Sediment dynamics and channel change in the Upper Waipaoa River, New Zealand, from Lidar differencing, 2005 to 2023

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# ABSTRACT

The Waipaoa River, in New Zealand’s Tairāwhiti/Gisborne region, is well known for its spectacular rates of landscape erosion, high sediment load and consequent rapid aggradation of the riverbed level in historic times (Marden et al 2008; Gomez & Rosser 2018). Reforestation of the upper Waipaoa River catchment since 1960 has reduced sediment loads from mass movement erosion in the highly erodible terrain (Marden et al 2014), and since the mid-1990’s has led to a reduction in the rate of bed level rise (aggradation) in the headwater reaches (Peacock & Marden 2019). Analysis of cross section data in the upper Waipaoa River reaches suggest that the Waipaoa mainstem may be now showing signs of incising through these aggradational deposits.

Gisborne District Council acquired airborne LiDAR data for the whole Gisborne Region in 2019/2020, and for parts of the Waipaoa River catchment in 2005. LiDAR was also acquired following Cyclone Gabrielle in February 2023. LiDAR differencing was used to derive the change in elevation between the surfaces. This allowed us to quantify changes in riverbed elevation and channel morphology between 2005 and 2019 for the upper Waipaoa River channel, and estimate rates of net sediment transfer through the study reaches. We also present preliminary results of the 2019 to 2023 LiDAR differencing, including the impacts of Cyclone Gabrielle.

Elevation changes in the upper Waipaoa and Te Weraroa rivers derived from LiDAR differencing show that channel incision is now the dominant trend in these reaches. Channel incision was initiated in the headwater reaches and proceeded downstream at least as far as the confluence with the Waingaromia River, near Whatatutu. This suggests that the river is responding to the reduction in sediment supply due to erosion control efforts in the headwater catchments, and that reforestation has been successful at reducing the sediment supply to the Waipaoa River. The implication of the transition from aggradation to degradation in the headwater reaches is that the dominant sediment source has switched from hillslope flux to sediment stored in beds of rivers and alluvial fans, plus the sediment supplied from badass gullies that are too big to be controlled by reforestation.

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