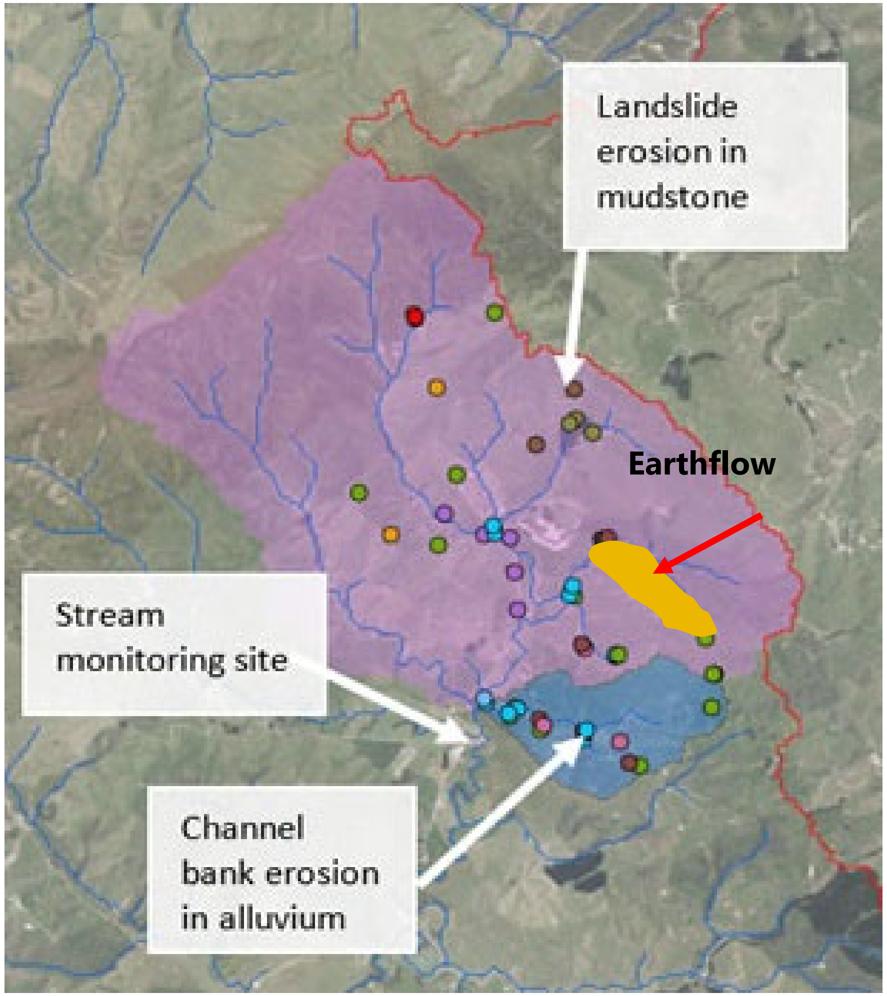
Haunui research catchment

Aim: better link land-based erosion processes to instream sediment load & quality

Haunui research catchment

Sediment sources

- Channel bank, Earthflow, Mudstone/cliff, Shallow Landslides, Surficial, Farm tracks



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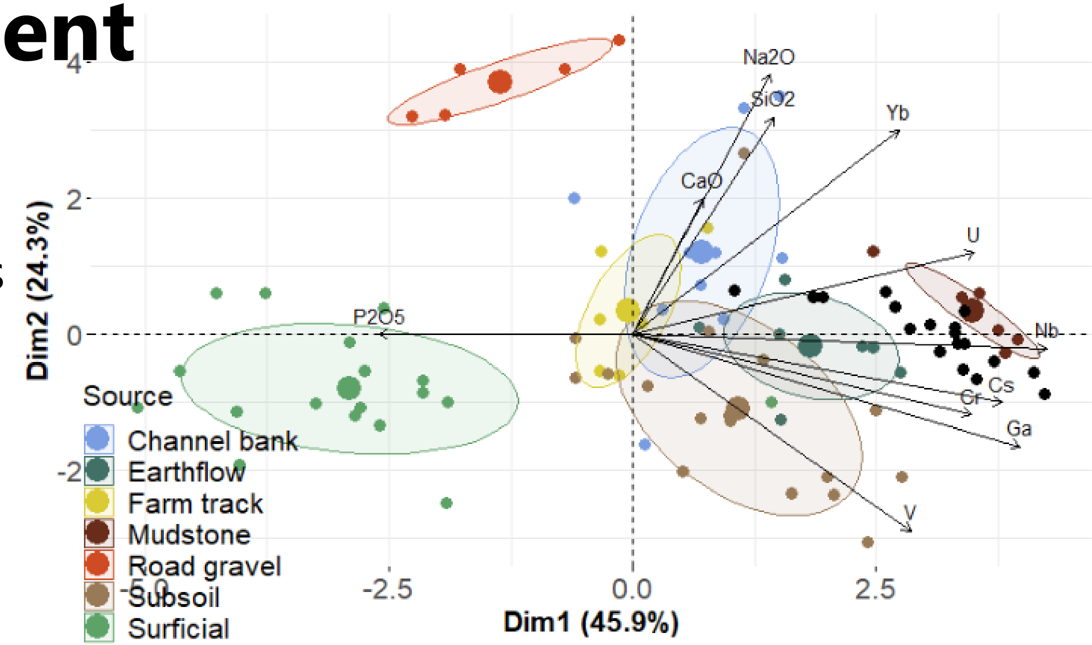
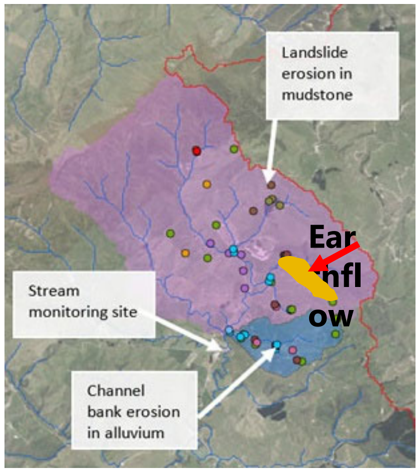
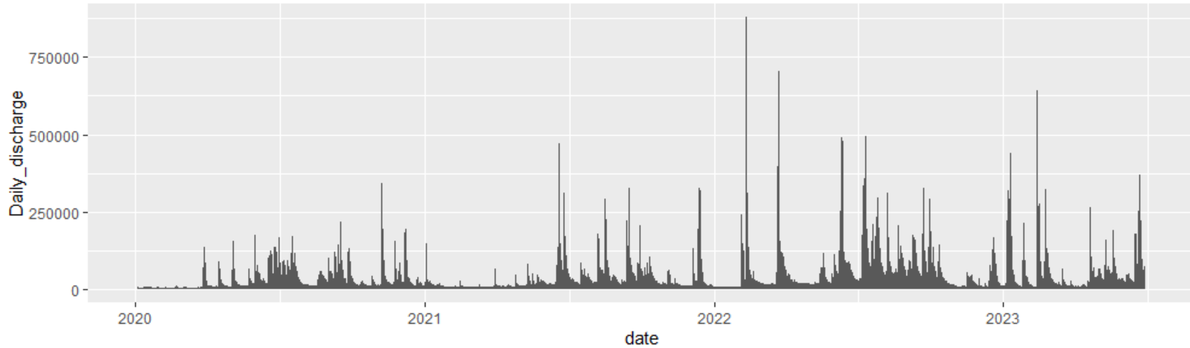


Sediment samples

- Monthly time-integrated sediment samples
- Bed sediment samples
- SSC samples from storm events





Overview

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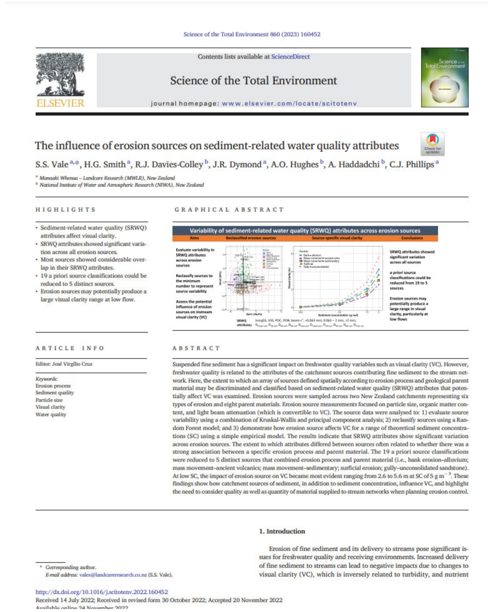
- Understand the influence of different erosion sources on **Sediment-Related Water Quality (SRWQ)** attributes
  - Visual clarity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GRAPHICAL ABSTRACT

Variability of sediment-related water quality (SRWQ) attributes across erosion sources

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1. Introduction

Erosion of fine sediment and its delivery to streams pose significant issues for freshwater quality and receiving environments. Increased delivery of fine sediment to streams can lead to negative impacts due to changes to visual clarity (VC), which is inversely related to turbidity, and nutrient

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B) Sediment source fingerprinting

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- Understand **sediment dynamics** and **source phasing** in an instrumented study catchment (Haunui research catchment)

To be completed soon...