Geomorphometric delineation of floodplains and terraces from slope and channel relief thresholds

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EP53C-0978

We have developed a new, efficient, and fully automated method for delineating floodplains and fluvial terraces from high-resolution topographic data.

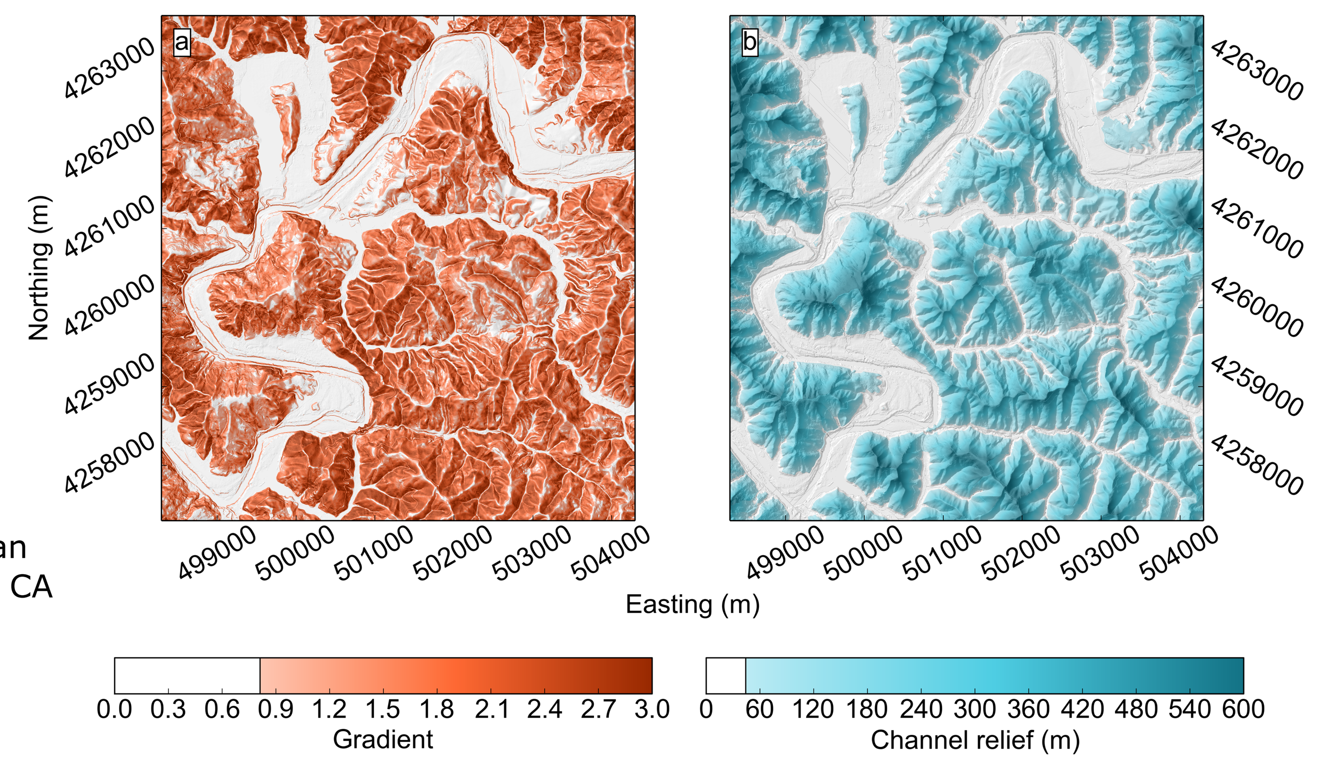
1 INTRODUCTION

Fluvial terraces and floodplains are important indicators of geomorphic processes. Understanding the location and morphology of terrace and floodplain features can provide information about lateral and vertical channel migration; sediment routing; and flood forecasting and response.

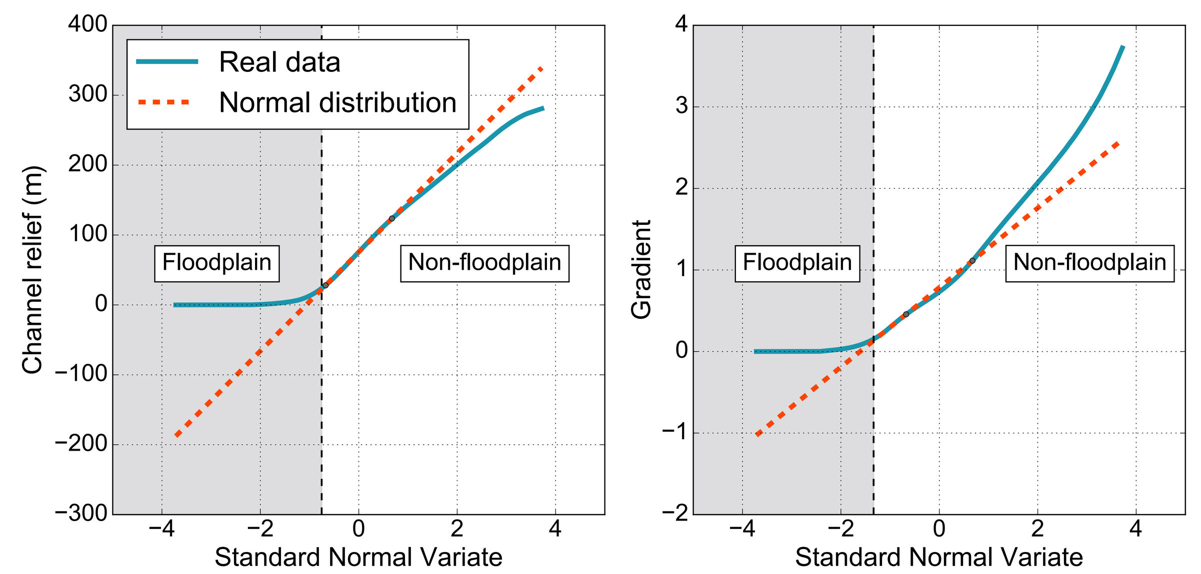
Traditional methods of identifying floodplain and terrace features rely either on intensive modelling studies (e.g. Noman et al., 2001), or extensive field campaigns. With the introduction of high-resolution lidar-derived digital elevation models (DEMs), new methods have been developed that can identify these features from topography (e.g. Stout and Belmont, 2013; Manfreda et al., 2014). However, these methods are generally semi-automated and require additional data sources. Here we present a new, efficient, and fully automated method for identifying floodplain and terrace features from high-resolution DEMs.

2 METHOD

We identify floodplains and terrace pixels based on thresholds of a) local gradient, and b) relief relative to the nearest channel.



We calculate the thresholds automatically from the DEM using quantile-quantile plots (e.g. Passalacqua et al., 2012).



3 FLOODPLAINS

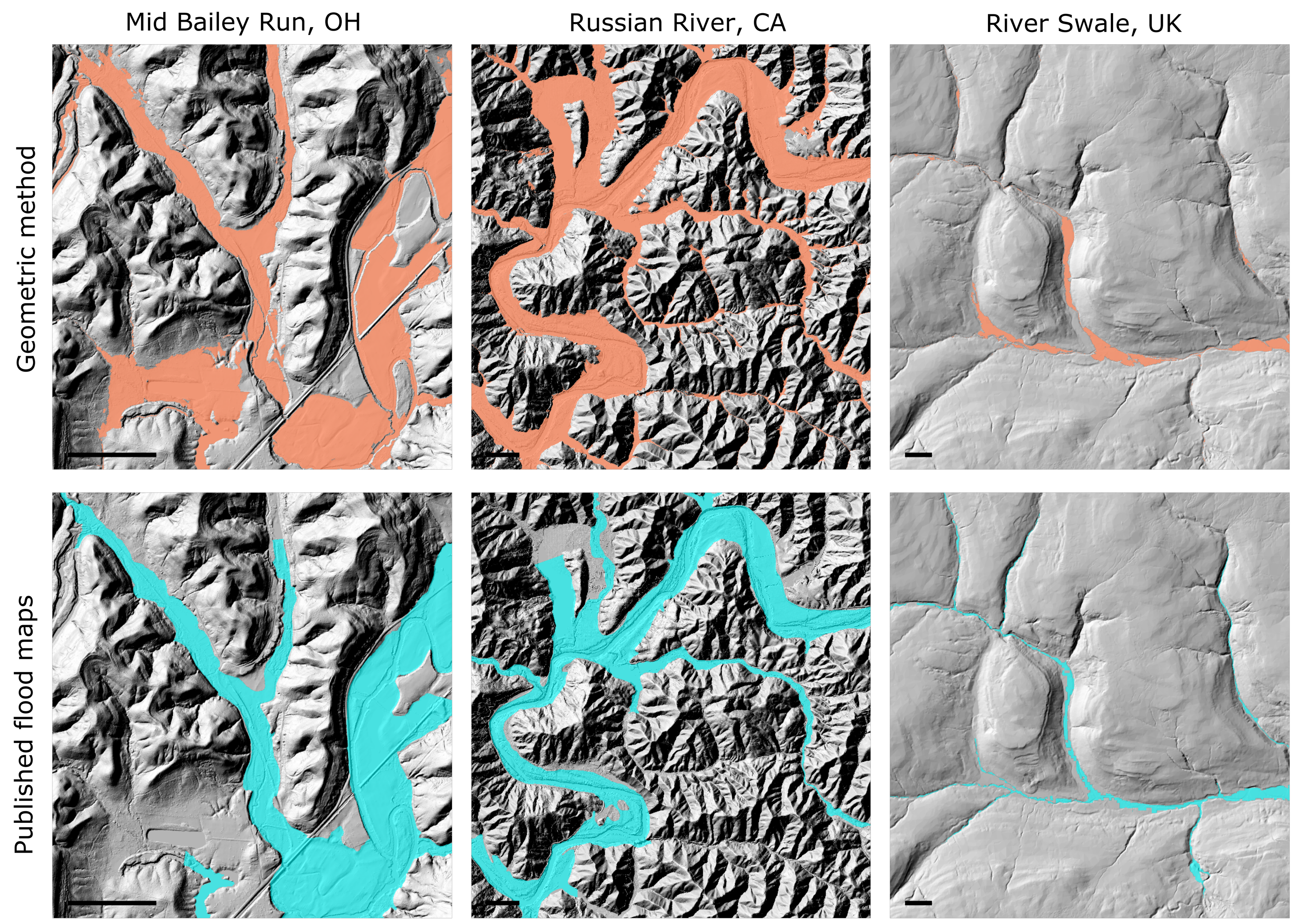
In order to validate our geomorphic floodplain extraction algorithm we tested the output against published flood maps from three field sites: Mid Bailey Run (OH), the Russian River (CA), and the River Swale (UK). The flood maps were produced by the Federal Emergency Management Agency (FEMA) for the US sites, and by the Environment Agency for the UK site. In each case we classified the published flood map to represent the 0.1% annual chance of flooding. We analysed the reliability (*r*) and sensitivity (*s*) of our method compared to the published maps.

$$r = \frac{\Sigma TP}{\Sigma TP + \Sigma FP}$$

$$s = \frac{\Sigma TP}{\Sigma TP + \Sigma FN}$$

TP = true positives
FP = false positives
FN = false negatives

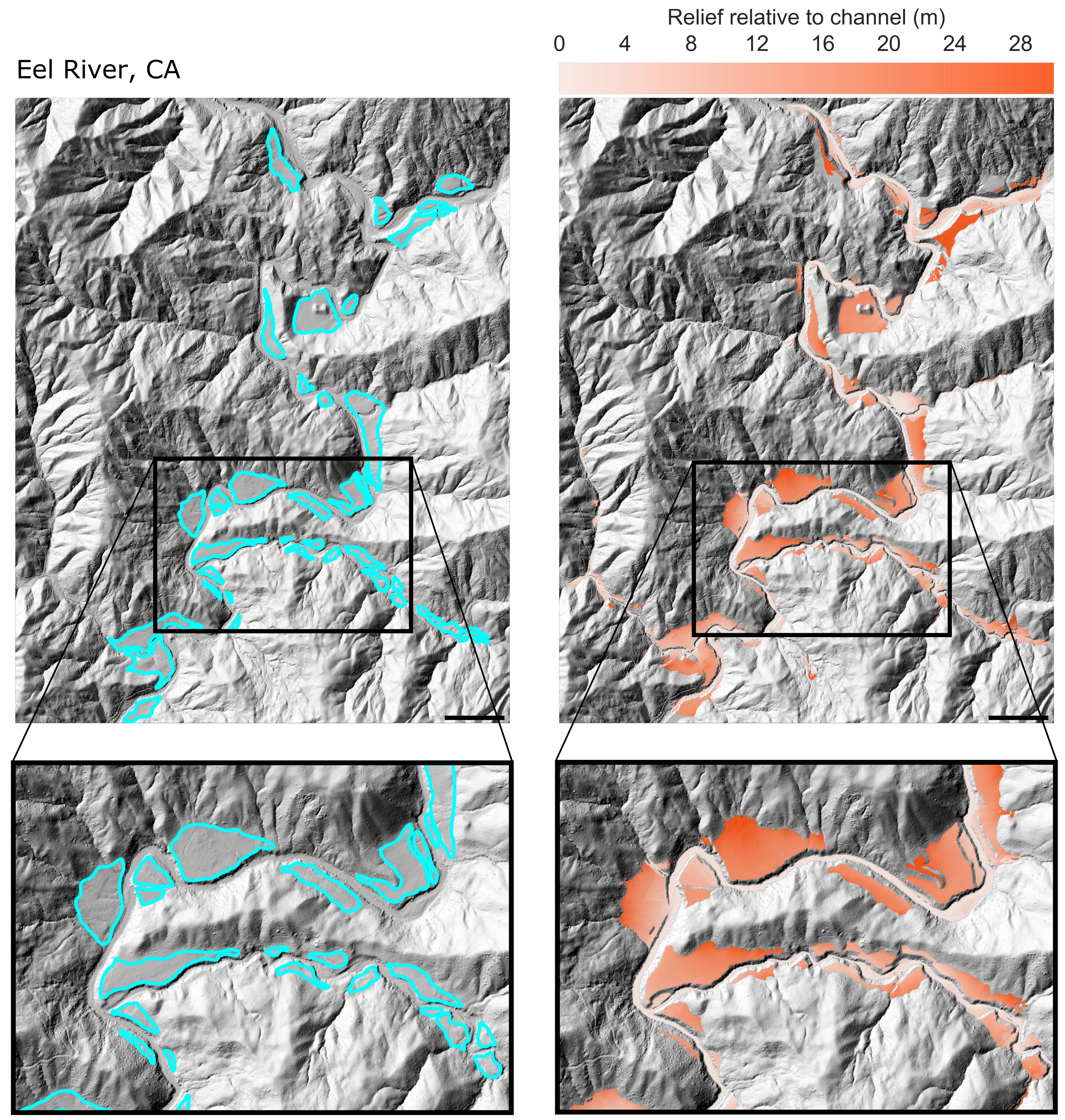
Field site	Grid resolution (m)	r	s
Mid Bailey Run, OH	1	0.73	0.76
	10	0.77	0.80
Russian River, CA	1	0.74	0.97
	10	0.70	0.96
River Swale, UK	5	0.84	0.65



Comparison of floodplains extracted through the geometric method (top row) with published flood risk maps produced by FEMA and the EA for three sites (bottom row). The geometric method selects some areas which are incomplete on the flood risk maps and extends up into all tributaries. The scale bar on each figure is 500 m.

4 TERRACES

We can also use our geometric algorithm to identify fluvial terrace surfaces of varying elevations in the landscape. In order to test the ability of our method to correctly select terrace surfaces we manually delineated terraces in the South Fork Eel River, California, constrained by field mapping carried out by Seidl and Dietrich (1992).



Shaded relief maps of the Eel River, CA, showing comparison of the field mapped terrace surfaces (left) with terraces predicted from our geometric method (right). The predicted terraces are coloured based on relief relative to the nearest channel. 86% of terrace pixels were correctly identified by our algorithm.

REFERENCES

Manfreda, S., Nardi, F., Samela, C., Grimaldi, S., Taramasso, A.C., Roth, G., and Sole, A (2014) Investigation on the use of geomorphic approaches for the delineation of flood prone areas, *Journal of Hydrology*
Noman, N.S., Nelson, E.J., and Zundel, A.K. (2001) Review of Automated Floodplain Delineation from Digital Terrain Models, *Journal of Water Resources Planning and Management*
Passalacqua, P., Do Trung, T., Foufoula-Georgiou, E., Sapiro, G., and Dietrich, W.E. (2012) A geometric framework for channel network extraction from lidar: Nonlinear diffusion and geodesic paths, *JGR-Earth Surface*
Seidl, M.A. and Dietrich, W.E. (1992) The problem of channel erosion into bedrock, *Catena Supplement*
Stout, J.C. and Belmont, P. (2014) TerEx Toolbox for semi-automated selection of fluvial terrace and floodplain features from lidar, *ESPL*

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