

# UC Davis

## UC Davis Previously Published Works

### Title

Supplementary material to "Analyzing bed and width oscillations in a self-maintained gravel-cobble bedded river using geomorphic covariance structures"

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1 **Supplemental materials**

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3 **1 Introduction Supplements**

4 None.

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6 **2 Experimental Design Supplements**

7 None.

8 **3 Study Area Supplements**

9 None.

10 **4 Methods Supplements**

11 *4.1 Physical data information*

12 Topographic data came from airborne LiDAR scanning (excluding Timbuctoo Bend) at  
13 flows ~ 10–16% of bankfull discharge plus thorough in-water mapping using total stations and  
14 RTK GPSs as well as boat-based bathymetry mapping with a single-beam echosounder  
15 coupled to an RTK GPS and professional hydrographic software (Pasternack, 2009). Essential  
16 quantitative information describing topographic and bathymetric data are reported in the box  
17 below.

18

Attribute	Description
Years of data collection	June–December 2006
Bathymetric Resolution	Within the 24.9 cms inundation area, points were collected along longitudinal lines, cross-sections, and on ~3x3 m grids, yielding an average grid point spacing of 28 pts/100m <sup>2</sup> .
Topographic Resolution	Outside the 880 cfs inundation area, points were collected on a grid, yielding an average grid point spacing of 11.4 pts/100 m <sup>2</sup> .
Bathymetric Accuracy	Comparison of overlapping echosounder and total station survey points yielded observed differences of 0.07-0.09 m.
Topographic	Regular total station control point checks yielded accuracies of 0.009 m -

Accuracy	0.018 m.
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20 *4.2 2D hydrodynamic modeling details*

21 The surface-water modeling system (SMS; Aquaveo, LLC, Provo, UT) user interface and  
 22 sedimentation and river hydraulics–two-dimensional algorithm (Lai, 2008) were used to produce  
 23 these 2D hydrodynamic models of the Lower Yuba River (LYR) with internodal mesh spacing of  
 24 0.91–1.5 m according to the procedures of Pasternack (2011). SRH-2D is a 2D finite-volume  
 25 model that solves the Saint Venant equations for depth and velocity at each computational  
 26 node, and supports a hybrid structured-unstructured mesh that can use quadrilateral and  
 27 triangular elements of any size, thus allowing for mesh detail comparable to finite-element  
 28 models. A notable aspect of the modeling was the use of spatially distributed and stage-  
 29 dependent vegetated boundary roughness (Katul et al., 2002; Casas et al., 2010). Model  
 30 simulations were comprehensively validated for flows ranging over an order of magnitude of  
 31 discharge (0.1 to 1.0 times bankfull) using three approaches: (i) traditional cross-sectional  
 32 validation methods, (ii) comparison of LiDAR-derived water surface returns against modeled  
 33 water surface elevations, and (iii) Lagrangian particle tracking with RTK GPS to assess the  
 34 velocity vectors (Barker, 2011). Note that the study reach was originally a subset model domain  
 35 of the LYR, while model performance is reported for the entire river. Model set-up and  
 36 performance details are reported in the box below:

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Attribute	Description
Computational Mesh Resolution	For Q<141.5 cms, 1 m internodal spacing. As flow goes overbank, cell size increases to 1.8 m. For flows >597.5 cms, different mesh has ~3 m internodal spacing.
Discharge Range of Model	8.5 to 3126 cms
Downstream WSE data/model source	Direct observation of WSE at a limited number of flows <~339.8 cms. For higher flows the downstream WSE was taken as the upstream WSE from the HR model

	at that flow.
River roughness specification	Because the scientific literature reports no consistent variation of Manning's n as a function of stage-dependent relative roughness or the whole wetted area of a river (i.e., roughness/depth), a constant value was used for all unvegetated sediment with 0.03 for TBR (based on preliminary testing in 2008-2009). For vegetated terrain, the Casas et al. (2010) algorithm was used to obtain a spatially distributed, flow-dependent surface roughness for each model cell on the basis of the ratio of local canopy height to flow depth.
Eddy viscosity specification	Parabolic turbulence closure with an eddy velocity that scales with depth, shear velocity, and a coefficient ( $e_0$ ) that can be selected between ~0.05 to 0.8 based on expert knowledge and local data indicators. $Q < 283.2$ cms: $e_0 = 0.6$ $Q \geq 283.2$ cms: $e_0 = 0.1$
Hydraulic Validation Range	Point observations of WSE were primarily collected at 880 cfs, with some observations during higher flows, but not systematically analyzed. Velocity observations were collected for flows ranging from 15-141.9 cms. Cross-sectional validation data collected at 22.65 cms.
Model mass conservation (Calculated vs Given Q)	0.001 to 1.98 %
WSE prediction accuracy	At 24.9 cms there are 197 observations. Mean raw deviation is -0.002 m. 27% of deviations within 0.031 m, 49% of deviations within 0.0762 m, 70% within 0.15 m, 94% within 0.31 m'. These results are better than the inherent uncertainty in LiDAR obtained topographic and water surface elevations.
Depth prediction accuracy	From cross-sectional surveys, predicted vs observed depths yielded a correlation (r) of 0.81.
Velocity magnitude prediction accuracy	5780 observations yielding a scatter plot correlation (r) of 0.887. Median error of 16%. Percent error metrics include all velocities (including $V < 0.91$ m/s, which tends to have high error percents) yielding a rigorous standard of reporting.
Velocity direction prediction accuracy	5780 observations yielding a scatter plot correlation (r) of 0.892. Median error of 4%. Mean error of 6%. 61% of deviations within 5 deg and 86% of deviations within 10 deg.

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39           Using the workflow of Pasternack (2011), SRH-2D model outputs were processed to  
40 produce rasters of depth and velocity within the wetted area for each discharge. The first task  
41 involved creating the wetted area polygon for each discharge. To do this, depth results were first

42 converted to triangular irregular networks (TIN) and then to a series of 0.9144-m hydraulic raster  
43 files. Depth cells greater than zero were used to create a wetted area boundary applied to all  
44 subsequent hydraulic rasters. Next, the SRH-2D hydraulic outputs for depth and depth-  
45 averaged velocity were converted from point to TIN to raster files within ArcGIS 10.1 staying  
46 within the wetted area for each discharge. The complete dataset was a series of 0.9144-m  
47 resolution hydraulics rasters derived from SRH-2D hydrodynamic flow simulations at the  
48 following discharges: 8.5, 9.9, 11.3, 12.7, 15.0, 17.0, 17.6, 19.8, 22.7, 24.9, 26.3, 28.3, 36.8,  
49 42.5, 48.1, 56.6, 70.8, 85.0, 113.3, 141.6, 212.4, 283.2, 424.8, 597.5, 849.5, 1195.0, 2389.9,  
50 and 3126.2 m<sup>3</sup>/s.

51 Despite best efforts with modern technology and scientific methods, the 2D models used  
52 in this study have uncertainties and errors. Previously it has been reported that 2D models tend  
53 to underrepresent the range of hydraulic heterogeneity that likely exists due to insufficient  
54 topographic detail and overly efficient lateral transfer of momentum (Pasternack et al., 2004;  
55 MacWilliams et al., 2006). For this study those deficiencies result in a conservative outcome,  
56 such that there could be more fine details to the sizes and shapes of peak velocity patches than  
57 what is revealed herein. Overall, this study involves model-based scientific exploration with  
58 every effort made to match reality at near-census resolution over tens of km of river length given  
59 current technology, but recognizing that current models do have uncertainties.

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