Manaaki Whenua
Landcare Research

Tool for relating land use/management to sediment rating curve for the Manawatu catchment

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Tool for relating land use/management to sediment rating curve for the Manawatu catchment

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Impact of sediment load on water clarity

Visual clarity of water is the distance (in metres) through water that objects can be seen. It is variable over time because it depends on suspended sediment concentration (SSC) that varies with river flow. Therefore, the median visual clarity is often used to characterise visual clarity at a site (Ballantine and Davies-Colley, 2009). When sediment loads in rivers are reduced through erosion mitigation (see references), SSC in the river will also reduce and median visual clarity will increase (Dymond et al. 2017).

To estimate increases in visual clarity due to reduced sediment load it is necessary to determine the relationship between visual clarity and SSC. Following Dymond et al. (2017), visual clarity (v) is related to SSC (s) by:

$$v = \exp(d)\, s^{c} \tag{1}$$

where d and c are constants at a given site on a river. To determine d and c, concurrent measurements of s and v are plotted in log-log space and a straight line fitted to the data. Figure 1 provides an example of this for the measurement site at Mangawhero at Raupiu Road. The gradient of the line is c and the intercept is d.

$$\log(v) = d + c.\log(s) \tag{2}$$

If the sediment load at a river site is reduced to a fraction (*frac*) of the baseline sediment load, then visual clarity will increase by the ratio $frac^{c}$. For example, if c = –0.5 and sediment load reduces by 40% (i.e. *frac* = 0.6), then visual clarity will increase by the ratio $0.6^{-0.5}$= 1.3 (i.e. visual clarity will increase by 30%). Equation 2 was derived for different suspended sediment gauging sites and used to convert predictions of the effect of SLUI in reducing sediment load to predictions of the impact on visual clarity.

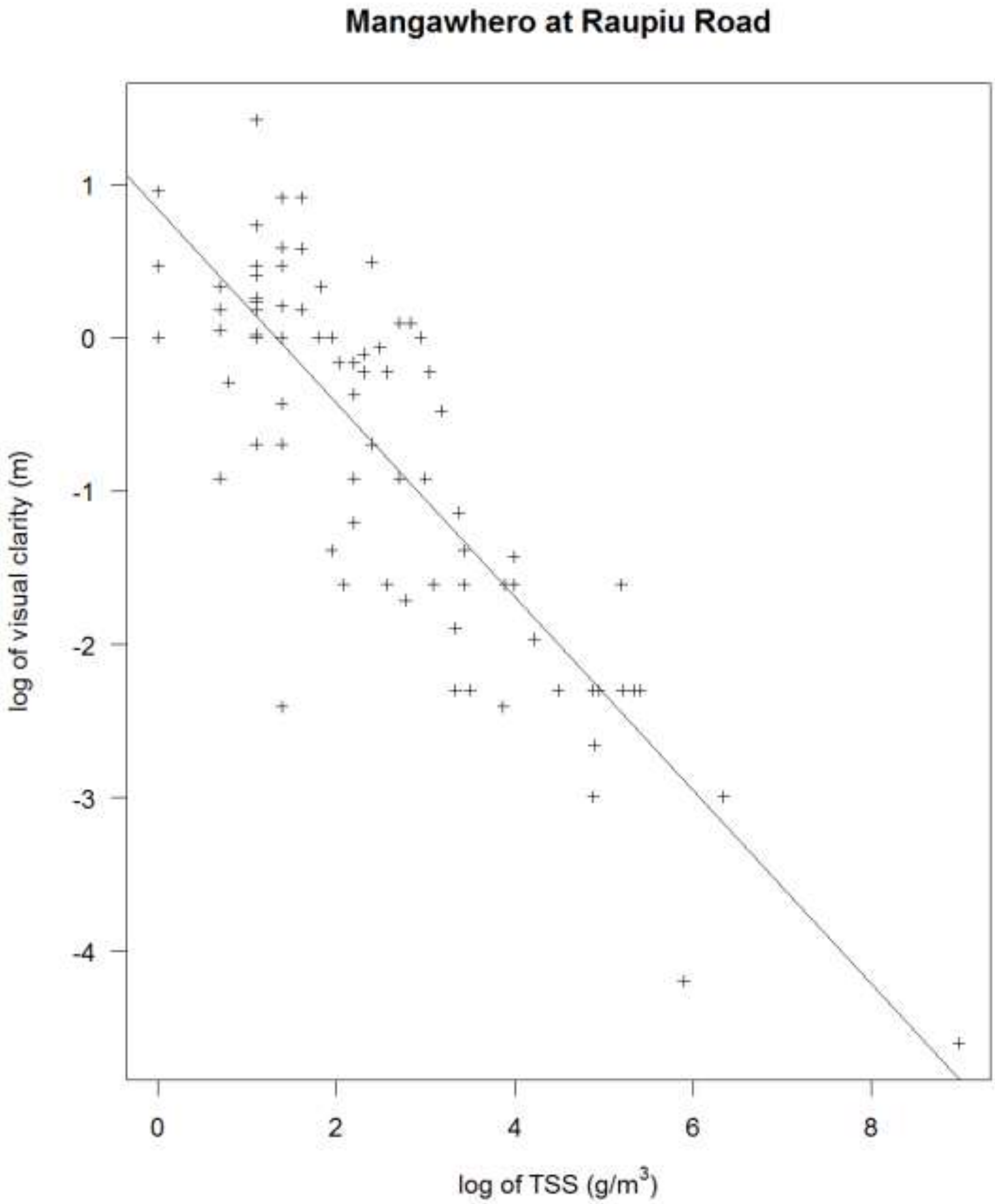

Figure 1. Relationship between visual clarity and suspended sediment concentration at the Mangawhero at Raupiu Road measurement site.

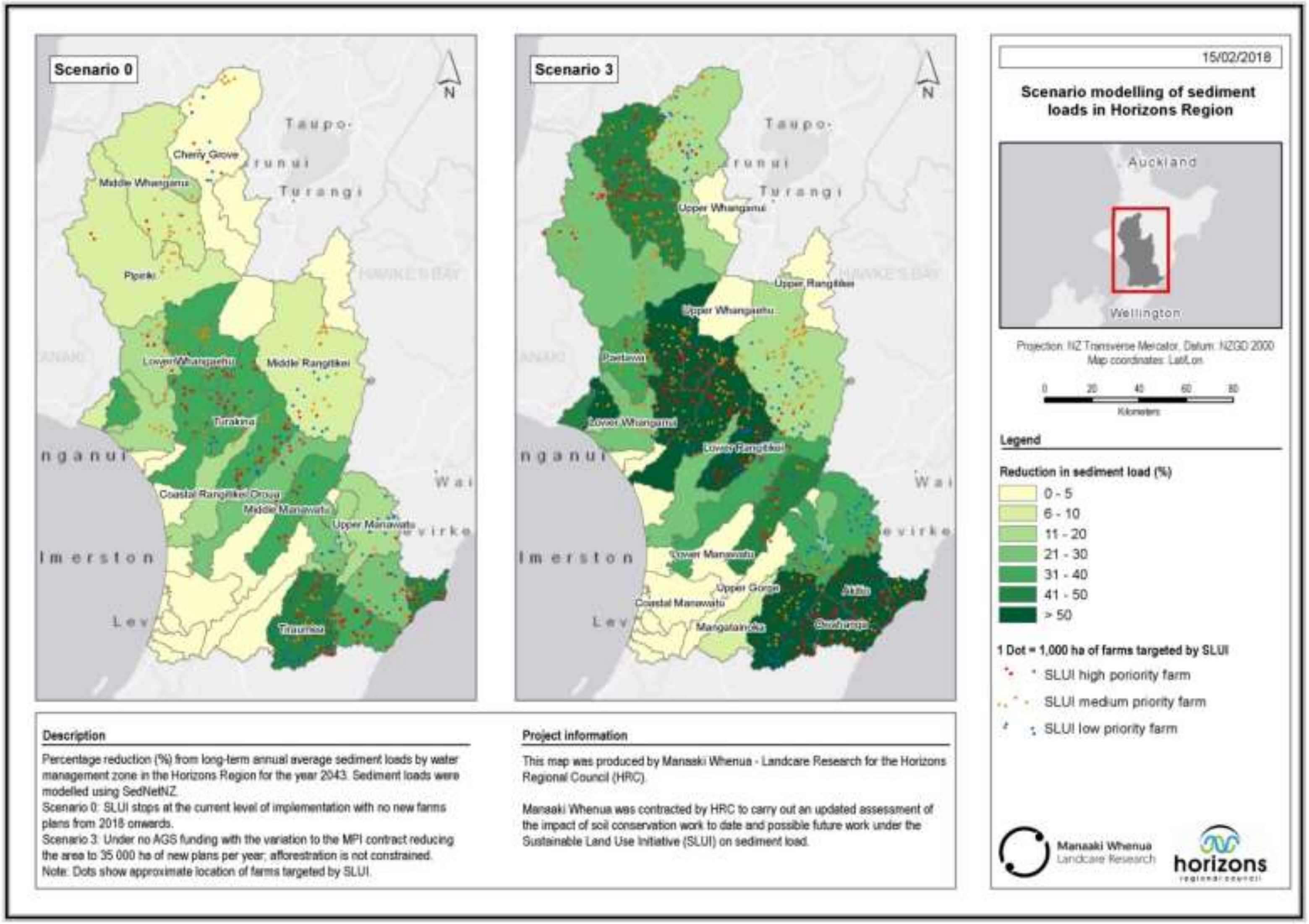

Figure 2. Example map showing percentage reductions of annual sediment loads for two different soil conservation scenarios by water management zone.

Assessing impact of soil conservation on water clarity in the Horizons region using the tool

Modelled reductions in sediment yields from soil conservation scenarios (e.g. Fig. 2 – from Basher et al., 2018) and associated increases in visual clarity in rivers can be used to assess the impact of soil conservation upstream of the measurement sites in the rivers. These assessments are limited to rivers with measurement sites. The visual clarity tool (VisualClarityTool.xlsx) tabulates median water clarity for 84 measurement sites and associated water management zones and subzones in the Horizons region. Predicted median water clarity is shown in column "new median VC" and results from frac shown in column "frac". Figure 3 (from Basher et al., 2018) shows median visual clarity at measurement sites and the predicted impact of example soil conservation scenarios 0 and 3. Figure 4 shows the same for the management subzones. The increase in visual clarity is based on the relationship between visual clarity and suspended sediment concentration summarised in columns E and F of the tool.

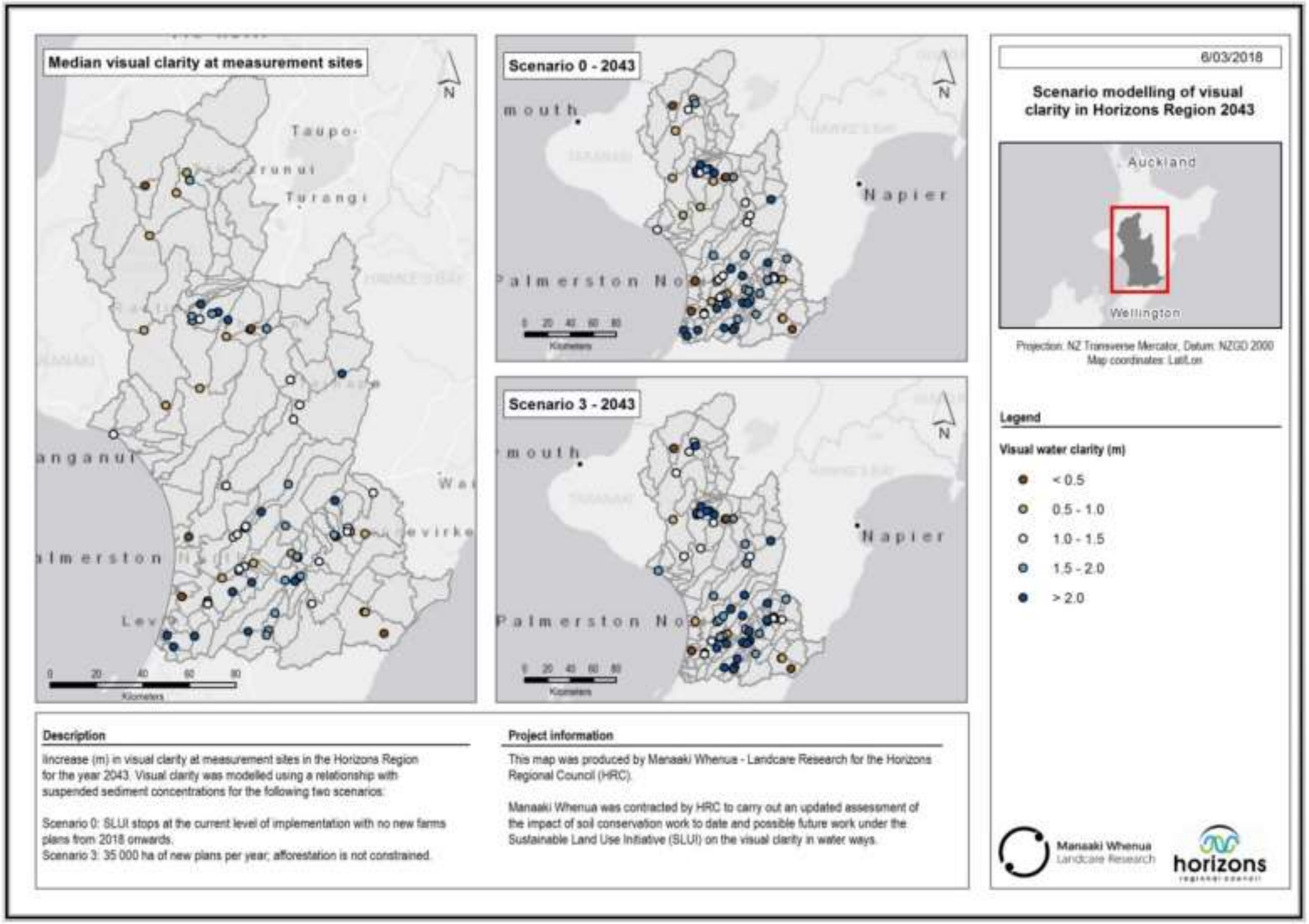

Figure 3. Example map showing modelled increase (m) in visual water clarity at measurement sites resulting from two soil conservation scenarios.

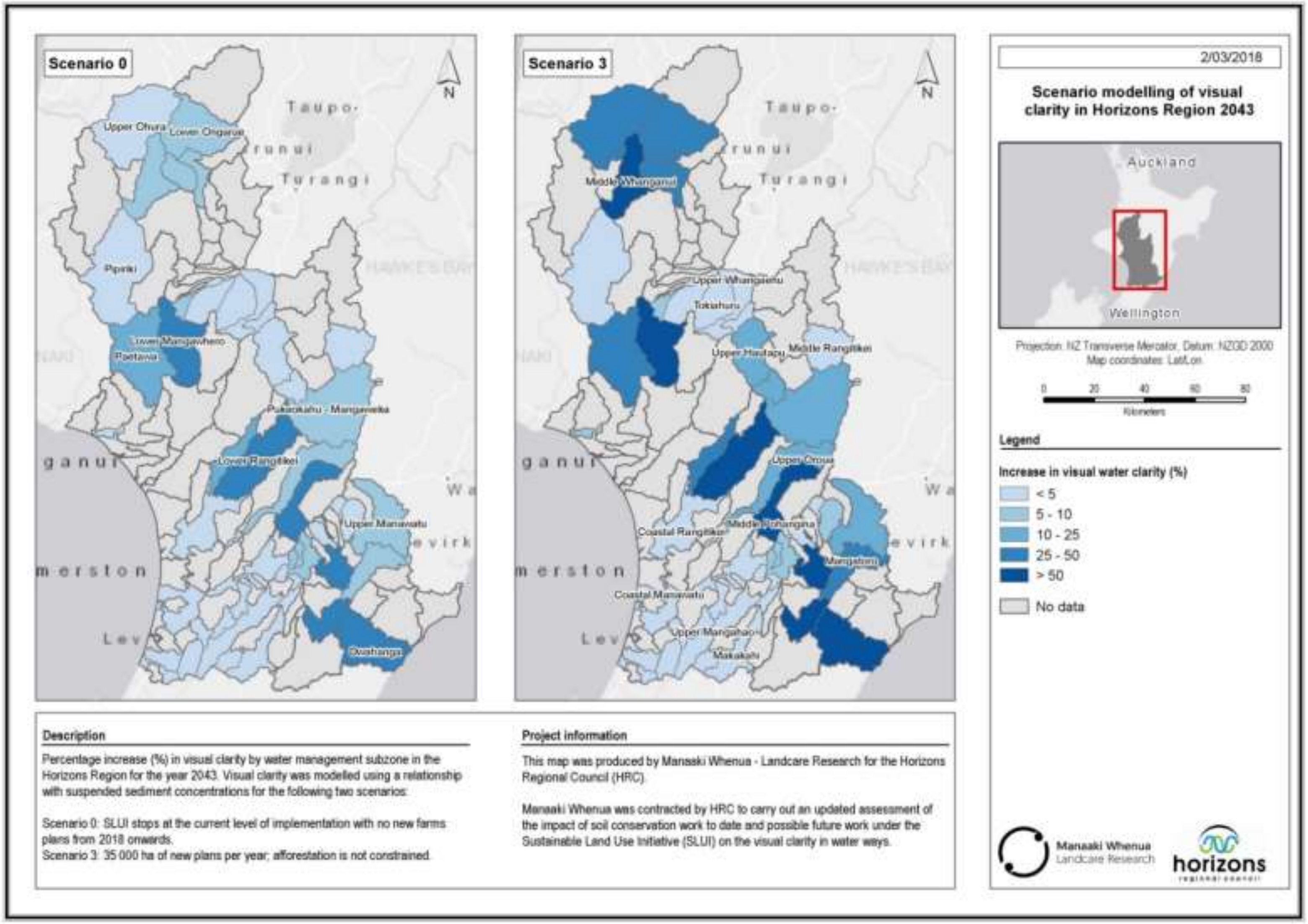

Figure 4. Example map showing modelled percentage increase in visual clarity in water management subzones resulting from two soil conservation scenarios.

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Predicting improved optical water quality in rivers resulting from soil conservation actions on land

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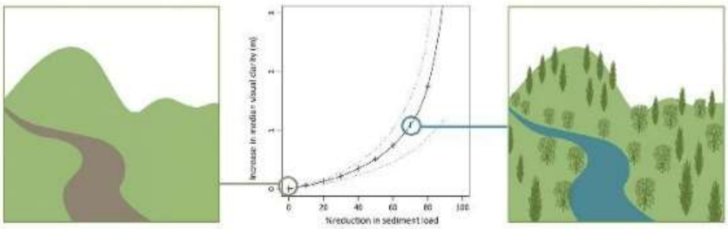
HIGHLIGHTS

- Optical water quality in rivers can be related to sediment loads.
- Improved optical water quality may be predicted from soil conservation.
- In the Wairua River, visual clarity will increase 0.5 m after soil conservation.

GRAPHICAL ABSTRACT



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ABSTRACT

Deforestation in New Zealand has led to increased soil erosion and sediment loads in rivers. Increased suspended fine sediment in water reduces visual clarity for humans and aquatic animals and reduces penetration of photosynthetically available radiation to aquatic plants. To mitigate fine-sediment impacts in rivers, catchment-wide approaches to reducing soil erosion are required. Targeting soil conservation for reducing sediment loads in rivers is possible through existing models; however, relationships between sediment loads and sediment-related attributes of water that affect both ecology and human uses of water are poorly understood. We present methods for relating sediment loads to sediment concentration, visual clarity, and euphotic depth. The methods require upwards of twenty concurrent samples of sediment concentration, visual clarity, and euphotic depth at a river site where discharge is measured continuously. The sediment-related attributes are related to sediment concentration through regressions. When sediment loads are reduced by soil conservation action, percentiles of sediment concentration are necessarily reduced, and the corresponding percentiles of visual clarity and euphotic depth are increased. The approach is demonstrated on the Wairua River in the Northland region of New Zealand. For this river we show that visual clarity would increase relatively by approximately 1.4 times the relative reduction of sediment load. Median visual clarity would increase from 0.75 m to 1.25 m (making the river more often suitable for swimming) after a sediment load reduction of 50% associated with widespread soil conservation on pastoral land. Likewise euphotic depth would increase relatively by approximately 0.7 times the relative reduction of sediment load, and the median euphotic depth would increase from 1.5 m to 2.0 m with a 50% sediment load reduction.

1. Introduction

There is widespread recognition of the extent and significance of changes in land use and land cover on river ecosystems worldwide (Allan, 2004; Jones et al., 2012; Kemp et al., 2011; Wood and Armitage,

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